14th INTERNATIONAL CONFERENCE

DYNAMICAL SYSTEMS THEORY AND APPLICATIONS

ŁÓDŹ, DECEMBER 11-14, 2017

ABSTRACTS

EDITORS:

J. AWREJCEWICZ
M. KAŹMIERCZAK
J. MROZOWSKI
P. OLEJNIK

DSTA 2017

14th Conference
on
DYNAMICAL SYSTEMS
Theory and Applications
DSTA 2017

ABSTRACTS

EDITORS

J. Awrejcewicz, M. Kaźmierczak, J. Mrozowski, P. Olejnik

Łódź, December 11-14, 2017

POLAND

ORGANIZING COMMITTEE

Lodz University of Technology, Faculty of Mechanical Engineering
Department of Automation, Biomechanics and Mechatronics
1/15 Stefanowski Str., 90-924 Łódź, Poland
Phone: +48 42 631-22-25, Fax: +48 42 631-24-89
http://abm.p.lodz.pl

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SCIENTIFIC COMMITTEE

PREFACE

This is the fourteen time when the conference "Dynamical Systems – Theory and Applications" gathers a numerous group of outstanding scientists and engineers, who deal with widely understood problems of theoretical and applied dynamics.

Organization of the conference would not have been possible without a great effort of the staff of the Department of Automation, Biomechanics and Mechatronics. The patronage over the conference has been taken by the Committee of Mechanics of the Polish Academy of Sciences and the Ministry of Science and Higher Education.

It is a great pleasure that our invitation has been accepted by so many people, including good colleagues and friends as well as a large group of researchers and scientists, who decided to participate in the conference for the first time. With proud and satisfaction we welcome nearly 250 persons from 38 countries all over the world. They decided to share the results of their research and many years experiences in the discipline of dynamical systems by submitting many very interesting papers.

This booklet contains a collection of 375 abstracts, which have gained the acceptance of referees and have been qualified for publication in the conference proceedings. Included abstracts belong to the following topics:

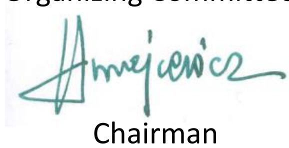
- asymptotic methods in nonlinear dynamics,
- bifurcation and chaos in dynamical systems,
- optimization problems in applied sciences
- control in dynamical systems,
- dynamics in life sciences and bioengineering,
- engineering systems and differential equations,
- non-smooth systems
- mathematical approaches to dynamical systems
- original numerical methods of vibration analysis,
- stability of dynamical systems,
- vibrations of lumped and continuous systems,
- experimental/industrial studies,
- mechatronics.

Our previous experience shows that an extensive thematic scope comprising dynamical systems stimulates a wide exchange of opinions among researchers dealing with different branches of dynamics. We think that vivid discussions will influence positively the creativity and will result in effective solutions of many problems of dynamical systems in mechanics and physics, both in terms of theory and applications.

Every two years we extend scope and recognition of the conference. This time, we have opened 6 special sessions gathering 62 presentations.

We do hope that DSTA 2017 will contribute to the same extent as all the previous conferences to establishing new and tightening the already existing relations and scientific and technological co-operation between both Polish and foreign institutions.

On behalf of both Scientific and
Organizing Committees



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KEYNOTE LECTURES

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: BIF137 (keynote talk)

Nonlinear damping: modelling and experiments

Marco Amabili

Abstract: Experimental data clearly show a strong and nonlinear dependence of damping from the maximum vibration amplitude reached in a vibration cycle for macro and nano structural elements. This dependence takes a completely different level with respect to the frequency shift of resonances due to geometric nonlinearity, which is commonly of 10 to 25 % at most for common structural elements. Experiments show that a damping value several times larger than the linear one must be expected for vibration of thin plates when the vibration amplitude is about twice the thickness. This is a huge change. The present study derives the nonlinear damping from viscoelasticity. The damping model obtained is nonlinear and the parameters are identified from experiments. Numerical results are compared to experimental forced vibration responses measured for large-amplitude vibrations of several different continuous structural elements.

1) Marco Amabili, Professor: McGill University, Dept Mechanical Eng, 817 Sherbrooke Street West, CANADA (marco.amabili@mcgill.ca), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: CON327 (keynote talk)

Variable structure systems with sliding modes

Andrzej Bartoszewicz

Abstract: The main purpose of control engineering is to steer the regulated plant in such a way that it operates in a required manner. The desirable performance of the plant should be obtained despite the unpredictable influence of the environment on all parts of the control system, including the plant itself, and no matter if the system designer knows precisely all the parameters of the plant. Even though the parameters may change with time, load and external conditions, still the system should preserve its nominal properties and ensure the required behaviour of the plant. In other words, the principal objective of control engineering is to design systems which are robust with respect to external disturbances and modelling uncertainty. This objective may be very well achieved using the sliding mode technique which is the main subject of this talk. The theory of variable structure systems (VSS) with sliding modes is currently one of the most significant research topics within the control engineering domain. Moreover, recently a number of important applications of the theory have also been reported. Therefore, this paper presents a tutorial introduction to the theory of sliding mode control. Important results on the chattering attenuation, reaching phase elimination, finite time convergence and optimal sliding surface design are discussed.

[1)] Andrzej Bartoszewicz, Professor: Institute of Automatic Control, Lodz University of Technology, 18/22 Stefanowskiego St., 90-924 Lodz, POLAND (andrzej.bartoszewicz@p.lodz.pl), the author presented this contribution at the conference.

14th INTERNATIONAL CONFERENCE
Dynamical Systems - Theory and Applications
December 11-14, 2017. Lodz, POLAND.

paper id: MAT353 (keynote talk)

Some developments in Symbolic Computational Dynamics

Matthew Cartmell, Niloufar Motazedi

Abstract: Research into Symbolic Computational Dynamics (SCD) is based on the idea that an approximate analytical solution can usually be found for a reduced order model, given certain conditions and constraints, and that it can accurately represent the dynamics of the problem - within the confines of the approximations. Ease of application of these methods is conventionally limited by the scale of algebraic manipulation needed for nonlinear problems involving more than a few coupled coordinates. They have therefore been excellent candidates for semi-automation through symbolic computation. The motivation behind our research is that there is a lot of useful information that is naturally lost when doing complicated mathematics. One example is due to the on-going processes of algebraic simplification. Another relates to the different mathematical-physical reasoning processes behind the small perturbation parameter, as it appears and then re-appears throughout an analysis. A third is the way in which we define relative strengths of physically based terms when they are first introduced, and the repercussions of getting this wrong, or at least partially wrong. So, the long-term goal has been to create a symbolic computational process which efficiently applies a semi-automated asymptotic method in a correct, consistent, and adaptable manner, and which also provides a facility for the identification and retention of all the mathematical-physical information generated that can then be represented back to the user in an easy-to-interpret visualisation.

[1] Matthew Cartmell, Ph.D.: Department of Mechanical and Aerospace Engineering, University of Strathclyde, Glasgow, G1 1XJ, SCOTLAND (matthew.cartmell@strath.ac.uk), the author presented this contribution at the conference.

[2] Niloufar Motazedi, M.Sc. (Ph.D. student): Department of Mechanical Engineering, University of Sheffield, S1 3JD, ENGLAND (n.motazedi@sheffield.ac.uk).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: MAT341 (keynote talk)

On the acoustic metamaterial with negative effective mass

Livija Cveticanin

Abstract: Recently a significant attention is directed toward so called 'acoustic metamaterials' which have large similarity with already known 'electromagnetic metamaterials' which are applied for elimination of the electromagnetic waves. The stop of electromagnetic waves is realized with the negative refractive index: negative permittivity and permeability. Motivated by the mathematical analogy between acoustic and electromagnetic waves the acoustic metamaterials are introduced. It was asked the material to have negative mass and Young's modulus. To obtain the negative mass the artificial material, usually composite, has to be designed. The basic unit is a vibration absorber which consists of a lumped mass attached with a spring to the basic mechanical system. The purpose of the unit is to give a band gap where some frequencies of acoustic wave are stopped. We investigated the nonlinear mass-in-mass unit excited with any periodic force. Mathematical model of the motion is a system of two coupled strong nonlinear and nonhomogeneous second order differential equations. The solution of equations is assumed in the form of the Ateb periodic function. The frequency of vibration is obtained as the function of the parameters of the excitation force. The effective mass of the system is also determined. Regions of negative effective mass are calculated. For these values motion of the forced mass stops. It is concluded that the stop frequency gaps are much wider for the nonlinear than for the linear system. Based on the obtained parameter values the acoustic metamaterial could be designed.

[1)] Livija Cveticanin, Professor: Obuda University, Nepszinhaz u. 7, Budapest, Hungary, Faculty of Technical Sciences, Trg D. Obradovica 6, Novi Sad,, SERBIA (cveticanin@uns.ac.rs), the author presented this contribution at the conference.

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: VIB342 (keynote talk)

Tailoring of hysteresis across different material scales

Walter Lacarbonara

Abstract: Hysteresis is discussed as a multi-scale material feature that can strongly affect the linear and nonlinear dynamic performance of a structure. It is shown that the hysteresis exhibited by assemblies of short wire ropes can be tailored via a synergistic use of different dissipation mechanisms (inter-wire frictional sliding, phase transformations) combined with geometric nonlinearities. The blend of material and geometric nonlinearities is a powerful and promising way to design new advantageous types of hysteretic responses in macro- or micro-scale devices and structures. Hysteretic vibration absorbers are examples of such systems with superior performance and stability when the control of earthquake- or flutter-induced oscillations is sought in multi-story buildings or suspension bridges. It is shown that the design of these nonlinear absorbers can be effectively tackled by the use of asymptotic methods and differential evolutionary optimization algorithms. Indeed, moving from macro-scale structures towards much smaller material scales, carbon nanotubes in nanocomposites are shown to dissipate energy through stick-slip with the polymer chains. The hysteresis of these materials can be largely modified and optimized by adjusting the micro-structural constitutive features. Recent experimental and modeling efforts are discussed in the context of new directions in material design and dynamic behavior of nanocomposites.

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1) Walter Lacarbonara, Professor: Sapienza University of Rome, via Eudossiana 18 - 00184 Rome, ITALY (walter.lacarbonara@uniroma1.it>), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: BIF318 (keynote talk)

Stochastic bifurcations of discontinuous and impacting nonlinear systems

Sayan Gupta, Pankaj Kumar, Sadagopan Narayanan

Abstract: Stochastic bifurcations of discontinuous nonlinear dynamical systems, such as a Duffing Van der Pol(DVDP) oscillator with unilateral or bilateral rigid constraints subjected to white noise excitation are analyzed which are characterized either as dynamical D-bifurcations or phenomenological P- bifurcations. D-bifurcations are accompanied by abrupt changes in the topology of the phase portrait and are quantified in terms of the largest Lyapunov exponent (LLE) which is computed using the Nordmark-Poincare map in conjunction with Wedig's algorithm to bypass the difficulties associated with the discontinuity in the governing equations.P-bifurcation is deemed to occur when there is a change in the topology of the associated probabilistic structure of the state variables. The joint probability density function of the state variables is computed from the corresponding Fokker-Planck(FP) equation after applying a suitable non-smooth variable transformation and mapping the problem into a continuous phase plane. The finite element method is used to solve the corresponding FP equation. A newly developed quantitative measure has been developed to identify the onset of P-bifurcations. A global parametric study has been carried out to identify the stochastic stability regimes for both the single sided and double sided vibro-impact DVDP oscillator. Numerical examples are presented that provide insights into the dynamics of these oscillators.

[1] Sayan Gupta, Ph.D.: Indian Institute of Technology Madras, IIT Madras, Chennai-600036, INDIA (sayan@iitm.ac.in).

[2] Pankaj Kumar, Ph.D.: Indian Institute of Technology Madras, IIT Madras, Chennai-600036, INDIA (pankajiit1@yahoo.co.in).

[3] Sadagopan Narayanan, Professor: Indian Institute of Information Technology (Design and Manufacturing), Kancheepuram, Melakottaiyur, Off Vandalur-Kelambakkam Road, Chennai, 600127, INDIA (drs.narayanan@gmail.com), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: CON380 (keynote talk)

Emergent behavior, synchronization and control

Henk Nijmeijer

Abstract: Synchronization is a subject apparently first discussed by the Dutch scientist Christiaan Huygens around 1650. Today the subject is seen in a large number of biological and engineering applications. In some cases this is well understood, but in many cases, particularly in case a large network of systems is involved, this is much less the case. The purpose of this talk is to review the basics of network synchronization and to develop an understanding how cooperative behavior can develop in networks. Examples from biology and engineering (including Huygens's pendulum clocks and vehicle platoons) will enlighten the presentation.

[1)] Henk Nijmeijer, Professor: Department of Mechanical Engineering, Dynamics & Control Group Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, THE NETHERLANDS (h.nijmeijer@tue.nl), the author presented this contribution at the conference.

SPECIAL SESSION 1

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: MAT313

Damping and dissipation relations

Adnan Akay

Abstract: Damping generally refers to loss of kinetic energy of mechanical oscillations or waves and is often measured as a reduction of amplitude at the observation points. Energy “lost” may be dissipated or it may be transported to other spatial or frequency domains before it is eventually dissipated. Dissipation describes the mechanism by which work on a medium is irreversibly converted to heat by increasing the energy of thermalized motion of the molecules in the medium. During dissipation energy is transferred from few to many degrees of freedom and from larger length and time scales to molecular scales. The relation between damping and dissipation can be illustrated by the damped motion of a massless piston sliding without friction in an adiabatic cylinder. The results have shown existence of two time scales for the damped motion of the piston. One is associated with the relaxation of piston to mechanical equilibrium. The other is thermal equilibrium reached over a longer time scale at the end of which the piston still oscillates around its equilibrium position as a Brownian particle in accordance with the fluctuation-dissipation theorem. In this presentation, the evolution of piston motion will be reviewed and the relationship between damping and dissipation will be illustrated.

[1)] Adnan Akay, Professor: Bilkent University, 06800 Ankara, TURKEY (akay@bilkent.edu.tr), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

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December 11-14, 2017. Lodz, POLAND.

paper id: EXP227

Experimental observations on rotor-to-stator contact

Oliver Alber, Ulrich Ehehalt, Richard Markert, Georg Wegener

Abstract: If a flexible rotor contacts its stator, the nonlinearities induced by contact may result in a great variety of vibration phenomena. This article presents experimental results gained at test rigs. Fundamental phenomena are analyzed and discussed. First, a modular kit for rotordynamic experiments is described. The kit allows customizing the properties of rotor and stator that are relevant for the dynamic behavior. The system allows to specify target values for natural frequencies, modal damping, clearance width, contact friction and others. Basic configurations based on this kit were used to study the influence of masses, stiffness and damping of both rotor and stator, contact friction and misalignment of the stator. Extensions of the kit allowed the experimental investigation of systems with a multitude of natural frequencies, highly flexible stators and even drop down and overload incidents of rotor supported by active magnetic bearings. The article also analyzes and explains the various vibration phenomena resulting from contact. In particular, resonance diagrams from run-up and run-down processes, orbit plots and frequency spectra are utilized to discuss the dynamic characteristics. The motion types encountered include not only rotor synchronous motions, but also multi frequency motions (forward and backward whirl), sub- and super-harmonic motions, motions including sidebands as well as chaotic motions. Emphasis is put on sensitive system parameters and on existence and stability of the various types of motion.

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1) Oliver Alber, Ph.D.: MTU Aero Engines AG, Dachauer Str. 665, 80995 Muenchen, GERMANY (oliver.alber@gmx.de).

2) Ulrich Ehehalt, Ph.D.: Siemens AG, Rheinstr. 100, 45479 Mülheim, GERMANY (u.ehehalt@gmx.de).

3) Richard Markert, Professor: TU Darmstadt, Otto-Berndt-Straße 2, 64287 Darmstadt, GERMANY (markert@ad.tu-darmstadt.de), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

4) Georg Wegener, Professor: Hochschule Aschaffenburg - University of Applied Sciences, Wuerzburger Str. 45, 63743 Aschaffenburg, GERMANY (georg.wegener@h-ab.de).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: STA257

Stability of linearized non-conservative systems: The role of the damping matrix

Fadi Dohnal

Abstract: Many problems in mechanical engineering can be described by a linearized second order system of differential equations, with coefficient matrices corresponding to inertia, damping, gyroscopic, stiffness and circulatory forces. The properties of these matrices determine the underlying eigenvalue problem. Their stability behaviour may strongly depend on the structure on the damping matrix. For example circulatory systems may lead to self-excitation and are very sensitive to damping. Recent results from the Dynamics and Vibration Group led by Prof. Hagedorn on non-conservative systems are shortly discussed, especially findings for infinitesimally small, incomplete and indefinite damping matrices.

[1)] Fadi Dohnal, Associate Professor: Private University for Health Sciences, Medical Informatics and Technology (UMIT), Amlacher Str. 10, 9900 Lienz, AUSTRIA (fadi.dohnal@umit.at), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

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paper id: CON86

Nonlinear dynamics and control applied to an aircraft in a longitudinal flight considering gusts of wind in flight

Guilherme Pacheco dos Santos, Jose Manoel Balthazar, Frederic Conrad Janzen, Rodrigo Tumolin Rocha, Airton Nabarrete, Angelo Marcelo Tusset

Abstract: Modern high-performance aircrafts operate regularly in-flight regimes where system's nonlinearities influence directly into their dynamic response. This paper considers the study of a fighter aircraft which operates in high angles of attack of the wing. The mathematical modelling and numerical simulations were developed, becoming at a system of nonlinear differential equations that represent the dynamics of an aircraft in longitudinal flight, considering the effect of wind speed variation due to atmospheric turbulence in the dynamic response of the aircraft. The dynamic system consists in a two-degrees-of-freedom coordinate for the aircraft and a single-degree-of-freedom for the variation of wind gusts. To understand the system we performed the 0-1 test to determine if the system is chaotic or periodic, performed in relation to the speed and angle of attack of the aircraft F-8 "Crusader". The control is proposed having as control parameter the tail deflection angle and designed using the control method of State Dependent Riccati Equations (SDRE) with the purpose of stabilizing oscillations of angle of attack of the wing, considering critical regions of aircraft behaviour. Numerical simulations demonstrated the effectiveness of the proposed control strategy, where controller was able to respond quickly to retrieve the aircraft Keywords: Longitudinal Nonlinear Flight Dynamics, Wind Gusts, SDRE Control,

[1] Guilherme Pacheco dos Santos, B.A.: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (guipacheco37@gmail.com).

[2] Jose Manoel Balthazar, Professor: UNESP/ITA, Aeronautics Technological Institute (ITA), São José dos Campos, SP, BRAZIL (jmbaltha@gmail.com), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[3] Frederic Conrad Janzen, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (fcjanzen@utfpr.edu.br).

[4] Rodrigo Tumolin Rocha, Ph.D.: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (digao.rocha@gmail.com).

[5] Airton Nabarrete, Assistant Professor: ITA, Aeronautics Technological Institute (ITA), São José dos Campos, SP, BRAZIL (: profnabarrete@gmail.com).

[6] Angelo Marcelo Tusset, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (tusset@utfpr.edu.br).

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paper id: MAT291

Modelling of rigid body dynamics with spatial frictional contacts

Grzegorz Kudra, Michał Szewc, Michał Ludwicki, Krzysztof Witkowski, Jan Awrejcewicz

Abstract: The work focuses on a special class of reduced models of resultant friction forces coupled with rolling resistance for finite size of contact area and their applications in modelling and effective numerical simulations of spatial rigid body dynamics. The contact models are based on on the integral expressions assuming fully developed sliding and Coulomb's friction law at each element of a finite contact zone. The integral models are then approximated by special functions, more effective in numerical simulations. The contact models are applied in different configurations of a spatial pendulum with Cardan joints, equipped with a special movable obstacle situated below the pendulum and limiting the space of admissible positions of the system. The models are tested numerically during investigations of bifurcation dynamics of the pendulum as well as a special experimental rig is prepared for their experimental validation.

1) Grzegorz Kudra, Assistant Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (grzegorz.kudra@p.lodz.pl).

2) Michał Szewc, M.Sc. (Ph.D. student): Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (michu.szewc@gmail.com), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

3) Michał Ludwicki, Assistant Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (michal.ludwicki@p.lodz.pl).

4) Krzysztof Witkowski, M.Sc. (Ph.D. student): Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (krzys_wit@wp.pl).

5) Jan Awrejcewicz, Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (jan.awrejcewicz@p.lodz.pl).

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paper id: STA376

Nonlinear analysis of rotors with rigid coupling misalignment

Airton Nabarrete, Vinicius Yoshida de Melo, José Manoel Balthazar, Angelo Marcelo Tusset

Abstract: Most rotating machinery consists of a driver coupled to a driven system through mechanical couplings. In these, angular and parallel misalignment of shafts are common with more or less degree due to system assembly or maintenance proceedings. Several mechanical couplings can be present in a long shaft-line and the misalignment between connected shafts causes vibration to the holy assembly. In the literature, theoretical and experimental analyses were published in order to demonstrate the stability and misalignment effects on a rotor system. In this work, the misalignment of a rigid coupling is analyzed and highlighted to give the diagnostic information. Superharmonic components in the system vibration response are the most remarkable effects of rigid coupling misalignment due to the variable loading on the bearings. The stability and bifurcation analysis of the problem consider the nonlinear damping and stiffness of the journal bearings. The finite element model of the shaft-line considers the Timoshenko beam theory. The nonlinear behavior of the journal bearings is analyzed as function of the periodical change of the bearing load after adding a significant level of coupling misalignment. Nonlinear oil film forces and their Jacobians are calculated simultaneously. The analysis of the unstable periodic orbit and the period-doubling orbit is performed for the center of the rotor at the bearing station. A bifurcation occurs with the increasing rotating speed. Beyond the bifurcation point, unbalanced responses show attractors in the projection of the Poincaré map.

[1] Airton Nabarrete, Professor: Instituto Tecnológico de Aeronáutica - ITA, Praça Marechal Eduardo Gomes 50, São José dos Campos, SP, 12228-900, BRAZIL (nabarrete@ita.br), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[2] Vinicius Yoshida de Melo, B.A. (M.Sc. student): Instituto Tecnológico de Aeronáutica - ITA, Praça Marechal Eduardo Gomes 50, São José dos Campos, SP, 12228-900, BRAZIL (nabarrete@ita.br).

[3] José Manoel Balthazar, Professor: Instituto Tecnológico de Aeronáutica - ITA, Praça Marechal Eduardo Gomes 50, São José dos Campos, SP, 12228-900, BRAZIL (jmbaltha@gmail.com).

[4] Angelo Marcelo Tusset, Professor: Federal University of Technology - UTFPR, Avenida Monteiro Lobato, Jardim Carvalho, Ponta Grossa, PR, 84016-210, BRAZIL (a.m.tusset@gmail.com).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: VIB70

Theoretical and experimental investigations of nonlinear vibrations of a beam with piezoelectric actuators

Jacek Przybylski, Grzegorz Gąsiorski

Abstract: This paper presents theoretical and experimental investigations of the nonlinear flexural vibrations of a structure composed of a host beam with piezoelectric ceramic actuators symmetrically bonded to its top and bottom surfaces. The composite beam is supported at its ends to completely restrain axial displacements or to impose the displacement of one or both ends. Applying voltage to piezoelectric actuators one creates prestress which can stabilize the structure when the external compressive force appears. The analytical model for describing flexural vibration of a beam under both the external load and piezoelectric actuation is based on the Euler–Bernoulli model. The piezo material exhibits linear piezoelectricity with constitutive equations including electromechanical coupling. Due to the geometrical nonlinearity, the solution to the problem has been obtained by using the Lindstedt-Poincare method. The main results concern the effect of the residual piezo force on the non-linear vibration frequency of the structure. In the experimental part of the study two laboratory stands has been designed and built for three- and five segmented beams to find out and prove the effect of the electric field on the residual force and the natural frequency of both systems. A very good agreement between theoretical and experimental results has been observed.

1) Jacek Przybylski, Professor: Czestochowa University of Technology, Dabrowskiego 73, 42 201 Czestochowa, POLAND (jacek.pr@imipkm.pcz.pl), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

2) Grzegorz Gąsiorski, Ph.D.: Czestochowa University of Technology, Dabrowskiego 73, 42 201 Czestochowa, POLAND (masteroff4@tlen.pl).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: EXP368

Nonlinear mode veering for enhanced resonant sensing

Dennis Roeser, Samuel Jackson, Thomas Sattel, Stefanie Gutschmidt

Abstract: A research trend in micro systems for resonant sensing is a sensitivity enhancement utilizing nonlinear and coupling e ects, which is mainly applied to gas sensing and timing applications. In this article, we propose such an enhancement of the sensitivity for an atomic force microscopy probe. This scheme is based on a two beam array, where one beam is active and acting as probe, while the other beam is passive. Both beams of this array are designed to have an identical resonance frequency at a de ned distance between the active beam and a surface, in the mechanically uncoupled case. The occurring mode localization close to this distance and the nonlinear interaction potential lead to an increased sensitivity in this region, with respect to frequency change and amplitude ratio. The proposed scheme is experimentally validated with a macro-scale test setup, mimicking a micro-scale system.

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[1] Dennis Roeser, M.Sc. (Ph.D. student): TU-Ilmenau, Ilmenau, GERMANY (dennis.roeser@tu-ilmenau.de).

[2] Samuel Jackson, Ph.D.: University of Canterbury, Christchurch, NEW ZEALAND (samuel.jackson@pg.canterbury.ac.nz).

[3] Thomas Sattel, Professor: TU-Ilmenau, Ilmenau, GERMANY (thomas.sattel@tu-ilmenau.de), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[4] Stefanie Gutschmidt, Associate Professor: University of Canterbury, Christchurch, NEW ZEALAND (stefanie.gutschmidt@canterbury.ac.nz).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

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paper id: NUM340

On artifacts in nonlinear dynamics

Utz von Wagner, Lukas Lentz

Abstract: Non-Linear Oscillations are of permanent interest in the field of dynamics of mechanical and mechatronic systems. There exist several well-known semi-analytical methods like Harmonic Balance, perturbation analysis or multiple scales for such problems. We reconsider in our presentation the method of Harmonic Balance but add some additional steps in order to avoid artifacts and get information about the stability. The classical method of Harmonic Balance is therefore added by an error criterion, which considers the neglected terms. Looking on this error for increasing ansatz order, it can be decided whether a solution exists or is an artifact of the method. For the low error solutions, a stability analysis is performed. As examples, extended Duffing oscillators with additional nonlinear damping, excitation and time delay terms are considered showing regions of separated “island” solutions. Also a nonlinear piezo-beam energy harvesting system is investigated. The described method enables to calculate in a rapid manner with comparable low effort, to get an overview over regular solutions of nonlinear systems.

[1] Utz von Wagner, Professor: Technische Universität Berlin, Institute of Mechanics, FG Mechatronische Maschinendynamik, Einsteinufer 5, 10587 Berlin, GERMANY (utz.vonwagner@tu-berlin.de), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[2] Lukas Lentz, M.Sc. (Ph.D. student): Technische Universität Berlin, Institute of Mechanics, FG Mechatronische Maschinendynamik, Einsteinufer 5, 10587 Berlin, GERMANY (lukas.lentz@tu-berlin.de).

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paper id: VIB113

Vibration modes of rotating thin-walled composite blades

Jerzy Warminski, Jaroslaw Latalski, Zofia Szmit

Abstract: Dynamics of a rotating structure composed of a rigid hub with attached flexible beams is studied in the paper. The beams are considered as nonlinear due to large oscillations and thus geometrical non-linearities occur. It has been shown that the hub has an important influence on the vibration modes of the structure. The modes of the rotor for selected resonances are demonstrated if periodic torque is supplied to the hub. The synchronisation phenomenon of and localization of vibrations is analysed for fully symmetric and slightly detuned blades. 1. Crespo da Silva, M.R.M. and Hodges, D.H., Nonlinear flexure and torsion of rotating beams with application to helicopter Blade-I: Formulation, Vertica, 10, pp.1225-1234, 1986. 2. Warminski J. and Balthazar J.M., Nonlinear vibrations of a beam with a tip mass attached to a rotating hub, Proceedings of 20th ASME: Biennial Conference on Mechanical Vibrations and Noise}, Long Beach, California, USA, 2005, DETC2005-84518:1-6.

[1] Jerzy Warminski, Professor: Department of Applied Mechanics, Lublin University of Technology, Nadbystrzycka 36, 20-560 Lublin, POLAND (j.warminski@pollub.pl), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[2] Jaroslaw Latalski, Ph.D.: Lublin University of Technology, Faculty of Mechanical Engineering, Department of Applied Mechanics, Nadbystrzycka 36, 20-560 Lublin, POLAND (j.latalski@pollub.pl).

[3] Zofia Szmit, M.Sc. (Ph.D. student): Lublin University of Technology, Faculty of Mechanical Engineering, Department of Applied Mechanics, Nadbystrzycka 36, 20-560 Lublin, POLAND (z.szmit@pollub.pl).

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paper id: VIB244

Nonlinear acoustic metamaterials: Editable dynamics

Tianzhi Yang, Zhiguang Song

Abstract: Metamaterials are man-made composites that control waves in ways that are not available in natural materials, resulting in exotic behavior. Acoustic metamaterials (AM) with properly designed lattice can manipulate acoustic/elastic waves in unprecedented ways. Although many previous studies focused on passive AM, whose structures are not reconfigurable. In this paper, we present a new design of an active nonlinear acoustic metamaterial, whose dynamic properties can be modified instantaneously with reversibility. By incorporating electric magnets and buckled strips in a single unit cell, we realized an intrinsic nonlinear active resonator. We show that the electrically triggered deformation can control the nonlinear stiffness of internal resonators in an easier way, offering an alternative solution to implement nonlinear AM. Therefore, a real-time tunability and switchability of the band gap is achieved. In addition, we demonstrate the presented metamaterial has a dynamic “editing” ability for shaping transmission spectra, which can be used to create the desired band gap and resonance. This feature is impossible to achieve in passive metamaterials. These advantages demonstrate the versatility of the proposed device, paving the way to smart acoustic devices, like logic elements, diode and transistor.

[1] Tianzhi Yang, Ph.D.: Technische Universite at Darmstadt, 64293, GERMANY (21172485@qq.com), the author presented this contribution at the conference in the special session: "Dedicated to Professor Peter Hagedorn on the occasion of granting him the honor of doctor honoris causa of the Lodz University of Technology" organized by J. Awrejcewicz.

[2] Zhiguang Song, Ph.D.: Dynamics and Vibrations Group, Technische Universite at Darmstadt, 64293, GERMANY (song@dyn.tu-darmstadt.de).

SPECIAL SESSION 2

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: STA77

Rotation of vane with viscous filling

Marat Dosaev

Abstract: The motion of a four-blade axisymmetric vane with fixed point is considered in the constant flow of medium. The quasi-steady approach is used for modeling an aerodynamic load. Nonlinear approximation of the aerodynamic fineness function is used. This is a mechanical system with variable dissipation. A case for blades with low fineness is considered. Corresponding dynamic system is simulated for different set of parameters. Two types of body (oblate and oblong) as well as two types of cavity are considered.

[1)] Marat Dosaev, Associate Professor: LMSU Institute of Mechanics, 119192, Moscow, Michurinskiy pr-t, 1, RUSSIA (dosayev@imec.msu.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

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paper id: LIF75

Simulation of contact equilibrium between two deformable axisymmetric bodies

Marat Dosaev, Vladislav Bekmemetev, Vitaly Samsonov

Abstract: This abstract is intended for the special session "Advanced approaches to mathematical modeling of systems interacting with a medium". A portable pneumatic video-tactile sensor for determining the local stiffness of soft tissue and the methodology for its application are considered. The device is designed to determine the characteristics of tissues that are close in mechanical properties to the skin with subcutis and muscles. The expected rate of the device efficiency is 10 kPa - 10 MPa. To select the device parameters, a numerical simulation of the contact between the sensor head and the soft tissue was performed using the finite element method. For small loads and deformations, the results of the calculation correlate with estimates obtained from the Hertz theory. For the case of large deformations, the results of the calculation are confirmed by experiments.

[1)] Marat Dosaev, Associate Professor: LMSU Institute of Mechanics, 119192, Moscow, Michurinskiy pr-t, 1, RUSSIA (dosayev@imec.msu.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2)] Vladislav Bekmemetev, B.A. (M.Sc. student): LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (winter.in.head@gmail.com).

[3)] Vitaly Samsonov, Professor: LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (samson@imec.msu.ru).

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paper id: ASY45

An iterative approach to describing periodic solutions of a dynamical system

Liubov Klimina

Abstract: Behavior of a mechanical system with a single rotational coordinate is studied. It is supposed that the system is acted upon by anti-dissipative forces (e.g. induced by flow), as well as viscous friction. In order to construct a bifurcation diagram of autorotation motions depending on the viscous friction coefficient, an iterative procedure is proposed. It represents a modification of the Picard approach and differs from this approach in that it is intended to search for periodic solutions only. If the system is near-Hamiltonian, the first iteration of this procedure coincides with the Poincare-Pontryagin method. The interrelation between the Picard approach and the Poincare-Pontryagin theorem is discussed.

[1)] Liubov Klimina, Ph.D.: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (klimina@imec.msu.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

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December 11-14, 2017. Lodz, POLAND.

paper id: ASY204

Nonlinear dynamics of a pendulum under parametric excitation

Margarita Kovaleva, Valery Smirnov, Francesco Romeo, Leonid Manevitch

Abstract: We study the nonlinear dynamics of a parametrically excited pendulum . The proposed analytical approach is conceived in order to describe the pendulum dynamics beyond the simplified regimes usually considered in literature, where stationarity and small amplitude oscillations are assumed. By combining complexification and Limiting Phase Trajectory (LPT) concepts the pendulum dynamics in the neighborhood of the main parametric resonance is investigated. The non-stationary dynamics in the quasilinear approximation is considered; afterwards, both stationary and non-stationary regimes are studied without any restriction on the pendulum oscillation amplitudes. In the latter case the semi-inverse asymptotical method is introduced. The identification of the bifurcations of the stationary states as well as the large-amplitude corrections of the stability thresholds emanating from the main parametric resonance are the main results provided by the proposed study.

[1] Margarita Kovaleva, Ph.D.: N.N.Semenov Institute of Chemical Physics, 119991 Moscow, Kosygin st, 4, RUSSIA (margo.kovaleva@gmail.com), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Valery Smirnov, Ph.D.: N.N.Semenov Institute of Chemical Physics, 119991 Moscow, Kosygin st, 4, RUSSIA (smirnovvv@gmail.com).

[3] Francesco Romeo, Associate Professor: Dipartimento di Ingegneria Strutturale e Geotecnica, Sapienza University of Rome, Rome, Piazzale Aldo Moro 5, 00185 Roma, ITALY (francesco.romeo@uniroma1.it).

[4] Leonid Manevitch, Professor: N.N.Semenov Institute of Chemical Physics, 119991 Moscow, Kosygin st, 4, RUSSIA (manevitchleonid3@gmail.com).

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paper id: OPT60

Performance of a vertical axis wind turbine system with a pair of rotors investigated using CFD method

Ching-Huei Lin, Dao-An Yang

Abstract: Output performance of a system of two identical vertical axis wind turbine rotors with opposite rotating directions arranged with different spacing was investigated in this article. The output power of two identical and independent operating vertical axis wind turbines is used as a reference for comparison. We adopted two- and three-dimensional computational fluid dynamics simulations to study the optimized spacing between two rotors under wind speeds with 5m/s and 11m/s. Both two- and three-dimensional results show that the maximum values of output power, output torque and the related tip speed ratio (TSR) all increase significantly as the spacing decreases for high wind speed of 11m/s. For slow wind speed of 5m/s and while the TSR be larger than 0.65, the output power and output torque also increase. Gain analysis of output power and output torque show both are promoted obviously as the spacing ratio decreases for two- and three-dimensional simulations with high wind speed of 11m/s. The gains however decrease under slow wind speed condition of 5m/s. It indicates the output performance of paired vertical axis wind turbines with narrower spacing is overall much better than that of two single turbines under higher wind speed conditions.

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[1] Ching-Huei Lin, Associate Professor: Department of Electrical Engineering, Chien Hsin University of Science and Technology, 229, Jianxing Rd., Zhongli Dist., Taoyuan City 32097, TAIWAN (chlin@gapps.uch.edu.tw), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Dao-An Yang, M.Sc.: Department of Electrical Engineering, Chien Hsin University of Science and Technology, 229, Jianxing Rd., Zhongli Dist., Taoyuan City 32097, TAIWAN (yanjung82411@gmail.com).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: EXP190

Dynamic properties of pipes with pulsating flows in transient states (sweeping up and down) for different air temperatures and pipe geometries

Tomasz Pałczyński

Abstract: Understanding the dynamic properties of pipes with pulsating flows in transient states (sweeping up and sweeping down pulsation frequencies) is of great interest for ensuring efficient fluid transportation, including in process plants, the power and chemical industries, compressed air systems and in automobiles. Pulsating flows can occur during start–stop procedures and due to frequency changes determined by the system requirements. In this study, a test rig was prepared to investigate the flow parameters of pipes with pulsating flows caused by a wide range of pulsation frequency and intensity changes and two directions of changes (up and down). The proposed procedure enabled complex analysis of the transient states of pipes with pulsating flows. Three fields were measured: mass flow rate from 0,005 kg/s to 0,030 kg/s, air temperature from 288 K to 343 K and pipe geometry determined by different partially-closed end ratios from 10% to 90%. The experimental results were analyzed in the Matlab environment using the classical Short Fast Fourier Transform and the author's own version of this algorithm. Amplitude frequency characteristics under the influence of two dominant cases (sweeping up and down) were also estimated and compared using relative and absolute values. The presented results are significant for the industrial and theoretical understanding of transient stages of flow phenomena along pipelines with pulsating flows.

[1] Tomasz Pałczyński, Ph.D.: Lodz Univesity of Technology, Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (tomasz.palczynski@p.lodz.pl), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: EXP189

Influence of air temperature on dynamic properties of pipes supplied with pulsating flow

Tomasz Pałczyński

Abstract: Air temperature has a significant influence on the dynamic properties of pipes supplied with pulsating flows. In many applications (power plants, pipelines, intake and exhaust systems for internal combustion engines), air temperature has an effect on resonance. Depending on the air temperature, and its influence on transient flow parameters (pressure, temperature, density, speed of sound), there may be significant changes in the pipe dynamic properties of the test pipe, such as resonant frequencies and the damping coefficient. In this study, experiments were conducted in an air temperature range of between 288 K and 343 K with a very a short air temperature step of around 5 K. Each measurement series was performed tree times. The results were processed in the Matlab environment using Fast Fourier Transforms. For each measurement, the amplitude and phase characteristics, resonant frequencies, damping coefficient and quality of approximation were estimated. The empirical coefficients were visualized as 3D maps including the influence of air temperature on pulsation dynamics in pipes. Finally, the experimental results were compared with author's 1D model (based on Method of Characteristics) of the analyzed phenomenon. The results are significant both for the theoretical understanding of flows in pipelines with pulsating flows and for practical applications in industry.

[1)] Tomasz Pałczyński, Ph.D.: Lodz Univesity of Technology, Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (tomasz.palczynski@p.lodz.pl), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: EXP191

Influence of partially-closed end ratio on dynamic properties of pipes with pulsating flow

Tomasz Pałczyński

Abstract: The partially closed end ratio has a significant influence on the dynamic properties of pipes supplied with pulsating flows. In many applications (power plants, pipelines, intake and exhaust systems for internal combustion engines) the partially closed end ratio causes resonance. Depending on the diameter of the nozzle (mounted at the end of the test pipe), and its influence on the transient flow parameters (pressure, temperature, density, speed of sound), there may be significant changes in the dynamic properties of pipes, such as resonant frequencies and the damping coefficient. In this study, experiments were conducted with a relative nozzle diameter of between 10% and 90%. Each measurement series was performed three times. The results were processed in the Matlab environment using Fast Fourier Transforms. The amplitude and phase characteristics, resonant frequencies, damping coefficient and quality of approximation were estimated for each measurement. The empirical coefficients were visualized as 3D maps including the influence of the partially closed end ratio on the pulsation dynamics in pipes. Finally, the experimental results were compared with the author's 1D model (based on the Method of Characteristics) of the analyzed phenomenon. The results are significant both for the theoretical understanding of flows in pipelines with pulsating flows and for practical applications in industry.

[1)] Tomasz Pałczyński, Ph.D.: Lodz Univesity of Technology, Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (tomasz.palczynski@p.lodz.pl), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

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December 11-14, 2017. Lodz, POLAND.

paper id: STA375

Aeroelastic stability analysis via multiparameter eigenvalue problems

Arion Pons, Stefanie Gutschmidt

Abstract: This paper presents a new method of identifying and analysing stability boundaries in parametric systems using multiparameter spectral theory. Considering our driving application, the analysis of aeroelastic flutter instability, we identify methods by which the location of the stability boundary can be expressed as a multiparameter eigenvalue problem and thus solved. This approach yields far-reaching results, including direct solvers for arbitrarily large polynomial stability problems, iterative and approximate direct solvers for systems that are strongly nonlinear in the frequency domain, and a novel method of system visualisation. These solvers and methods are tested on two aeroelastic section models and the Goland wing benchmark model, and their advantages and limitations are explored. The application of multiparameter methods – in aeroelasticity and in other disciplines – has the potential to provide a wide variety of new methods for stability analysis.

[1] Arion Pons, M.Sc. (Ph.D. student): Department of Engineering, University of Cambridge, Trumpington st., Cambridge CB2 1PZ, UK, UNITED KINGDOM (adp53@cam.ac.uk), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Stefanie Gutschmidt, Ph.D.: Department of Mechanical Engineering, University of Canterbury, Private Bag 4800, Christchurch 8140, NEW ZEALAND (stefanie.gutschmidt@canterbury.ac.nz).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: STA69

Equilibria and global dynamics of a 2 DoF aeroelastic system

Yury Selyutskiy

Abstract: Study of aerodynamic flutter has a long history. Interest to this problem is stimulated by applications: on the one hand, the flutter effect should be eliminated in order to ensure durability of structures; on the other hand, this phenomenon can be used to harvest energy from the flow. In the present work, an aeroelastic system with two degrees of freedom (translational and rotational) is considered. Aerodynamic load is simulated using the quasi-steady approach. Evolution of the set of equilibrium positions of the system (including both trivial and “oblique” ones) is studied depending on structural parameters. Stability criteria are obtained for these equilibria, and attraction domains are analyzed. Numerical simulation of the system behavior is performed for different values of parameters, including in the area of large angles of attack.

[1)] Yury Selyutskiy, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, 119192, Michurinsky prosp. 1, Moscow, RUSSIA (seliutski@imec.msu.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: ENG177

Mathematical modeling of the action of a medium on a conical body

Maxim V. Shamolin

Abstract: We consider a mathematical model of a plane-parallel action of a medium on a rigid body whose surface has a part which is a circular cone. We present a complete system of equations of motion under the quasi-stationarity conditions. The dynamical part of equations of motion form an independent system that possesses an independent second-order subsystem on a two-dimensional cylinder. We obtain an infinite family of phase portraits on the phase cylinder of quasi-velocities corresponding to the presence in the system of only a nonconservative pair of forces.

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[1] Maxim V. Shamolin, Professor: Institute of Mechanics, Lomonosov Moscow State University, 1 Michurinskii Ave., 119192, Moscow, RUSSIAN FEDERATION (shamolin@rambler.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: VIB238

Dynamic problem for an elastic rod with decreasing function of elastoplastic external resistance

Ivan Shatskyi, Vasyl Perepichka

Abstract: The wave problem of propagation and deceleration of shock perturbation in semi-infinite elastic rod interacting with the medium is investigated using the model of elastoplastic resistance with decreasing relation between shear stress and jump of displacement on the lateral surface. An exact solution of the initial-boundary problem is obtained using the Laplace transforms. A wave pattern of perturbation including the prefront zone of rest, the area of motion and the domain of stationary residual stresses has been built. The three-dimensional diagrams for nonstationary fields of velocity and stresses have been constructed too.

[1] Ivan Shatskyi, Professor: Ivano-Frankivsk Branch of Pidstryhach-Institute for Applied Problems in Mechanics and Mathematics, NAS of Ukraine / Department of modelling of damping systems, Mykytynetska Str., 3, 76002, Ivano-Frankivsk, UKRAINE (ipshatsky@gmail.com), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Vasyl Perepichka, Associate Professor: Ivano-Frankivsk Branch of Pidstryhach-Institute for Applied Problems in Mechanics and Mathematics, NAS of Ukraine / Department of modelling of damping systems, Mykytynetska Str., 3, 76002, Ivano-Frankivsk, UKRAINE (an_w@i.ua).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: CON57

Model of a quarter car suspension with a silencer containing magnetorheological fluid and with damaged parts controlled by backstepping method control

Maciej Słomczyński, Stanisław Radkowski

Abstract: This work focuses on minimizing the body deflection from its equilibrium position after deflection by force applied to the wheel which has a task to simulate obstacles encountered by the wheel. The model presents a quarter of the car's suspension with nonlinear spring and a silencer with magnetorheological fluid, by which the damping of the suspension is modified. System was created in harmony with the Lyapunov stability theory. Model was designed in Matlab – Simulink program. Model was designed for testing many different damaged parts of suspension, for example the spring or silencer. Damaged part was represented by changing characteristics during the simulation. In further attempts, the model was tested for many damaged parts and the sequence of events was different. The model was tested for different characteristic of springs and dampers and various methods of forcing the wheel from its equilibrium position. The test results shows which damages were critical for the model of suspension and with what category of fault backstepping control method still works.

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[1] Maciej Słomczyński, B.A. (M.Sc. student): Faculty of Automotive and Construction machinery Engineering, Warsaw University of Technology, Narbutta 84, 02-524 Warszawa, POLAND (maciej.slomczynski@op.pl), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Stanisław Radkowski, Professor: Faculty of Automotive and Construction Machinery Engineering, Warsaw University of Technology, Narbutta 84, 02-524 Warszawa, POLAND (ras@simr.pw.edu.pl).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: OPT31

Support reaction in the brachistochrone problem in a resistant medium

Alena Zarodnyuk, Oleg Cherkasov

Abstract: The horizontal coordinate's maximization problem as well as related brachistochrone problem are considered. The particle is moving in a vertical plane under influence of gravity, viscous drag that proportional to n-th degree of the velocity. The reaction of the basement is considered as a control. Optimal control problem is reduced to the boundary value problem for the system of two nonlinear equations. It was established that the reaction force of the basement could change its sign no more than one time, moreover, it changes only from the negative value to the positive value. Qualitative features of the optimal control allows to elaborate the results obtained in other studies.

[1] Alena Zarodnyuk, M.Sc. (Ph.D. student): Lomonosov Moscow State University, 119991, RUSSIA (alenaz_90@inbox.ruL), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

[2] Oleg Cherkasov, Associate Professor: Lomonosov Moscow State University, 119991, RUSSIA (oyuche@yandex.ru), the author presented this contribution at the conference in the special session: "Advanced approaches to mathematical modeling of systems interacting with a medium" organized by L. Klimina, Y. Selyutskiy and M. Dosaev.

SPECIAL SESSION 3

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: OPT214

Parametric optimization in enumeration of alternative structures of mechanisms

Stefan Chwastek

Abstract: The Machine and Mechanism Theory provides a method of enumerating kinematic chains which involves identification of all possible alternatives of kinematic structures with respect to the required number of degrees of freedom and field of work. This article outlines a methodology of selecting optimal structure from a set of possible solutions. By introducing a certain quality criterion, such as the minimum force or minimum energy, most often in the form of quadratic functionals, a set of parameters optimized for the full range of motion is determined for each structure. Accordingly, each structure is assigned a value of the optimum quality index. The method was illustrated for a one-link crane with bilateral constraints (eg. lever mechanisms), and comparison was made with mechanisms in rope instlaations, optimised in previous works [1, 2]. For each of the optimized crane mechanisms, a separate optimization task was formulated by defining a specific objective function: • counterweight mechanism → minimum boom lifting, • boom lifting mechanism → minimum boom pull force. Optimization tasks were formulated assuming the ideal stiffness of the structure in quasi-static conditions. Effectiveness was verified under dynamic impact conditions, taking into account rope flexibility.

1) Stefan Chwastek, Ph.D.: Cracow University of Technology, Faculty of Mechanical Engineering, al. Jana Pawła II 37, 31-864 Kraków, POLAND (stefan.chwastek@mech.pk.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: MAT6

Some value distribution and growth properties of solutions of Painleve and Riccati equations

Ewa Ciechanowicz

Abstract: By Malmquist theorem, the first order non-linear algebraic differential equations with rational coefficients and admitting transcendental meromorphic solutions were recognised to be the Riccati equations. Classification of the second order ordinary differential equations without movable branch points, on the other hand, led to recognition of so-called Painleve equations. Among them, six irreducible equations, usually denoted as P1-P6, are best known. The equations P1, P2, P4 and modified P3, P5 have only meromorphic solutions. Moreover, for certain parameters, equations P2-P6 have particular solutions, which can be expressed in terms of Riccati equations with rational coefficients. Meromorphic solutions of both Riccati and Painleve equations have been thoroughly studied by methods of value distribution theory since 1950's, with the topic gaining in popularity since 1990's, yet still leaving space for further research.

[1)] Ewa Ciechanowicz, Ph.D.: Faculty of Mathematics and Phisics, University of Szczecin, Instytut Matematyki US, ul. Wielkopolska 15, 70-451 Szczecin, POLAND (ewa.ciechanowicz@usz.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: MAT235

Value distribution and growth of solutions of certain Painleve equations

Ewa Ciechanowicz, Galina Filipuk

Abstract: As a result of classification of second order ordinary differential equations without movable branch points, a number of the so-called Painleve equations was obtained. Among them, six irreducible equations are the best known. They led to the recognition of new functions, called the Painleve transcendents. The Painleve equations have numerous applications in modern mathematics and mathematical physics. The solutions of these equations, as they are meromorphic in the complex plane, can be studied from the perspective of value distribution and growth theory, with such values as defect, deviation or multiplicity index estimated.

[1] Ewa Ciechanowicz, Ph.D.: Faculty of Mathematics and Physics, University of szczecin, Instytut Matematyki US, ul. Wielkopolska 15, 70-451 Szczecin, POLAND (ewa.ciechanowicz@usz.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

[2] Galina Filipuk, Associate Professor: Faculty of Mathematics, Informatics and Mechanics, University of Warsaw, Wydział Matematyki, Informatyki i Mechaniki UW, ul. Banacha 2, 02-097 Warszawa, POLAND (filipuk@mimuw.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: MAT10

Nonlinear differential-difference equations related to the second Painleve equation

Galina Filipuk

Abstract: As a result of classification of second order ordinary differential equations without movable branch points, f''=F(z,f,f'), f=f(z), '=d/dz, where F is rational in f, algebraic in f' and analytic in z, a number of the so-called Painleve equations was obtained. Among them, six irreducible equations are best known. They led to the recognition of new functions, called the Painleve transcendents. The Painleve equations have numerous applications in modern mathematics and mathematical physics. They can be obtained by similarity reductions from certain integrable partial differential equations (e.g., KdV, mKdV and others). They possess a number of other remarkable properties (e.g., Backlund transformations, classical solutions, the Hamiltonian structure). Via the Hamiltonian structure the Painleve equations are related to their associated equations, the so-called sigma-equations. In this paper we derive Backlund transformations for two \sigma-forms of the second Painleve equation (with respect to two different Hamiltonians) and use these transformations to obtain nonlinear differential-difference and difference equations for the solutions.

1) Galina Filipuk, Ph.D.: University of Warsaw, 02-097, POLAND (filipuk@mimuw.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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A mathematical model of the slow/fast atrioventricular nodal reentrant tachycardia

Beata Jackowska-Zduniak, Urszula Foryś

Abstract: A proposed model consisting of two coupled van der Pol equations is considered as a description of the heart's action potential. System of ordinary differential equations with time delay is used to recreate pathological behaviour in the heart's conducting system such as slow/fast and slow/slow type of atrio-ventricular nodal reentrant tachycardia (AVNRT). In our study, introducing the feedback loops and couplings entails the creation of waves which can correspond to the re-entry waves occurring in the AVNRT. Our main aim is to study solutions of the given equations and take into consideration the influence of feedback and delays which occur in these pathological modes. We also present stability analysis for proposed model.

1) Beata Jackowska-Zduniak, Ph.D.: Warsaw University of Life Sciences, Nowoursynowska 166, 02-787 Warsaw, POLAND (beata_jackowska_zduniak@sggw.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

2) Urszula Foryś, Professor: Warsaw University, Faculty of Mathematics, Informatics, and Mechanics, 2 Banacha Str., 02-097 Warsaw, POLAND (urszula@mimuw.edu.pl).

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paper id: MAT135

Kahan discretisation of a cubic Hamiltonian system

Thomas Kecker

Abstract: An important criterion for an equation or system of equations in the complex plane to be integrable is the Painlevé property, stating that all movable singularities of all solutions of the equation are poles. The six Painlevé equations are essentially the only non-linear equations in the class of second-order rational ODEs with this property, the solutions of which define new transcendental functions. They are equivalent to certain Hamiltonian systems with polynomial Hamiltonian. An analogue of the Painlevé property for discrete equations is known as singularity confinement. When passing from a discrete Painlevé equation to a differential equation, which can be achieved by taking an appropriate continuous limit, integrability is preserved. Going the other direction, known as discretisation, is not as straightforward. We discuss a discretisation method due to Kahan applied to a certain cubic Hamiltonian system, leading to a discrete system which possesses a sort of partial singularity confinement. This also manifests itself in the value for the algebraic entropy of this system, a measure of complexity for the iterates under the discrete map, which, although non-zero, is smaller than expected for a generic, non-integrable discrete mapping. Joint work with Galina Filipuk.

[1)] Thomas Kecker, Assistant Professor: University of Portsmouth, Portsmouth, UNITED KINGDOM (thomas.kecker@port.ac.uk), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: MAT136

Derivation and investigation of the generalized nonlinear Schrödinger equation of cosmogonical body forming

Alexander Krot

Abstract: This work considers the statistical theory of gravitating spheroidal bodies to derive a new generalized nonlinear Schrödinger equation of a gravitating cosmogonical body formation. The statistical theory for a cosmogonical body forming (so-called spheroidal body with fuzzy boundaries) has been proposed in our previous works. This paper investigates different dynamical states of a gravitating spheroidal body and respective forms of the generalized nonlinear time-dependent Schrödinger equation. In particular, the derived time-dependent generalized nonlinear Schrödinger equation describes not only the state of virial mechanical equilibrium and the quasi-equilibrium gravitational condensation state, but the initial equilibrium gravitational condensation state taking place in a forming gas-dust protoplanetary cloud as well as the soliton disturbances state occurring in a spheroidal body under formation and also the gravitational instability states including the increase of gravitational compression of spheroidal body providing a formation of core of cosmogonical body. The separation of a spheroidal body on its core and exterior hull leads to the fragmentation stage of spheroidal body modelling the initial process of formation of an exoplanetary system.

[1] Alexander Krot, Professor: Head of Laboratory of Self-Organization System Modeling,United Institute of Informatics Problems of National Academy of Sciences of Belarus, 6, Surganov Str., Minsk, BELARUS (alxkrot@newman.bas-net.by), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: MAT141

Dynamics of a block sliding on a plane with variable coefficient of friction

Alexander Prokopenya

Abstract: It is known that a body sliding on a rough surface is acted on by the friction force that is parallel to the surface and is directed opposite to the velocity of the body. According to the Amontons-Coulomb law, the friction force does not depend on the area of contact of the body and the surface and is proportional to the normal reaction force. Note that in case of a finite dimension of the contact area the normal force is inevitably distributed over the area of contact. Therefore, the equations of the body motion may be written only if a model of the normal force distribution is given. In the present talk we analyze dynamics of a homogeneous rectangular block sliding on a rough horizontal plane. To obtain the equations of motion we consider the following model of dry friction of the block and the plane. First, we assume that deformation of the block is negligible and it may be considered as a rigid body. Besides, the elastic properties of the plane are the same in all its points and does not depend on the coefficient of friction. In the framework of such a model one can consider that a density of the normal force is a linear function of a local coordinate measured along the block from its center of mass. Two parameters of this function may be found from the conditions of the block motion without rotation. Doing necessary symbolic and numerical calculations, we have analyzed motion of the system and demonstrated some peculiarities of the block sliding on the plane with variable coefficient of friction.

[1)] Alexander Prokopenya, Associate Professor: Warsaw University of Life Sciences - SGGW, Faculty of Applied Informatics and Mathematics, Nowoursynowska str. 166, 02-787 Warsaw, POLAND (alexander_prokopenya@sggw.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

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paper id: ENG268

Analytical model of damaged circular membrane using a pseudo torus

Aleksandra Waszczuk-Młyńska, Stanisław Radkowski

Abstract: The presented analytical model shows the vibration analysis of a circular membrane with a damage located in its central part. The damage has a form of a hole. The model uses the general vibration differential equation of circular membrane; however, a torus has been used to describe the investigated object. The flat circular membrane with an opening in the centre was described by the surface of torus intersection with the plane created as a result of a rotation. A vital element is the fact that the radius r describing the torus circumference is a variable from within the range (0,r0). For a surface created in such a way, the Laplace operator has been computed, and as a result, the vibration equation for a new object. Next, the obtained second-order partial differential equation was computed using the Bessel substitution. To evaluate the damage, changes in natural frequencies were used.

[1] Aleksandra Waszczuk-Młyńska, M.Sc. (Ph.D. student): Warsaw University of Technology Faculty of Automotive and Construction Machinery Engineering, Narbutta 84, 02-524 Warsaw, POLAND (awm@simr.pw.edu.pl), the author presented this contribution at the conference in the special session: "Differential, difference equations and complex analysis" organized by G. Filipuk and E. Ciechanowicz.

[2] Stanisław Radkowski, Professor: Warsaw University of Technology Faculty of Automotive and Construction Machinery Engineering, Narbutta 84, 02-524 Warsaw, POLAND (ras@simr.pw.edu.pl).

SPECIAL SESSION 4

14th INTERNATIONAL CONFERENCE
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December 11-14, 2017. Lodz, POLAND.

paper id: OPT64

Optimization of servicing satellite control torques generated by a system of four reaction wheels

Elżbieta Jarzębowska, Meltem Sozeri

Abstract: Reaction wheels provide an Attitude Satellite Control System (ACS) for many satellites. Reaction wheels (RWs) generate torques along their axis of rotations and this way contribute to the satellite orientation. RWs are mounted on a satellite in different numbers and configurations in order to obtain desired torque magnitudes or power consumption. In this study, a four RWs configuration is optimized due to overall control torques they generate on the satellite in order to provide the ACS stability during a servicing mission. Also, the influence of the satellite mass and inertia changes during a servicing mission upon RWs configuration is discussed. Depending on the satellite mass and inertia changes, control torques generated by the RWs are calculated and their configuration is optimized to provide the stability of the satellite delivering service as well as optimal torques for performing a mission. Theoretical development is illustrated by numerical simulation studies of different RWs configurations selected according to desired optimization criteria and a servicing mission

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[1] Elżbieta Jarzębowska, Associate Professor: Warsaw University of Technology, 00-665 Warsaw, POLAND (elajarz@meil.pw.edu.pl), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

[2] Meltem Sozeri, B.A. (M.Sc. student): Warsaw University of Technology, 00-665 Warsaw, Nowowiejska 24, POLAND (sozerimeltem@hotmail.com).

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paper id: CON73

Computational based constrained dynamics generation for a model of a crane with compliant support

Elżbieta Jarzębowska, Andrzej Urbaś, Krzysztof Augustynek

Abstract: The paper presents a new computational based generation method of dynamic models of systems subjected to position or kinematic constraints as well as having compliant mechanical components in their structures. The constraints are referred to as programmed and they are imposed as control goals upon system performance or service task requirements. The computational procedure for the generation of constrained dynamics, which provides dynamic models satisfying all constraints upon them, was successfully developed and implemented for rigid system models, e.g. a manipulator model. The advantage of this procedure is that it serves both reference and control oriented dynamics derivation and the final dynamics models are obtained in the reduced state form, i.e. constraint reaction forces are eliminated. However, real machines and servicing equipment are never composed of all rigid systems. They are compliant mechanical systems and compliance may significantly affect their performance. Compliance effects have to be taken into account, e.g. for verification of a system model performance or for realistic controller designs. The novelty of the presented method is to include compliance into modeling and to require predefined constraints satisfaction as well. The developed method of constrained compliant reference dynamics generation is applied to a compliant crane model, which may carry loads moving according to specified programmed constraints. Simulation results present constrained motion performance of the crane model.

[1] Elżbieta Jarzębowska, Associate Professor: Warsaw University of Technology, Plac Politechniki 1, 00-661 Warszawa, POLAND (elajarz@meil.pw.edu.pl).

[2] Andrzej Urbaś, Ph.D.: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biala, POLAND (aurbas@ath.eu), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

[3] Krzysztof Augustynek, Ph.D.: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biala, POLAND (kaugustynek@ath.eu).

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paper id: CON239

A reverse analysis of the remote controlled artillery-missile set dynamics under the influence of disturbances

Zbigniew Koruba, Daniel Gapiński, Piotr Szmidt

Abstract: In today's battlefield, there is a constant need for increased combat capabilities including speed, target detection and identification, as well as firefighting capabilities by short range artillery rockets. The challenge is to be able to successfully fire such sets in response to disturbance not only from the cannon side but also from the moving platform on which the cannon and homing missiles are mounted. In addition, the set is a system with variable mass because in a short time can be fired from a few to dozens or even hundreds of bullets - so we are dealing with a strongly nonlinear system with variable parameters (non-stationary). The paper presents a dynamic model of hypothetical missile-artillery set mounted on a moving object (e.g. mobile platform or warship). Model inputs are driving torques for the azimuth and elevation angle, and the angular and linear displacements of the set base relative to the given stationary coordinate system. The output of the model is the resulting position of the line of sight relative to the mentioned stationary coordinate system. The effect of disturbances (motion) from the moving object was studied and the reverse dynamic analysis of the presented system under the influence of the disturbance was performed. This has been investigated to ensure if the set’s drive systems will be able to work out the required torque in time to maintain the desired line of sight. Simulations were made using the SciLab environment. Some results of numerical simulation tests was presented in graphical form.

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[1] Zbigniew Koruba, Professor: Department of Applied Computer Science and Armament Engineering, Kielce University of Technology, Al. Tysiąclecia PP 7 St., 25-314 Kielce, POLAND (ksmzko@tu.kielce.pl).

[2] Daniel Gapiński, Ph.D.: Department of Applied Computer Science and Armament Engineering, Kielce University of Technology, Al. Tysiąclecia PP 7 St., 25-314 Kielce, POLAND (tu_daniel_kielce@wp.pl).

[3] Piotr Szmidt, M.Sc. (Ph.D. student): Department of Applied Computer Science and Armament Engineering, Kielce University of Technology, Al. Tysiąclecia PP 7 St., 25-314 Kielce, POLAND (petersz@wp.pl), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

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paper id: NUM149

Probability analysis of the unsymmetrical effects to seismic resistance of the symmetrical high rise buildings

Juraj Králik, jr., Juraj Králik

Abstract: This paper presents the results from the deterministic and probabilistic seismic analysis of the influence of the unsymmetrical effects (centre mass eccentricity, variable seismic excitation, variable soil stiffness under foundation and others) to symmetric high rise building considering dynamic soil-structure interaction. The effect of the centre mass eccentricity represents the uncertainties in the location of masses and in the spatial variation of the seismic motion. During the structural design process, the problems of the safety, reliability and durability of a single structural element as well as the entire structure from the point of view of its planned life cycle must be considered. The methodology of the seismic analysis of the reinforced concrete high rise building structures on the base of deterministic and probabilistic assessment are presented. The methodology of the seismic analysis of the symmetrical structures in Eurocode and JCSS is discussed. The possibilities of the utilization the LHS method to analyse the extensive and robust tasks in FEM is presented in the case of high rise buildings with central core and columns system. The influence of the various input parameters (material, geometry, soil, masses,…) is considered. The deterministic and probability analysis of the seismic resistance of the structure was calculated in the ANSYS program. This analysis was realized on the example of the one, biaxial and L symmetrical tall building structures.

[1] Juraj Králik, Professor: Slovak University of Technology in Bratislava, Radlinského 11, 81005 Bratislava, SLOVAKIA (juraj.kralik@stuba.sk), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

[2] Juraj Králik, jr., Ph.D.: Slovak University of Technology in Bratislava, Radlinského 11, 81005 Bratislava, SLOVAKIA (kralik@fa.stuba.sk).

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paper id: BIF142

Remote synchronization and multistability in a star-like network of oscillators

Juliana Lacerda, Celso Freitas, Elbert Macau

Abstract: In the phenomenon of remote synchronization, oscillators that are not directly connected synchronize. In this work, we investigate this phenomenon for a system of Stuart-Landau oscillators interconnected in a network with a star-like structure in which all oscillators have different natural frequencies, being that the peripheral nodes have close frequencies and the central node's frequency is detuned against them. We numerically find a regime of remote synchronization, where the peripheral nodes synchronize and the hub continues at its own dynamics. In this regime, the nodes exhibit a quasi-periodic motion in their phase space. By changing the initial conditions of the system, we were able to find that the peripheral nodes lose their synchronization with each other for some of these conditions, causing remote synchronization to disappear, which characterize a multistability behavior. The behavior of the system is studied extensively for initial conditions that give and do not give rise to remote synchronization for a fixed value of the coupling strength.

[1] Juliana Lacerda, M.Sc. (Ph.D. student): National Institute for Space Research - INPE, 12243-010, BRAZIL (juliana.lacerda@inpe.br).

[2] Celso Freitas, Ph.D.: National Institute for Space Research - INPE, 12227-010, BRAZIL (cbnfreitas@gmail.com).

[3] Elbert Macau, Professor: National Institute for Space Research - INPE, 12227-010, BRAZIL (elbert.macau@inpe.br), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

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Ocean wave energy harvesting of a floating pendulum platform coupled system

Carlos Eduardo Marques, José Manoel Balthazar, Angelo Marcelo Tusset, Rodrigo Tumolin Rocha, Frederic Conrad Janzen, Jeferson José de Lima De Lima, Airton Nabarrete

Abstract: This work presents the analysis of an ocean wave energy harvesting system, which consists of a floating ocean platform with a DC motor power generator attached at the platform considering the ocean waves motion to swing the platform in order to convert mechanical energy into electric energy. The mechanical energy is provided by a pendulum which is coupled to the DC generator axis, which will acquire rotational motion due to the vertical excitation of the floating platform, therefore, varying the magnetic flux of the permanent magnets of the DC power motor, generating electric energy. The study of the mass of the pendulum settings and the amplitudes of the ocean wave is important to optimize the power provided by the DC motor, such study that is based on Brazilian's coast characteristics. Therefore, the dynamical behaviour of the system is shown through numerical simulations as well as the efficiency of conversion of the pendulum swings into electricity. Keywords: Pendulum System; Mathematical Modeling; Energy Harvesting; Ocean Wave Energy; Particle Swarm Optimization.

1) Carlos Eduardo Marques, M.Sc. (Ph.D. student): UNESP, UNESP – São Paulo State University, Department of Mechanical Engineering, Bauru – SP, BRAZIL (carlos_e_marques@hotmail.com).

2) José Manoel Balthazar, Professor: ITA, Aeronautics Technological Institute (ITA), São José dos Campos, SP, BRAZIL (jmbaltha@gmail.com), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

3) Angelo Marcelo Tusset, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (tusset@utfpr.edu.br).

4) Rodrigo Tumolin Rocha, Ph.D.: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (digao.rocha@gmail.com).

5) Frederic Conrad Janzen, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (fcjanzen@utfpr.edu.br).

6) Jeferson José de Lima De Lima, M.Sc. (Ph.D. student): UNESP, UNESP – São Paulo State University, Department of Mechanical Engineering, Bauru – SP, BRAZIL (jefersonjl82@gmail.com).

7) Airton Nabarrete, Assistant Professor: Aeronautics Technological Institute, Marechal Eduardo Gomes Square, 50 - Vila das Acacias, São José dos Campos - SP,, BRAZIL (nabarret@ita.br).

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paper id: CON296

The impact of the shock absorber damage on vehicle control

Krzysztof Parczewski, Henryk Wnęk

Abstract: The article contains an analysis of the impact of a defective shock absorber of the vehicle on his control. The study was conducted on a Class B passenger car for selected road tests. Have been compared of the measurement results obtained for the efficient and inefficient vehicle for various position of the vehicle gravity center. The impact of the inefficiency shock absorber on the change of the vehicle control in steady-state and dynamically changing conditions has been analyzed. To assess it has been used overshot indicators that are based on the steering and stability analysis of the vehicle. Designated indicators show the required change in the range of vehicle control and their impact on road safety.

[1] Krzysztof Parczewski, Associate Professor: Akademia Techniczno-Humanistyczna w Bielsku-Białej (University of Bielsko-Biala), 43-309 Bielsko-Biala, Willowa str 2, POLAND (kparczewski@ath.bielsko.pl), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

[2] Henryk Wnęk, Ph.D.: Akademia Techniczno-Huamnistyczna w Bielsku-Białej (University of Bielsko-Biala), 43-309 Bielsko-Biala, Willowa str 2, POLAND (hwnek@ath.bielsko.pl).

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December 11-14, 2017. Lodz, POLAND.

paper id: ASY194

Resonance behavior of nonlinear dissipative systems

Katarina Y. Plaksiy, Yuri Mikhlin

Abstract: Resonance behavior of nonlinear dissipative systems Katarina Plaksiy, Yuri Mikhlin Abstract: Nonlinear dissipative systems under external and internal resonance conditions are considered. In such systems all important characteristics of dynamical process depend on time. Besides, vibration modes here are not the classical nonlinear normal vibration modes (NNMs) because the vibration amplitude decreases here. The Reduced systems are used. These systems are written with respect to variables which characterizes the system energy, the arctangent of the ratio of amplitudes and the difference of phases. Interaction of NNMs and appearance of the so-called Transient nonlinear normal modes (TNNMs), which exist only for some levels of energy, are analyzed. The system motions approach TNNMs when the system energy is close to these specific levels. Then the energy decreases and motions tend to other stable vibration mode due to vanishing of the TNNM. All obtained results fully correspond to direct simulation of basic systems. References [1] Mikhlin, Yu.V., and Avramov, K.V. Nonlinear normal modes for vibrating mechanical systems. Review of theoretical developments, Appl. Mech. Review 63 (2010), 4-20. [2] Plaksiy, K.Y., and Mikhlin, Yu.V. Dynamics of nonlinear dissipative systems in the vicinity of resonance. J. of Sound and Vibr., 334 (2015), 319-337. [3] Plaksiy, K.Y., and Mikhlin, Yu.V. Resonance behavior of the limited power-supply system coupled with the nonlinear absorber. Math. in Engineering, Science and Aerospace 6 (2015), 475-495.

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[1] Katarina Y. Plaksiy, Ph.D.: Department of Applied Mathematics, National Technical University , 2 Kirpichev Str. , 61002 Kharkov, UKRAINE (plaksiyya@rambler.ru).

[2] Yuri Mikhlin, Professor: Department of Applied Mathematics, National Technical University, 2 Kirpichev Str. , 61002 Kharkov, UKRAINE (Yuri_Mikhlin@mail.ru), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

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paper id: STA179

Directional stability control of body steer wheeled articulated vehicles

Aleksander Skurjat

Abstract: Demanding higher travel velocities of rigid body articulated wheeled vehicles and maintaining high safety while moving on stiff ground requires finding more accurate methods of adjusting steering angle between rigid frames and using special solutions allowing the driver keeping desired path. In this article, identification of factors affecting directional stability is discussed. A new mathematical algorithm for estimating vehicles directional stability is proposed and tested. Computer simulations of methods counteracting snaking behavior indicates that the speed limit of 50-60km/h for articulated rigid body vehicles can be exceeded by using new solutions.

[1)] Aleksander Skurjat, Ph.D.: Wrocław Uniwersity of Science and Technology, ul. Ignacego Łukasiewicza 5, 50-371, Wrocław, POLAND (aleksander.Skurjat@pwr.edu.pl), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

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paper id: CON253

A compensation for positioning of the remote control artillery-missile set in external disturbance conditions

Piotr Szmidt

Abstract: An artillery-missile set mounted on a moveable object, such as a battleship, is subjected to movements that cause the line of sight to move relative to desired line of sight. This is a highly undesirable phenomenon during defense operations. The paper presents an attempt to compensate for these disturbances by using PID controllers and set's own driving systems. It has also been assumed that disruptive movements came from the ship's motion on the sea wave, and that the object (e.g. a attack helicopter) hovers in place. Numerical simulations were performed in SciLab environment and the results was graphically presented.

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1) Piotr Szmidt, M.Sc. (Ph.D. student): Department of Applied Computer Science and Armament Engineering, Kielce University of Technology, Al. Tysiąclecia PP 7 St., 25-314 Kielce, POLAND (petersz@wp.pl), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

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paper id: CON106

Multi-stage orbital maneuvers control for a servicing satellite mission

Michal Szwajewski, Elzbieta Jarzebowska

Abstract: The paper presents orbital maneuvers control scenario for a satellite servicing mission. The satellite dynamic model follows the latest trends in spacecraft research, for which complex models are derived, analyzed, and dedicated to specific missions first. Based upon full spacecraft dynamics, control dynamics is then derived and tested for potential applications. The dynamic control model presented in the paper is derived in Earth centered equatorial coordinate system and allows including special perturbation as the third body attraction such as Sun or Moon, the non sphericality of the Earth, atmospheric drag, out-gassing or solar-radiation drag. A control goal for servicing activity is specified as a multi–stage docking maneuver, for which a control algorithm is designed accordingly. The new approach to a controller design and control execution is three folded. Firstly, the controller presented in the paper is based on an adaptive algorithm, which may adapt with respect to the servicing mission type and the external perturbations. Secondly, the satellite control dynamics simulation model is based on the multi step predictor – corrector method. Thirdly, a novel approach for the satellite mission execution is applied, i.e. control commends are generated on board. To the best of our knowledge, no mission with such control system was launched.

[1] Michal Szwajewski, M.Sc. (Ph.D. student): SENER Sp. z o.o., Aleje Jerozolimskie 202, POLAND (michal.szwajewski@gmail.com), the author presented this contribution at the conference in the special session: "New trends in dynamics and control of nonlinear naval and aerospace systems" organized by J.M. Balthazar and E. Jarzębowska.

[2] Elzbieta Jarzebowska, Professor: Warsaw University of Technology, Faculty of Power and Aeronautical Engineering, ul. Nowowiejska 24, 00-665 Warsaw, POLAND (elajarza@meil.pw.edu.pl).

SPECIAL SESSION 5

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: LIF78

The burden of the coinfection of HIV and TB in the presence of multi-drug resistant strains

Ana Carvalho, Carla M. A. Pinto

Abstract: We introduce a fractional-order model for the coinfection of HIV and tuberculosis, in the presence of drug resistant TB strains and treatment for both diseases. We compute the reproduction number of the model. Numerical simulations show the different dynamics of the model for variation of relevant parameters. Moreover, the order of the fractional derivative plays an important role in the severity of the epidemics. We introduce a fractional-order model for the coinfection of HIV and tuberculosis, in the presence of drug resistant TB strains and treatment for both diseases. We compute the reproduction number of the model. Numerical simulations show the different dynamics of the model for variation of relevant parameters. Moreover, the order of the fractional derivative plays an important role in the severity of the epidemics.

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[1] Ana Carvalho, M.Sc.: Faculty of Sciences, University of Porto, 4100, PORTUGAL (up200802541@fc.up.pt).

[2] Carla M. A. Pinto, Assistant Professor: School of Engineering, Polytechnic of Porto, 4200-072, PORTUGAL (cap@isep.ipp.pt), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

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paper id: VIB230

Vibrations of a cantilevered viscoelastic beam of a fractional derivative type with a tip mass and subjected to the base motion

Jan Freundlich

Abstract: The objective of the present study is vibration of the Bernoulli-Euler cantilevered beam carrying a tip mass subjected to a base motion. The tip mass centre of gravity coincide with the point of attachment.The viscolestic properties of the beam material are expressed in terms of a fractional Kelvin-Voigt model. The Riemann –Liouville fractional derivative of order $0 < \alpha < 1$ is used. Exact relationships for natural frequencies and mode shapes of the beam are derived. The forced-vibration solution of the beam is derived using the mode superposition method. Steady-state and transient vibrations analysis are presented. Transient movement of the base is expressed by a oscillating function with linearly time-varying frequency. A convolution integral of the fractional Green's function and forcing function is used to achieve the beam response. The Green's function is formulated by two terms. The first term describes damped vibrations around the drifting equilibrium position, while the second term describes the drift of the equilibrium position. The dynamic responses are numerically calculated. A comparison between results obtained using the fractional and integer viscoelastic material models is presented. In the analysed system, the influence the term describing the drift of the equilibrium position on the beam deflection is relatively low and may be neglected in some cases. Achieved results show that an increase in the derivative order causes a decrease in vibration amplitudes of the beam.

[1)] Jan Freundlich, Ph.D.: Warsaw University of Technology, 02-254 Warszawa, ul. Narbutta 84, POLAND (jfr@simr.pw.edu.pl), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

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Dynamical Systems - Theory and Applications

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paper id: CON277

Comparative experimental results of vibration suppression with switching model of the aircraft wings

Konrad A. Markowski, Cristina I. Muresan

Abstract: For modelling the dynamics and study of the active vibration suppression possibilities in aircraft wings, the smart beam is widely used. The advantages obtained through this approach are numerous. Some of them are: aircraft stability and manoeuvrability, turbulence immunity, passenger safety and reduced fatigue damage. In this paper, the identification process of a particular smart beam is presented, as a first step. It should be noted that several models have already been proposed for this specific smart beam, but experiments carried out on the system showed both transient and steady state differences between the integer order mathematical model and experimental data, for various frequencies of vibration. This suggests that changes in the oscillation frequency should be accompanied by changes in the model. In this paper, the model of the smart beam is determined as a switching system in the frequency domain. As a result, transfer function of the fractional continuous-time linear system will be given.

[1)] Konrad A. Markowski, Assistant Professor: Warsaw University of Technology, Faculty of Electrical Engineering, Institute of Control and Industrial Electronics, Koszykowa 75, 00-662 Warsaw, POLAND (Konrad.Markowski@ee.pw.edu.pl), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

[2)] Cristina I. Muresan, Associate Professor: Technical University of Cluj-Napoca, Faculty of Automation and Computer Science, Department of Automation, 400114 Cluj-Napoca, ROMANIA (Cristina.Muresan@aut.utcluj.ro), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

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paper id: CON276

Modelling of the fractional kinetics of compartmental systems: discretization, approximation, realization

Konrad A. Markowski, Cristina I. Muresan

Abstract: In the last two decades, integral and differential calculus of a fractional order has become a subject of great interest in different areas of physics, biology, economics and other sciences. The idea of such a generalization was mentioned in 1695 by Leibniz and L'Hospital. The first definition of the fractional derivative was introduced by Liouville and Riemann at the end of the 19th century. Fractional calculus was found to be a very useful tool for modelling the behaviour of many materials and systems. This work uses some previously defined fractional differential pharmacokinetic models, which were derived from classical differential equations. It should be noted that the pharmacokinetic model is a special kind of compartmental model. The presented model is discretized and approximated for different fractional order using a new and very efficient method. Then, all possible externally quasi-positive realizations are determined, which are based on one-dimensional digraph theory. The proposed method was discussed and illustrated in detail with some numerical examples.

[1] Konrad A. Markowski, Assistant Professor: Warsaw University of Technology, Faculty of Electrical Engineering, Institute of Control and Industrial Electronics, Koszykowa 75, 00-662 Warsaw, POLAND (Konrad.Markowski@ee.pw.edu.pl), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

[2] Cristina I. Muresan, Associate Professor: Technical University of Cluj-Napoca, Faculty of Automation and Computer Science, Department of Automation, 400114 Cluj-Napoca, ROMANIA (Cristina.Muresan@aut.utcluj.ro), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

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paper id: CON95

Existence conditions for fractional order PI/PD controllers

Cristina Muresan, Isabela Birs, Clara Ionescu, Robin De Keyser

Abstract: Fractional order Proportional Integral (FO-PI) and Proportional Derivative (FO-PD) controllers are increasingly used in controlling various types of processes, with several papers demonstrating their advantage over the traditional ones. Quite frequently the design of these FO-PI/FO-PD controllers is based on a set of performance specifications that refer to the open loop gain crossover frequency, phase margin and the iso-damping property. These three performance specifications lead to a system of three nonlinear equations that need to be solved in order to determine the three tuning parameters of the controllers. However, it might occur that for a certain process and with some specific gain crossover frequency and phase margin values, the computed parameters of the FO-PI/FO-PD controllers do not fall into a range of values with correct physical meaning. In this paper, a study regarding this limitation, as well as the existence conditions for the FO-PI/FO-PD parameters are presented. The paper shows that given a certain phase margin specification, the gain crossover frequency must be selected such that the process phase fulfills a set of conditions. Then, a procedure for an accurate selection of the performance specifications is addressed, such that the tuning parameters of the fractional order controller will have a physical meaning. Illustrative examples are included.

1) Cristina Muresan, Associate Professor: Technical University of Cluj-Napoca, 400114, ROMANIA (cristina.muresan@aut.utcluj.ro).

2) Isabela Birs, B.A. (M.Sc. student): Technical University of Cluj-Napoca, 400114, ROMANIA (isabela.birs@aut.utcluj.ro), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

3) Clara Ionescu, Professor: University of Ghent, 9052, BELGIUM (claramihaela.ionescu@ugent.be).

4) Robin De Keyser, Professor: University of Ghent, 9052, BELGIUM (robain.dekeyser@ugent.be).

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Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: LIF145

Impact of diabetes and drug-resistant strains in a model for TB transmission

Carla M. A. Pinto, Ana Carvalho

Abstract: We present a fractional order model to assess the impact of diabetes and drug-resistant strains in tuberculosis (TB) transmission. The reproduction number of the model, defined as the `expected number of secondary cases produced, in a completely susceptible population, by a typical infective individual', is determined as well as the equilibria of the model and corresponding stabilities. Numerical simulations are performed for variation of significant parameters and the order of the fractional derivative, α. We find that diabetes fuels TB epidemics and progression to active TB. The drug-resistant strains increase the severity of TB.These patterns are seen for all values of the order of the fractional derivative. We present a fractional order model to assess the impact of diabetes and drug-resistant strains in tuberculosis (TB) transmission. The reproduction number of the model, defined as the `expected number of secondary cases produced, in a completely susceptible population, by a typical infective individual', is determined as well as the equilibria of the model and corresponding stabilities. Numerical simulations are performed for variation of significant parameters and the order of the fractional derivative, α. We find that diabetes fuels TB epidemics and progression to active TB. The drug-resistant strains increase the severity of TB.These patterns are seen for all values of the order of the fractional derivative.

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[1] Carla M. A. Pinto, Assistant Professor: School of Engineering, Polytechnic of Porto, 4200-072, PORTUGAL (cap@isep.ipp.pt), the author presented this contribution at the conference in the special session: "Recent advances in fractional calculus" organized by C.M.A. Pinto and C.I. Muresan.

[2] Ana Carvalho, M.Sc. (Ph.D. student): Faculty of Sciences, University of Porto, 4100, PORTUGAL (up200802541@fc.up.pt).

SPECIAL SESSION 6

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: MAT387

Topological and measure-theoretical entropies of solenoid

Andrzej Bis

Abstract: A mathematical solenoid is a geometric object which can be presented either in an abstract way as in inverse limits or in a geometric way as a nested intersections of solid tori. In dynamical systems solenoids were introduced by Smale as hyperbolic attractors of a diffeomorphism of a three-dimensional manifold. The topological complexity of a solenoid can be expressed by a topological entropy which is equal to a upper capacity of some Caratheodory structure, in a sense of Pesin. With Agnieszka Namiecińska we consider topological and measure-theoretical approach to dynamical properties of a solenoid. In general case there is no invariant measure for a solenoid, therefore one can not say neither on measure-theoretical entropy nor on a measure of maximal entropy of a solenoid. Following Bowen, we define a homogeneous measure for a solenoid and study its properties. We show that if a solenoid admits a homogeneous measure, the measure has similar properties to the measure of maximal entropy in classical dynamical systems.

[1)] Andrzej Bis, Associate Professor: University of Lodz, Department of Mathematics and Computer science, ul. Banacha 22. 90-238 Lodz, POLAND (andbis@math.uni.lodz.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

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December 11-14, 2017. Lodz, POLAND.

paper id: BIF390

Attractors in Rotation Theory

Jan Boronski

Abstract: In my talk I shall discuss some recent results concerning attractors and minimal 1-dimensional continua, where entropy arises from rotational dynamics. This will include the construction of pseudo-suspensions of minimal Cantor systems by ``lifting'' Handel-Anosov-Katok attractors, the construction of minimal almost-Slovak spaces whose Cartesian square is not minimal, and results on entropy values arising from rotational chaos on Birkhoff-like attractors. This is joint work with A. Clark (Leicester) and P. Oprocha (AGH).

[1)] Jan Boronski, Ph.D.: AGH and IT4Innovations OU, 30-059, POLAND (jan.boronski@osu.cz), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: STA383

On local aspects of entropy

Ewa Korczak-Kubiak, Ryszard Jerzy Pawlak

Abstract: On local aspects of entropy Although the notion of an entropy has a global character, in many cases the value of an entropy depends on the behaviour of a function near some point. For that reason, in many papers various versions of a notion of "entropy point" are considered. We will examine properties and relations between full entropy points and focal entropy points. Moreover, we will introduce the notion of full* entropy point and unbalanced point and examine the possibility of graph approximation of some kind of functions by functions having either full* entropy point or unbalanced point.

[1] Ewa Korczak-Kubiak, Ph.D.: University of Lodz, Faculty of Mathematics and Computer Science, Banacha 22, 90-238 Łódź, POLAND (ekor@math.uni.lodz.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

[2] Ryszard Jerzy Pawlak, Professor: University of Lodz, Faculty of Mathematics and Computer Science, Banacha 22, 90-238 Łódź, POLAND (rpawlak@math.uni.lodz.pl).

paper id: MAT386

Entropy in a theory of quantum measurement

Andrzej Łuczak, Hanna Podsędkowska

Abstract: For a physical system whose (bounded) observables are selfadjoint elements of a von Neumann algebra, and states are positive elements in its predual, the total change of state caused by measurement is described by a unital normal positive linear map acting on this algebra. Assume that the algebra in question is finite with a normal finite trace. Following Segal, we define the entropy of a state in a way analogous to the definition of von Neumann's entropy in the full algebra of all bounded linear operators on a Hilbert space. If we assume that the trace is invariant with respect to the map describing the measurement, then the entropy of the transformed state is less then or equal to the entropy of the initial state (i.e. the one before measurement). Our aim is to investigate the situation when these two entropies are the same. It turns out that for repeatable measurements (the ones considered by J. von Neumann) the conservation of Segal's entropy is equivalent to the invariance of the state under measurement.

[1] Andrzej Łuczak, Professor: Faculty of Mathematics and Computer Science, Łódź Univeersity, ul. Banacha 22, 90-238 Łódź, POLSKA (anluczak@math.uni.lodz.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

[2] Hanna Podsędkowska, Ph.D.: Faculty of Mathematics and Computer Science, Łódź Univeersity, ul. Banacha 22, 90-238 Łódź, POLSKA (hpodsedk@math.uni.lodz.pl).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: MAT385

Shadowing, entropy and minimal sets

Piotr Oprocha, Jian Li

Abstract: In this talk we will discuss consequences of shadowing property for the space of invariant measures of a given dynamical system. The main object of study is approximation of invariant measures by ergodic measures with additional properties of their supports (minimality, positive entropy, mixing). For a topologically transitive system with the shadowing property, we show that ergodic measures supported on odometers are dense in the space of invariant measures, and that every invariant measure can be approximated by measures supported on almost 1-1 extensions of odometers and close value of entropy. We will also comment on other properties such as weak mixing.

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[1] Piotr Oprocha, Professor: AGH University, al. Mickiewicza 30, 30-059 Krakow, POLAND (oprocha@agh.edu.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

[2] Jian Li, Ph.D.: Shantou University, Shantou, Guangdong 515063, CHINA (lijian09@mail.ustc.edu.cn).

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paper id: MAT389

On axjomatic concepts of classical and quantum entropy

Adam Paszkiewicz

Abstract: We compare Khinchin - Fadeen aksjoms of Shanon entropy and Urbanik - Ingarden non-probabilistic aksjoms. The ultimate solutions on additive functions on independent experiments will be also presented. Let M ⊗ N be a composition o two independent experiments M, N with finite numbers of outcomes. Assume that for some function I of experiments we always have I(M⊗N) = I(M) + I(N). We shall give the general form of I in both classical and quantum case. The quantum case is modelled by the algebra B(H) of all bounded operators in a Hilbert space H. The analogical solution for any von Neumann algebra is conjectured.

[1] Adam Paszkiewicz, Professor: Faculty of Mathematics and Computer Science University of Lodz, 90-238 Lodz, Banacha 22, POLAND (adampasz@math.uni.lodz.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

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Dynamical Systems - Theory and Applications

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paper id: STA384

On points focusing entropy

Ryszard J. Pawlak, Anna Loranty, Ewa Korczak-Kubiak

Abstract: On points focusing entropy The starting point of the considerations will be a definition of a focal entropy point for nonautonomous discrete dynamical system. Unlike the notion of full entropy point, this definition concerns the behaviour of functions exclusively around a given point. Within the scope of these issues there will be presented new results connected with the existence of such points, as well as their relations with chaotic points (this notion is based on the existence of "homoclinic points"). Moreover, various kinds of disruptions of discrete dynamical systems leading to "appearing" or "vanishing" of such points will be considered.

1) Ryszard J. Pawlak, Professor: Faculty of Mathematics and Computer Scienece, Łódź, Banacha 22, POLAND (rpawlak@math.uni.lodz.pl), the author presented this contribution at the conference in the special session: "Entropy in classical and generalized dynamical systems" organized by A. Biś.

2) Anna Loranty, Ph.D.: Faculty of Mathematics Łódź University, 90-238 Łód,ź Banacha 22, POLAND (loranta@math.uni.lodz.pl).

3) Ewa Korczak-Kubiak, Ph.D.: Faculty of Mathematics Łódź University, 90-238 Łód,ź Banacha 22, POLAND (ekor@math.uni.lodz.pl).

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Dynamical Systems - Theory and Applications

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paper id: MAT382

Entropy of groups-pseudogroups-foliations

Paweł Walczak, Katarzyna Tarchała

Abstract: Entropy for groups and pseudogroups of continuous transformations of (compact) metric spaces as well as for foliations of (closed) Riemannian manifolds has been introduced by E. Ghys, R. Langevin and P. Walczak (1988). In the case of groups and pseudogroups, this notion is analogous to that of topological entropy for single continuous transformations; entropy of foliations has been defined via its holonomy pseudogroup. In this talk, we shall (1) recall all these notion, (2) discuss some of the related classical results obtained during the three recent decades and (3) provide some new entropy estimates related to the existence (in a group or a pseudogroup) of so called "ping-pong" (and "multi-ping-pong") obtained by the two of us during the last two years.

[1] Paweł Walczak, Professor: Katedra Geometrii, Uniwersytet Łódzki, Banacha 22, 90-238 Łódź, POLAND (pawelwal@math.uni.lodz.pl), the author presented this contribution at the conference.

[2] Katarzyna Tarchała, M.Sc. (Ph.D. student): Katedra Geometrii, Uniwersytet Łódzki, Banacha 22, 90-238 Łódź, POLAND (k.tarchala@vp.pl).

LECTURES

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: VIB98

Vibrations of risers with consideration of hydrodynamic forces

Iwona Adamiec-Wójcik, Łukasz Drąg, Stanisław Wojciech

Abstract: Consideration of the influence of water environment on eigenfrequencies and modes of free vibrations is an important problem in dynamic analysis of mooring lines and risers. Hydrodynamic forces usually consist of the buoyancy force, the added mass of water, and resistance proportional to the square of relative velocities. The rigid finite element method with its modifications is one of the effective methods for modelling slender systems. The paper presents the application of one of the modified formulations of the rigid finite element method, in which the influence of water environment is considered using the Morison equations for vibration analysis of risers. The results of numerical simulations are compared with those obtained by different authors and with experimental measurements. Good compatibility of results is obtained.

1) Iwona Adamiec-Wójcik, Professor: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biala, POLAND (i.adamiec@ath.bielsko.pl).

2) Łukasz Drąg, Ph.D.: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biała, POLAND (ldrag@ath.bielsko.pl), the author presented this contribution at the conference.

3) Stanisław Wojciech, Professor: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biała, POLAND (swojciech@ath.bielsko.pl).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

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paper id: VIB99

Model of the dynamics of a knuckle-boom crane

Iwona Adamiec-Wójcik, Łukasz Drąg, Kamil Nadratowski, Stanisław Wojciech

Abstract: Multilink cranes are often used in offshore engineering due to their larger operational capacities. The paper presents the 3D model of a crane with two booms and cylinders. The model takes into account the flexibility of the booms and cylinders. The rigid finite element method is used for discretization of the links. The flexibility of the rope system is also considered. Modelling of offshore cranes requires consideration of base motion, which is the movement of a vessel or platform caused by sea waves. In the paper it is assumed that this motion can be described by harmonic functions. Results of numerical simulations are presented. The model can also be used for simulation of an active overload protection system (AOPS).

[1] Iwona Adamiec-Wójcik, Professor: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biala, POLAND (i.adamiec@ath.bielsko.pl).

[2] Łukasz Drąg, Ph.D.: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biała, POLAND (ldrag@ath.bielsko.pl), the author presented this contribution at the conference.

[3] Kamil Nadratowski, M.Sc.: Protea sp z o.o., Galaktyczna 30a, 80-299 Gdansk, POLSKA (kamil.nadratowski@protea.pl).

[4] Stanisław Wojciech, Professor: University of Bielsko-Biala, Willowa 2, 43-309 Bielsko-Biała, POLAND (swojciech@ath.bielsko.pl).

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paper id: CON169

Optimal control applied to environmentally mediated infectious disease transmission models

Shohel Ahmed, Sumaiya Rahman

Abstract: We consider an SEIR model with variable size population and formulate an optimal control problem subject to the model with vaccination and treatment as controls. Our aim is to find the optimal combination of vaccination and treatment strategies that will minimize the cost of the two control measures as well as the number of infectives. We used Pontryagin's maximum principle to characterize the optimal levels of the two controls. The resulting optimality system is solved numerically. The results show that the optimal combination of vaccination and treatment strategy required to achieve the set objective will depend on the relative cost of each of the control measures. The results from our simulation are discussed.

[1] Shohel Ahmed, M.Sc.: Lecturer, Department of Mathematics Bangladesh University of Engineering and Technology (BUET), Dhaka-1000, BANGLADESH. (shohel2443@math.buet.ac.bd), the author presented this contribution at the conference.

[2] Sumaiya Rahman, M.Sc.: Department of Statistics, University of Dhaka, Dhaka-1000, BANGLADESH. (sumaiyarahman14.sr@gmail.com).

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paper id: VIB334

Torsional vibration energy harvesting through transverse vibrations of a passively tuned beam

Panagiotis Alevras, Stephanos Theodossiades, Homer Rahnejat, Tim Saunders

Abstract: The paper highlights the potential of harvesting vibration energy from mechanical systems in the form of electrical power to activate remote electronic devices. The principal idea lies on the resonant response of a lightweight oscillator to applied external excitation, coupled with an electrodynamic transducer (e.g. piezoelectric material, inductive coils). As far as the mechanical system is concerned, the aim is to maximize the harvested energy when an attachment vibrates with relatively high amplitudes. This means that the system natural frequency should be close to the expected dominant frequency of the applied (host) vibrations. In practice however, the dominant vibration frequency varies either within a limited range due to uncertainties, or across a large band due to the fundamental operation of the host structure, such as in rotational power transmission systems with speed variations. Recently, intentional introduction of nonlinearities has been proposed to compensate for small-scale frequency shifts. Nevertheless, in most cases one cannot fully bypass tuning effects, attributed to linear stiffness components in system dynamics. In this paper, a rotational vibration energy harvester is outlined, based upon a beam attachment coupled with an electromagnetic transducer. The stiffening effect of the centrifugal force is utilized in order to passively tune the attachment to the dominant frequency of the rotational host structure. A reduced order model of the harvester is presented and its power extraction potential is assessed.

[1] Panagiotis Alevras, Ph.D.: Loughborough University, LE11 3TU, UNITED KINGDOM (p.alevras@lboro.ac.uk), the author presented this contribution at the conference.

[2] Stephanos Theodossiades, Professor: Loughborough University, LE11 3TU, UNITED KINGDOM (S.Theodossiades@lboro.ac.uk).

[3] Homer Rahnejat, Professor: Loughborough University, LE11 3TU, UNITED KINGDOM (H.Rahnejat@lboro.ac.uk).

[4] Tim Saunders, M.Sc.: Ford Engineering Research Centre, Dunton, SS15 6GB, UNITED KINGDOM (tsaunde2@ford.com).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: MAT303

Natutral oscillations of rectangular plates with holes: using Reissner's approach

Igor V. Andrianov, Jan Awrejcewicz, Alexander A. Diskovsky

Abstract: The problem regarding the influence of holes on natural oscillations of rectangular plates has not been completely solved yet. Analytical solutions based on the traditional Rayleigh-Ritz and Bubnov-Galerkin approaches are associated with difficulties due to the approximate choice of the approximating functions for the plate deflections which should satisfy the boundary conditions. In this work, in order to study the influence of an arbitrary hole on the frequencies of a rectangular plate with an arbitrary hole, Reissner's variational principle is employed. In order to validate the proposed algorithm, a test problem is solved aimed defining the fundamental frequency of the continuous simply supported square plate. The proposed algorithm of the estimation of fundamental frequency of vibrations of the rectangular plates with a free hole possesses numerous advantages in comparison to the methods used in earlier published works. Namely, it does not introduce any limits on the dimension form and location of the hole and can be extended to study a few holes and other boundary conditions for both the plate and the hole. However, the obtained frequencies can be either larger or smaller than the exact values, and there is no any way to estimate the sign of this deviation.

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[1] Igor V. Andrianov, Professor: RWTH Aachen University, D-52056 Aachen, GERMANY (igor_andrianov@hotmail.com), the author presented this contribution at the conference.

[2] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl).

[3] Alexander A. Diskovsky, Associate Professor: National Metallurgical Academy of Ukraine, UA-49005 Dnepropetrovsk, UKRAINE (alex_diskovskiy@ukr.net).

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paper id: MAT308

A new method for finding soliton solutions of the nonlinear partial differential equations

Iosif E. Andrushkevich, Alexander M. Krot

Abstract: A new method for constructing soliton solution's of nonlinear partial differential equation based on separation of variables is proposed. Here we propose and justify the method for constructing exact solutions of nonlinear partial differential equations called the generalized Fourier method for separation of variables (GFM). The essence of the Fourier method lies in the fact that the general solution of a linear differential equation with given homogeneous initial and boundary conditions is sought as a superposition of solutions satisfying the boundary conditions and representing as a product of a function of a space variable and a function of time. Finding such solutions involves seeking the eigenfunctions and eigenvalues of certain differential operators with the subsequent expansion of the initial-state functions by means of the eigenfunctions found. This paper invegtigates the conditions for the appearance of solitons as solutions of the third-order partial differential equation with quadratic nonlinearity. Computational modeling of the obtained soliton waves is carried out.

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1) Iosif E. Andrushkevich, Ph.D.: The United Institute of Informatics Problems of the National Academy of Science of Belarus, Surganova str. 6, 220012, Minsk, Belarus, BELARUS (racursj@yandex.ru), the author presented this contribution at the conference.

2) Alexander M. Krot, Professor: The United Institute of Informatics Problems of the National Academy of Science of Belarus, Surganova str. 6, 220012, Minsk, Belarus, BELARUS (alxkrot@newman.bas-net.by).

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Modelling Coulomb friction by extended Filippov systems

Máté Antali, Gábor Stépán

Abstract: When modelling the contact of two rigid bodies in the presence of Coulomb friction, a special system of first-order differential equation is obtained, which is discontinuous on a codimension-2 submanifold of the state space. This leads to the concept of Extended Filippov Systems, which was introduced recently by the authors. By using the developed methods, the conditions of slipping or rolling/stickong of the contacting rigid bodies can be analysed from purely the structure of the phase space of the slipping dynamics. By calculating the so-called limit directions of the points of the discontinuity set, our theory provides a deeper understanding of the transitions between rolling and slipping in mechanical problems. Moreover, the calculation of the limit directions helps us to create an effective numerical method to simulate these systems.

[1] Máté Antali, M.Sc. (Ph.D. student): Budapest Univeristy of Technology and Economics, H-1111, Budapest, Muegyetem rkp. 5., HUNGARY (mate.antali@gmail.com), the author presented this contribution at the conference.

[2] Gábor Stépán, Professor: Budapest University of Technology and Economics, H-1111 Budapest, Muegyetem rkp. 5., HUNGARY (stepan@mm.bme.hu).

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Computational approach for complete Lyapunov functions

Carlos Argáez, Peter Giesl, Sigurdur Freyr Hafstein

Abstract: Ordinary differential equations arise in a variety of applications, including climate modeling, electronics, predator-prey modeling, etc., and they can exhibit highly complicated dynamical behaviour. Complete Lyapunov functions capture this behaviour by dividing the phase space into two disjoint sets: the chain-recurrent part and the transient part. The first one accounts for determining the long-time behaviour and the second for determining where solutions pass through. If a complete Lyapunov function is known for a dynamical system the qualitative behaviour of the system's solutions is transparent to a large degree. The computation of a complete Lyapunov function for a given system is, however, a very hard task. We present significant improvements of an algorithm recently suggested by the authors to compute complete Lyapunov functions. The method is based on mesh-free numerical approximation to a solution of a PDE derived from setting the orbital derivative equal to -1. Previously, however, this methodology was incapable to fully detect chain-recurrent sets in dynamical systems with high differences in speed. In the new approach we replace the system under consideration with another one having the same solution trajectories but such that they are traversed at a more uniform speed. The qualitative properties of the new system such as attractors and repellers are the same as for the original one. This approach gives a better approximation to the chain-recurrent set of the system under study. We give several examples of the method and discuss its theoretical foundation.

[1] Carlos Argáez, Ph.D.: University of Iceland, 107, ICELAND (carlos@hi.is), the author presented this work at the conference.

[2] Peter Giesl, Associate Professor: University of Sussex, BN1 9QH, UNITED KINGDOM (P.A.Giesl@sussex.ac.uk).

[3] Sigurdur Freyr Hafstein, Professor: University of Iceland, 107, ICELAND (shafstein@hi.is).

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Modal analysis of the hydro turbine shaft with cracks

Ivana Atanasovska, Dejan Momcilovic, Marija Vukšić Popović

Abstract: The design process for the elements which are the parts of the structures and equipment in power industry includes both of stress and strain state calculations, as well as an analysis of natural mode shapes and frequencies. During operation of the machine elements and systems, periodic vibration measurement in unloaded and loaded state is essential for high level of availability of the equipment operation. This is especially important after the reparation of particular elements of mechanical systems, when the vibration monitoring is source of the information necessary for their proper and safe use. Therefore, the previous numerical calculations of the eigen frequency and modal analysis give the necessary information for appropriate operation loading. In this paper the dynamics of the Kaplan turbine shaft is analyzed in accordance with these preferences. The Finite Element Analysis is used for numerical simulations and calculations. The real case of the shaft failure is chosen and the analyses are performed for the shaft before and after damage appearance. The cracks of different depth are modeled at the shaft to flange transition zone, in accordance with the real damages. Also, the model of the shaft with the shape and dimensions after the reparations is analyzed in order to compare the shaft dynamics with changed transition radius. Conclusions and discussion about the obtained results are given in comparison with the real operation conditions for the analyzed case study.

[1] Ivana Atanasovska, Associate Professor: Mathematical Institute of the Serbian Academy of Sciences and Arts, Kneza Mihaila 36, 11000 Belgrade, SERBIA (iviatanasov@yahoo.com), the author presented this contribution at the conference.

[2] Dejan Momcilovic, Assistant Professor: Institute for materials testing IMS, Bulevar vojvode Misica 43, 11000 Belgrade, SERBIA (dejanmomcilovic@yahoo.com).

[3] Marija Vukšić Popović, M.Sc. (Ph.D. student): College of Professional Railway Studies, Belgrade, Zdravka Čelara 14, 11000 Belgrade, SERBIA (vuksicpopovic@bvcom.net).

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Dynamics of train composition as a discrete non-homogeneous chain system

Ivana Atanasovska, Marija Vukšić Popović, Dejan Momcilovic

Abstract: The longitudinal train dynamics which included movement and oscillations of coupled railway vehicles only in the direction of the track (longitudinal) is analyzed. The one direction motion of the train, as well as the relative motions between vehicles, is presumed. The assumption of exclusion of movements of the vehicles in the vertical direction is taken in accordance with the real low values of these displacements components. Model of train is generally present as a discrete non-homogeneous chain system with viscoelastic non-linear frictional elements. This model simulates railway vehicles equipped with conventional pneumatic brake system and brake blocks. In the presented research, for the developed train model, a general solution of the system of ordinary differential equations, which described eigen and forced vibrations of a non-homogeneous chain under the external one frequency excitation, is obtained and analyzed. The methods and procedures used for solving the described task are explained in detail. The presented theoretical simulation model and real dynamics of train composition are compared and conclusions about the suitability and accuracy of the developed model are discussed.

[1] Ivana Atanasovska, Associate Professor: Mathematical Institute of the Serbian Academy of Sciences and Arts, Kneza Mihaila 36, 11000 Belgrade, SERBIA (iviatanasov@yahoo.com), the author presented this contribution at the conference.

[2] Marija Vukšić Popović, M.Sc. (Ph.D. student): College of Professional Railway Studies, Belgrade, Zdravka Čelara 14, 11000 Belgrade, SERBIA (vuksicpopovic@bvcom.net).

[3] Dejan Momcilovic, Assistant Professor: Institute for materials testing IMS, Bulevar vojvode Misica 43, 11000 Belgrade, SERBIA (dejanmomcilovic@yahoo.com).

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Review on the Cell Discretitation Method (C.D.M.)

Nicola Maria Auciello, Maria Anna De Rosa, Maria Lippiello, Stefania Tomasiello

Abstract: In the last 40 years, the Cell Discretitation method (CDM) has become a popular method for the statical and dynamical analysis of structures. According to this method, the structure is reduced to a set of rigid bars linked together by means of elastic constraints (cells). In this way, the structure is reduced to a rigid-elastic system with a finite number of Lagragian coordinates. The latter ones may be chosen in two alternative ways: the rotations of rigid bars or the displacements of the cells. This method found several applications, for instance: - the dynamics and stability of arches; - masonry arches; - statical and dynamical analysis of Euler-Bernoulli beams under several load and boundary conditions; - statical and dynamical analysis of Timoshenko and Rayleigh beams; - statical analysis of plates; - statical and dynamical analysis of carbon nanotubes, by taking into account nonlocal effects. Due to the renovated interest in this method, especially with regard to the application to the field of carbon nanotubes, it seems appropriate proposing a critical review on the method and its current and future applications.

1) Nicola Maria Auciello, Assistant Professor: University of Basilicata, 85100, ITALY (nicola.auciello@unibas.it).

2) Maria Anna De Rosa, Assistant Professor: University of Basilicata, 85100, ITALIA (maria.derosa@unibas.it).

3) Maria Lippiello, Ph.D.: University of Naples "Federico II", 80134, ITALIA (maria.lippiello@unina.it).

4) Stefania Tomasiello, Ph.D.: CORISA - University of Salerno, 84084, ITALIA (stomasiello@unisa.it), the author presented this contribution at the conference.

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The pendulum dynamic analysis with DC motors and generators for sea waves energy harvesting

Rafael Avanço, Angelo Tusset, Marcelo Suetake, Helio Navarro, José Balthazar, Airton Nabarrete

Abstract: The present analysis is based on ideal and nonideal excitation of a pendulum. The models studied considered 4 different pendulous mechanisms and comparisons among them. The first mechanism is a pendulum ideally excited on its pivot by a crank-shaft-slider mechanism above it and the second a nonideal excitation of the same mechanism powered by a DC motor. The third considers also a nonideal excitation, however the crank and the DC motor are on the left side of the pendulum, so horizontally displacing its support. Finally, the last considers a DC generator above the pendulum collecting energy from its motion. The pendulum is suspended on a boat by its pivot and sea waves shakes the set. Hence, the generator is spun by the pendulum pivot co-axially linked to the axis of the motor or linked by the crank-shaft-slider, where this crank is co-axially coupled to the generator. The first mechanism exhibits different types of motion including chaos, rotations, oscillations and fixed points for the main resonance frequency and subhamonic frequencies. The second and third, due to the nonideal source of energy, more commonly demonstrates results with synchronization. The last, where the DC generator is coupled to the pendulum, is the novelty brought by this paper. The types of motion observed in the pendulum coupled to the DC generator include both rotations and oscillations.

[1] Rafael Avanço, Ph.D.: Technological Institute of Aeronautics (ITA), Praça Marechal Eduardo Gomes, 50 - Vila das Acacias, São José dos Campos - SP, 12228-900, BRAZIL (avancorafael@gmail.com), the author presented this contribution at the conference.

[2] Angelo Tusset, Assistant Professor: UTFPR, Av. Monteiro Lobato, s/n - Jardim Carvalho, Ponta Grossa - PR, 84016-210, BRAZIL (a.m.tusset@gmail.com).

[3] Marcelo Suetake, Assistant Professor: Federal University of São Carlos, Rodovia Washington Luís, s/n, São Carlos - SP, 13565-905, BRAZIL (mclsuetake@gmail.com).

[4] Helio Navarro, Assistant Professor: University of São Paulo, Av. Trab. São-Carlense, 400 - Parque Arnold Schimidt, São Carlos - SP, 13566-590, BRAZIL (han@sc.usp.br).

[5] José Balthazar, Professor: Technological Institute of Aeronautics (ITA), Praça Marechal Eduardo Gomes, 50 - Vila das Acacias, São José dos Campos - SP, 12228-900, BRAZIL (jmbaltha@gmail.com).

[6] Airton Nabarrete, Assistant Professor: Technological Institute of Aeronautics (ITA), Praça Marechal Eduardo Gomes, 50 - Vila das Acacias, São José dos Campos - SP, 12228-900, BRAZIL (profnabarrete@gmail.com).

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Contact interaction of two-layer axially symmetric shells taking into account both geometric nonlinearity and contact interaction

Jan Awrejcewicz, Vadim A. Krysko - jr., Irina V. Papkova

Abstract: In this paper a mathematical model of the nonlinear dynamics of flexible two-layer axially symmetric spherical shells of the same curvature is proposed. The geometric nonlinearity is taken into account by the von Kármán model. The shell material is isotropic and homogeneous. For each layer the Kirchhoff-Love hypothesis is applied. The contact interaction between the shells is taken into account according to the Kantor model. The mathematic models include an infinite number of degrees-of-freedom. The method of finite differences of the second accuracy order and the Runge-Kutta type methods are employed. The convergence of methods depending on the integration step regarding spatial coordinates is investigated and the reliability of the results is studied. The largest Lyapunov exponent is determined by the methods of Wolf, Kantz and Rosenstein. The influence of the magnitude of the amplitude gap and the frequency of the driving load on the contact interaction as well as phase synchronization are analyzed. Acknowledgements This work has been supported by the grants the Russian Science Foundation, RSF 16-19-10290

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[1] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl), the author presented this contribution at the conference.

[2] Vadim A. Krysko - jr., M.Sc. (Ph.D. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (vadimakrysko@gmail.com).

[3] Irina V. Papkova, Assistant Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ikravzova@mail.ru).

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Chaotic dynamics of geometrically nonlinear axiallysymmetric shells taking into account nano-scale parameters and coupling of temperature and deformation fields

Jan Awrejcewicz, Irina V. Papkova, Vadim A. Krysko - jr.

Abstract: A mathematical model of flexible spherical axially symmetric shells in a temperature field is derived taking into account the nano-scale effects. There are no restrictions for the temperature field distribution. The resulting set of differential equations is of hyperbolic-parabolic and hyperbolic types. In the first case, the heat conduction equations are parabolic and the equations of the shell are of the hyperbolic type, and for the second case of the hyperbolic type, both for a heat equation and for a motion equation of the shell element. The material of structural members is homogeneous and isotropic. The theory is constructed taking into account nano-scale coefficients. In the first case, a system of integro-differential equations is obtained, and a method is proposed for converting the integro-differential equations to a system of differential equations. Its convergence is investigated. The partial differential equation are reduced to the Cauchy problem by the finite differences method of the second order accuracy. The system is considered as a system with an infinite number of degrees-of-freedom. The largest Lyapunov exponent is determined using three methods: Wolf, Kantz and Rosenstein to prove the truth of chaos. Four types of boundary conditions for the shell and three types for the heat equation are considered. It is investigated the effect of a dimension-dependent parameter that significantly affects the nonlinear dynamics of the shell. Acknowledgements This work has been supported by the grants the Russian Science Foundation, RSF 16-19-10290

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[1] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl), the author presented this contribution at the conference.

[2] Irina V. Papkova, Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ikravzova@mail.ru).

[3] Vadim A. Krysko - jr., M.Sc. (Ph.D. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (vadimakrysko@gmail.com).

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Dissipative dynamics of a geometrically nonlinear Bernouli-Euler beam under the action of a transverse load and color noises

Jan Awrejcewicz, Nikolay P. Erofeev, Vitalyi Dobriyan, Vadim A. Krysko

Abstract: In this paper the theory of nonlinear dynamics for Euler-Bernoulli flexible beams under the transverse alternating load influence with account of color noises is constructed. It is shown that the concept of a phase transition admits a further generalization. For such systems the medium properties are time impermanent, as usually assumed in the study of nonequilibrium phenomena, but are subject to random time variations known as external noise. The random nature of the medium induces a more finely structured system behavior. This new type of nonequilibrium transitions in [Horsthemke, W., Lefever, R., Noise-Induced Transitions. Theory and Applications in Physics, Chemistry, and Biology, Springer-Verlag, Berlin, 1984] is called noise induced transitions. In this paper we investigate the effect of color noises on a system with an infinite number of degrees-of-freedom. Acknowledgements: This work has been supported by the grants the Russian Science Foundation, RSF 16-19-10290.

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[1] Jan Awrejcewicz, M.Sc.: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski, POLAND (jan.awrejcewicz@p.lodz.pl), the author presented this contribution at the conference.

[2] Nikolay P. Erofeev, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (erofeevnp@mail.ru).

[3] Vitalyi Dobriyan, M.Sc. (Ph.D. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (dobriy88@yandex.ru).

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru).

paper id: ASY128

Nonlinear dynamics of a dependent nano-scale Euler-Bernoulli flexible beam in a supersonic gas flow

Jan Awrejcewicz, Irina V. Papkova, Ekaterina Y. Krylova, Vadim A. Krysko

Abstract: A mathematical model of a flexible nano-scale Euler-Bernoulli beam embedded into a supersonic gas flow is derived. Supersonic gas flow is taken into account using the piston theory and the modified supersonic piston theory. The problem is solved by finite-difference methods of the second order and by the Runge-Kutta type methods. The nonlinear dynamics of flexible dimension-dependent beams while increasing the Mach number is investigated. Acknowledgement: This work has been supported by the Grant RFBR 16-08-01108a, RFBR 16-01-00721a, as well as the Grant RFBR research project No 16-31-00092

[1] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl).

[2] Irina V. Papkova, Associate Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ikravzova@mail.ru).

[3] Ekaterina Y. Krylova, Associate Professor: Saratov State University, Astrakhanskaya 83, 410012, RUSSIAN FEDERATION (Kat.Krylova@bk.ru).

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru), the author presented this contribution at the conference.

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Nonlinear dynamics of inhomogeneous in two directions nano-beams with topologic optimal microstructure

Jan Awrejcewicz, Sergey P. Pavlov, Maxim V. Zhigalov, Vadim A. Krysko

Abstract: In the first step of our study a microstructure is designed based on the method of topological optimization. Namely, for the specific conditions of loading and fastening of the beam a topological optimization of its microstructure is carried out by the criterion of maximum stiffness. In result, an optimized beam exhibit heterogeneity in two directions, i.e. in thickness and length. In the second step investigations are aimed on the static and dynamic behavior of the beam using the Bernoulli–Euler model, including the size-dependent behavior on the basis of the modified couple stress theory and the geometric nonlinearity of the von Kármán type. Comparison of static and dynamic results for the optimal and homogeneous beams has been carried out taking into account the size-dependent behavior for various boundary conditions and load types. It is shown that for a uniform beam and a beam with optimal microstructure the stress deformed state and the values of natural frequencies are significantly different, both for linear and nonlinear cases. Acknowledgements This work has been supported by the Grant RSF № 16-11-10138

[1] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[2] Sergey P. Pavlov, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (pspsar@yandex.com).

[3] Maxim V. Zhigalov, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (max.zhigalov@gmail.com).

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru), the author presented this contribution at the conference.

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The theory of coupled deformation and temperature fields for three-layer nano-mechanical structures

Jan Awrejcewicz, Tatyana V. Yakovleva, Vadim S. Kruzhilin, Svetlana A. Mitskevich, Vadim A. Krysko

Abstract: In this work a mathematical model of a mechanical structure consisting of two nanoplates is developed, and between these nanoplates there is a nanobeam, and there are gaps between the elements. The resolving equations of this mathematical model are obtained using kinematic hypotheses of the first approximation (for the plates - Kirchhoff's conjecture, for beams - Bernoulli-Euler). The contact interaction is taken into account by the theory of Kantor. As a result, the obtained model takes into account the parabolic heat conduction equation. There are no restrictions on the temperature fields distribution in height for nanoplates and nanobeams (for nanoplates, the temperature field is three-dimensional, for a beam it is two-dimensional). The resulting system of partial differential equations is hyperbolic-parabolic and of different dimension. In addition, the equations are highly nonlinear and integro-differential, since the contact interaction between the elements of the structure is taken into account. To obtain reliable results, we reduce the resulting system to the Cauchy problem by two methods: the Faedo-Galerkin method in higher approximations and the finite difference method with the approximation 0(h2) and 0(h4) with respect to the spatial coordinates. Next, the Cauchy problem is solved by the Runge-Kutta methods of the 4th, 6th, 8th accuracy orders regarding time. Acknowledgement: This work has been supported by the Grant RFBR 16-08-01108a, RFBR 16-01-00721a, as well as the Grant President of the Russian Federation MK-5609.2016.8.

[1)] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl), the author presented this contribution at the conference.

[2)] Tatyana V. Yakovleva, Ph.D.: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION, and Cybernetic Institute, National Research Tomsk Polytechnic University, Lenin Avenue 30, 634050 Tomsk, RUSSIAN FEDERATION (Yan-tan1987@mail.ru).

[3)] Vadim S. Kruzhilin, B.A. (M.Sc. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (mrkruzhilin@mail.ru).

[4)] Svetlana A. Mitskevich, Associate Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (svetlana.mitskevich@gmail.com).

[5)] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION

paper id: ASY304

Theory of dimensionally dependent physically nonlinear Euler-Bernoulli beams in an aggressive medium with account of coupling of temperature and deformation fields

Jan Awrejcewicz, Tatyana Y. Yakovleva, Ekaterina Y. Krylova, Anastasiya O. Sinichkina, Vadim A. Krysko - jr.

Abstract: In this paper a dimensionally dependent theory of physically nonlinear beams described by the kinematic theory of the first approximation is constructed. The basis of the developed theory is the moment theory of elasticity. The physical nonlinearity is taken into account following the Birger method of variable elasticity parameters, according to which the physical parameters of the beam material are not constant, but are functions of coordinates and a stress-strain state of the structure. The input partial differential equations of motion are obtained from the Hamilton variation principle. Equations take into account the relationship between deformation and temperature fields, material dependence on temperature and the aggressive medium properties in which the beam is located. The governing equations are nonlinear of the hyperbolic-parabolic type and exhibit different dimension. The equation of beam motion is one-dimensional, and the equation of thermal conductivity is two-dimensional. It means that no any restrictions for temperature distribution over beam thickness are employed. A calculation algorithm with nested iterations is developed in order to solve the problem in a reliable and validated way.
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[1] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl), the author presented this contribution at the conference.

[2] Tatyana Y. Yakovleva, Ph.D.: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION, and Cybernetic Institute, National Research Tomsk Polytechnic University, 634050 Tomsk, Lenin Avenue, 30, RUSSIAN FEDERATION (Yan-tan1987@mail.ru).

[3] Ekaterina Y. Krylova, Associate Professor: Saratov State University, Russian Federation, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (Kat.Krylova@bk.ru).

[4] Anastasiya O. Sinichkina, M.Sc. (Ph.D. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (andreevaanastasiaolegovna@gmail.com).

[5] Vadim A. Krysko - jr., M.Sc. (Ph.D. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (vadimakrysko@gmail.com).

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Control of vibrations of multistorey buildings with use of passive dampers

Ersin Aydin, Baki Öztürk, Maciej Dutkiewicz

Abstract: In the paper, the analysis of control of vibrations of multi-storey building with use of passive dampers is performed. The purpose is application of additional dampers which will absorb the part of energy supplied to the building. The cost function is defined as the sum of damping coefficients of the dampers . Minimizing the sum of the damping coefficients of the added dampers is the criteria for analysis. After the optimal designs and the minimum costs and their variation with respect to fundamental period and target added damping are found, the optimal designs are tested using the spectral analysis. Numerical example is presented to prove the validity of the proposed method. The changes of optimal distributions of the dampers with respect to target damping ratios and structural periods in a particular range are investigated for multi-storey building model. The numerical results show that the proposed damper optimization method is efficient to find optimal damper distribution for a target damping ratio.

1) Ersin Aydin, Associate Professor: Faculty of Engineering, Department of Civil Engineering, Ömer Halisdemir University, Nigde, TURKEY (eaydin@ohu.edu.tr).

2) Baki Öztürk, Associate Professor: Faculty of Engineering, Department of Civil Engineering, Hacettepe University, Ankara, TURKEY (bakiozturk@hacettepe.edu.tr).

3) Maciej Dutkiewicz, Ph.D.: University of Science and Technology, Faculty of Civil, Architecture and Environmental Engineering, ul. Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (macdut@utp.edu.pl), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: EXP338

Reliability analysis of retaining wall using seismic cone test data

Irena Baginska, Marek Wyjadlowski

Abstract: The aim of this paper is to examine the influence of geotechnical uncertainties on the reliability retaining wall. The results from seismic piezocone tests (SCPTu) are shown to be applicable for providing all the necessary input parameters to drive the computations and calculate displacements of retaining wall. The physical uncertainties of action, the inherent variability of soil and model error were assessed by experimental in situ seismic piezocone test (SCPTu). The approach involves a combination of finite element analysis, random field theory and Monte Carlo simulations. Small-strain stiffness is mostly found to be manifold of stiffness obtained in classical laboratory testing. Therefore, not accounting for it in geotechnical analyses may result in overestimating retaining wall deflections. In this calculation HS-small input parameter soil stiffness Go (in program PLAXIS parameter: Goref) is derived from SCPTu testing In the analysis the soil parameter has been expected as a random variable: G shearing module and parameters entered for model HS-small: Goref (shear stiffness at very small levels). The value is described in a one-dimensional random field with Markov's correlation structureThe task shows usefulness of the used modelling tools with the help non-linear ground model and ground parameters based on SCPTu sounding.

[1] Irena Baginska, Ph.D.: Wroclaw University of Science and Technology, Wrocław, Wybrzeże Wyspiańskiego 27, POLAND (irena.baqinska@pwr.wroc.pl).

[2] Marek Wyjadlowski, Ph.D.: Wroclaw University of Science and Technology, Wrocław, Wybrzeże Wyspiańskiego 27, POLAND (marek.wyjadlowski@pwr.wroc.pl), the author presented this contribution at the conference.

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paper id: ASY157

Weak instability and small oscillations of non-conservative mechanical systems under the action of quadratic dissipative forces

Alexander Baikov

Abstract: Two-degrees-of-freedom holonomic mechanical systems under the action of non-conservative positional forces and quadratic dissipative forces are considered. It is assumed that there is exists an equilibrium point and this point is stable in linear approximation. The nonlinear Ziegler effect is investigated by the averaging method. Sufficient conditions of non-linear Ziegler effect are obtained. Further, weak instability of equilibrium point is investigated. Two cases are considered. There is no resonance between frequencies of linear oscillations in first case. Frequencies of linear oscillations are in resonance 1: 2 in second case. The sufficient conditions of weak instability are obtained in both cases. Small oscillations in a neighborhood of destabilized equilibrium point are investigated in second case. The small limit cycle is founded, the sufficient condition of its orbital stability is obtained. The limit cycle attraction domain is estimated by one theorem of averaging theory.

[1] Alexander Baikov, Ph.D.: Moscow Aviation Institute (National Research University), 125993, Moscow, Volokolamskoe shosse, 4, RUSSIA (alexbaikov16@gmail.com), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: NON151

Symbolic dynamics of piecewise linear systems and its application to some mechanical systems with dry friction

Alexander Baikov, Nikolay Kovalev

Abstract: The piecewise linear systems are considered. These systems had a discontinuity along a hyperplane. In each half-spaces of continuity, the phase flow is described by linear differential equations with constant coefficients. In addition, the trivial equilibrium position of motion equations is stable. Continuous trajectories are associated with Filippov-type solutions. Trajectories of such systems may return to the discontinuity. The evolution of trajectories is investigated by the methods of symbolic dynamics. Trajectory sections lying on the discontinuity are also obtained. Some mechanical systems with dry friction are considered and the main example is the linear oscillator on a rough plane. More precisely, double linear oscillator (with two degrees of freedom) on a moving rough horizontal plane is considered. The sticking zone is obtained, periodic and quasiperiodic trajectories are found, chaotic motions are investigated.

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1) Alexander Baikov, Ph.D.: Moscow Aviation Institute (National Research University), 125993, Moscow, Volokolamskoe shosse, 4, RUSSIA (alexbaikov16@gmail.com), the author presented this contribution at the conference.

2) Nikolay Kovalev, M.Sc. (Ph.D. student): Moscow Aviation Institute (National Research University), 125993, Moscow, Volokolamskoe shosse, 4, RUSSIA (nic_scr@mail.ru).

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paper id: EXP357

Vibration characteristics of FEUP new campus library building

Rui Barros, Fabio Paiva, Manuel Braz-Cesar

Abstract: This work determines the numerical vibration characteristics and verifies the seismic response of FEUP (School of Engineering of the University of Porto) new campus library building, through the application of new seismic regulations EN 1998-1 (Eurocode 8). The building under study was designed in 1995, so based on the previous design rules RSAEEP (Regulations on Safety and Actions for Structures of Buildings and Bridges) and REBAP (Regulations for Reinforced and Prestressed Concrete Structures). For the building characterization and seismic analysis and performance according to EN 1998-1, the respective numerical modeling was performed in two distinct software: SAP2000 and Robot Structural Analysis. These enabled comparisons between the results obtained in each software. The analysis performed, showed that the shear walls mostly resist to earthquake action; this led to a new numerical formulation in which the contributions of the columns in the resistance to the seismic action was not accounted for.

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[1] Rui Barros, Professor: FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division (VAT number for accounting purposes: 501 413 197), Rua Roberto Frias, PORTO 4200-465, PORTUGAL (rcb@fe.up.pt), the author presented this contribution at the conference.

[2] Fabio Paiva, M.Sc. (Ph.D. student): FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division, Rua Roberto Frias, PORTO 4200-465, PORTUGAL (fmp@fe.up.pt).

[3] Manuel Braz-Cesar, Assistant Professor: Polytechnic Institute of Braganca, Campus Santa Apolonia, Braganca 5300-253, PORTUGAL (brazcesar@ipb.pt).

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Dynamical Systems - Theory and Applications

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paper id: EXP156

Numerical and experimental analysis of crack detection system based on elastic waves propagation method

Marek Barski, Adam Stawiarski

Abstract: The current work is devoted to the problem of crack detection in the isotropic plate with a circular hole. It is assumed that in the geometrical center of a rectangular plate is a circular hole. The plate is made of aluminum alloy. The external load causes the stress concentration near the edge of the hole. The external load leads to crack initiation and its further growth. The main aim of the presented paper is to design a system of crack detection at the early stage of its evolution. Moreover, this system should also make possible the evaluation of the crack length. In order to cope with this task the advanced system based on the elastic waves propagation phenomenon is proposed. The elastic waves are excited and received by piezoelectric elements. The system is based on the pitch - catch measurement technique. The actuator is installed near the edge of a hole and 9 sensors are located in some distance from the hole. The actuator generates an excitation signal and next the rest of the piezoelectric transducers receive a dynamic response of the structure. The collected signals are then compared with the signals obtained for the reference (intact) structure. If these signals differ significantly it means that a damage exists between a particular pair of actuator and sensor. Advanced algorithm for visualization of the obtained results is proposed. In the work there are presented numerical simulations (finite element method) of the designed system. The simulations are performed for several length of the crack. Next, the experimental tests are performed.

[1] Marek Barski, Associate Professor: Cracow University of Technology, al. Jana Pawła II 37, 31-864 Kraków, Poland, POLAND (mbar@mech.pk.edu.pl).

[2] Adam Stawiarski, Assistant Professor: Cracow University of Technology, al. Jana Pawła II 37, 31-864 Kraków, Poland, POLAND (asta@mech.pk.edu.pl), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: STA82

Generic bifurcations in thermodynamics by fractional continuum mechanics

Peter B. Beda

Abstract: In the last years non-integer differentiation became a popular tool for modeling complex behaviors of systems from diverse fields of mechanics. Especially, long-range temporal or spatial dependence phenomena inherent to fractional order systems present unique and intriguing peculiarities, not supported by their integer order version. In dynamic stability analysis mathematical aspects of non-locality were studied by using the theory of dynamical systems. Such approach results in conditions for cases, when the differential operators have critical eigenvalues of zero real-parts. When the critical eigenvalues have nontrivial eigenspace, the ways of loss of stability is classified as a typical (or generic) bifurcation. Our experiences show that material non-locality and the generic nature of bifurcation at instability are connected and the basic functions of the non-trivial eigenspace can be used to determine internal length quantities of non-local mechanics. Fractional calculus is already successfully used in thermo-elasticity. In the paper non-locality is introduced via fractional strain into the constitutive relations. Then by defining dynamical systems stability and bifurcation is studied for states of thermo-mechanic solids. Stability conditions and genericity conditions are presented for constitutive relations under consideration. Internal length effects are also studied by calculating critical non-trivial eigenspaces and the basic functions of them. Such functions are essential in bifurcation analysis in non-linear studies.

[1] Peter B. Beda, Professor: Budapest University of Technology and Economics, H-1111 Műegyetem rkp. 1-3., HUNGARY (beda.peter.b@gmail.com), the author presented this contribution at the conference.

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paper id: CON166

Gait transitions in artificial non-standard snake-like locomotion systems using adaptive control

Carsten Behn, Jonas Kräml

Abstract: This paper contributes to the modeling, analysis and control of terrestrial artificial locomotion systems. Inspired by previous models, we set up an unconventional model for a snake-like locomotion systems in form of a chain of visco-elastically interconnected mass points in a plane with passive joints, but -- in contrast to literature -- active links (time-varying link-length) and rotatable skids to change the movement direction and to avoid obstacles. We investigate this model in a dynamical way and focus on controlling these link lengths to achieve a global movement, steered by the skids. From dynamics, the actuator forces have to adjust the prescribed link length for the locomotion. Since it is impossible to determine the necessary actuator forces a-priori, we apply an adaptive lambda-tracking controller to enable the system to adjust these force outputs on-line on its own. Prescribed motion patterns, i.e. specific gaits, are required to guarantee a controlled movement that differ in the number of resting mass points, the load of actuators and spikes, and the lateral forces of the skids. In contrast to literature, the investigated system of n=10 mass points exhibit a large variety of possible gaits. To determine the most advantageous gaits, numerical investigations are performed and a weighting function offers a decision of best possible gaits. Using these gaits, a gait transition algorithm, which autonomously changes velocity and number of resting mass points depending on the spike, actuator and lateral skid force load, is presented and tested in numerical simulations.

[1] Carsten Behn, Associate Professor: Technische Universität Ilmenau, Dept. of Mechanical Engineering, Technical Mechanics Group, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (carsten.behn@tu-ilmenau.de), the author presented this contribution at the conference.

[2] Jonas Kräml, M.Sc.: Technische Universität Ilmenau, Dept. of Mechanical Engineering, Technical Mechanics Group, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (jonas.kraeml@tu-ilmenau.de).

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paper id: LIF163

Tracking control of a muscle-like actuated double pendulum

Carsten Behn, Konrad Siedler

Abstract: Adaptive control strategies are analyzed in numerical simulations to control a robot arm with a double pendulum structure. Powered by antagonistic, muscle-like actuators, the controller shall enable the system to track prescribed trajectories for a desired movement as quickly and precisely as possible. But, due to the natural muscle behavior, the control variables underly prescribed bounds: the limited control inputs are generated by muscle intensities. Therefore, feedback strategies are sought which have to be limited from the very beginning. For this, at first, the principles of adaptive lambda-tracking control are introduced by simulations of a system with a DoF=1. Lambda-tracking allows a simple feedback and gain adaptation structure. A preselection of the best-rated controllers is made to apply them to a system with DoF=2. After some model adjustments to the real mechanics of a prototype (for experimental verification), an intensity control is determined, to divide the controller variables to the respective muscle pairs. Then, various numerical simulations of a system with DoF=2 are performed. The previously described and analyzed control structures are then checked regarding to set-point control and tracking. For the optimization of the simulation results different approaches are introduced, for example: limitation of the muscle activity, the insertion of an error vector, adaptive determination of factors of a saturated controller.

[1] Carsten Behn, Associate Professor: Technische Universität Ilmenau, Dept. of Mechanical Engineering, Technical Mechanics Group, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (carsten.behn@tu-ilmenau.de), the author presented this contribution at the conference.

[2] Konrad Siedler, M.Sc.: Technische Universität Ilmenau, Dept. of Mechanical Engineering, Technical Mechanics Group, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (konrad.siedler@tu-ilmenau.de).

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paper id: LIF211

Fractional calculus evaluation of hyaluronic acid cross-linking in a nanoscopic part of articular cartilage model system

Piotr Beldowski, Piotr Weber, Adam Gadomski, Tristan De Leon, Wayne Augé

Abstract: Hyaluronic acid is one of the most important components of articular cartilage (AC) synovial joint organ systems. One of its primary roles is to provide viscoelasticity to the system. However, at changing physiological conditions, including those related to pathogenesis, hyaluronic acid properties change dramatically. This work presents a study of the mechanism of physical cross-linking of hyaluronic acid in the presence of common phospholipids in synovial joint organ systems. Molecular dynamic simulations have been performed to understand the formation of hyaluronan networks at various phospholipid concentrations. The results of the simulations suggest that the mechanisms exhibit sub-diffusion characteristics. Transportation quantities derive as a function of time during numerical calculations of mean square displacement, and observations of sublinear growth were noted. Coarse-grained models are deployed to obtain a mathematical description where a random walker and several sub-diffusion schemes of its motion describe the models. The findings of this study may establish mechanisms of biopolymer network formations in normal and pathologic synovial fluid and help elucidate the mechanism of facilitated AC bio-lubrication.

1) Piotr Beldowski, M.Sc. (Ph.D. student): University of Science and Technology, Bydgoszcz, 85-796, POLAND (piobel000@utp.edu.pl), the author presented this contribution at the conference.

2) Piotr Weber, Ph.D.: Atomic and Optical Physics Division: Department of Atomic, Molecular and Optical Physics; Gdansk University of Technology, 80-233, POLAND (pweber@mif.pg.gda.pl).

3) Adam Gadomski, Professor: University of Science and Technology, Bydgoszcz, 85-796, POLAND (agad@utp.edu.pl).

4) Tristan De Leon, B.A.: Delaware State University, College of Mathematics, Natural Sciences and Technology, 19901, UNITED STATES (tristan.deleon12@gmail.com).

5) Wayne Augé, Ph.D.: NuOrtho Surgical, Inc., 02723, UNITED STATES (nnmoc@aol.com).

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paper id: LIF53

Reconstruction of motor force during stick balancing

László Bencsik, Bálint Bodor, Tamás Insperger

Abstract: To understand the mechanism of human balancing is a scientifically challenging task. As a characteristic measure of balancing and its ability many times the stick balancing is studied. In the stick balancing tests the stick have to be balanced on the fingertip. The goals of the measurements are to find the control forces and to discover the nature of the human controller during this task. Since the kinematics of the motion can be measured directly using a motion capturing system, the calculation of the control forces is more problematic. It seems straightforward to calculate the control forces using an inverse dynamic calculation based on the accelerations. Using a classical motion capturing systems these values can be derived only by numerical differentiation, which cause large drift in the computation. Thus the calculated control forces not results the same motion. In order to overcome this problem in this study a new approach will be proposed. In this method the solution of the linearized method is used then an optimization problem is solved to find a control force which results same motion with capture motion in the numerical simulation. In the proposed technique for the calculation of the control forces there is no need for the numerical differentiation of the measured data.

[1] László Bencsik, M.Sc.: MTA-BME Human Balancing Research Group, H-1111, Budapest Megyetem rkp 5, HUNGARY (l.bencsik@hotmail.com), the author presented this contribution at the conference.

[2] Bálint Bodor, B.A. (M.Sc. student): Budapest University of Technology and Economics, 5 Muegyetem Rakpart, Budapest, Hungary, H-1111, HUNGARY (bodor.balus@gmail.com).

[3] Tamás Insperger, Professor: MTA-BME Human Balancing Research Group, 5 Muegyetem Rakpart, Budapest, Hungary, H-1111, HUNGARY (insperger@mm.bme.hu).

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paper id: LIF118

Stokes' flow through a tube with wavy walls

Włodzimierz Bielski, Ryszard Wojnar

Abstract: The problem of steady flow through a tube with a wavy wall appears in different applications. It is very important in hemorheology and hemodynamics. The task is also related to geophysical problems of stream flows past the rough bottom, in peculiarity in channels with obstacles on the bottom. To account this phenomenon the effect of small amplitude wall waviness on the steady flow in a tube is studied. Namely, we consider a Stokesian pressure driven flow in tube with a wavy wall. The problem is axially-symmetric. Thus, we are dealing with two dimensional steady problem, described by two position co-ordinates r and z. The radius R of the pipe cross-section is a periodic function of the z-axis, what means that the wall shape is described by a surface periodic along the z-axis, $R=R_o+\epsilon a\cos Kz$. Here R_o is the mean value of the pipe radius, ϵ is a dimensionless smallness parameter, a is the amplitude of the wall wave, and $K=2\pi/ \lambda$, where λ denotes the length of the wall wave. The solution v belongs to the class of periodic functions with period λ in z. A study of Stokesian flow is performed on instance of Malevich - Mityushev - Adler's papers, (e.g. Acta Mechanica 197, 247, 2008) and a correction to Hagen-Poiseuille's type flow is found. The solution was obtained by expanding the stream function in a Fourier series and expanding the boundary surface in Taylor's series. Even in the first order approximation $O(\epsilon)$, new results are obtained.

[1] Włodzimierz Bielski, Professor: Institute of Geophysics Polish Academy of Sciences, ul. Księcia Janusza 64, 01-452 Warsaw, POLAND (wbielski@igf.edu.pl).

[2] Ryszard Wojnar, Ph.D.: Institute of Fundamental Technological Research PAS, Pawińskiego 5B, 02-106 Warszawa, POLAND (rwojnar@ippt.pan.pl), the author presented this contribution at the conference.

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paper id: LIF352

A novel human "broomstick" forward fall model and its application in the strength analysis of the human upper extremity

Paweł Biesiacki, Dariusz Grzelczyk, Jerzy Mrozowski, Jan Awrejcewicz

Abstract: In this paper we present a human forward fall model simulating the process of "falling like a broomstick" to the ground on the outstretched arms as the worst scenario of a forward fall. The proposed model, implemented in Mathematica, is constructed based on a mechanical system and the biomechanical relationships between the hands and the ground are modelled by a non-linear impact law. The parameters of the model are estimated based on the scanned computer model of the human body and the experimental investigations performed with the help of the Optitrack motion capture system. The proposed fall model allows to estimate time histories of ground reaction force in various scenarios of fall, and the obtained numerical simulations fit qualitatively and quantitatively with other results presented in the literature. The obtained ground reaction forces are used as a time-varying load conditions in the finite element model of the human upper extremity created in Mimics software from computed tomography data. Finally, strength analysis of radius and ulna with two different fracture risk criteria are carried out, and the performed numerical analysis indicates that the strain criterion seems to be more useful for estimating the radius fracture site in comparison to the stress criterion.

[1] Paweł Biesiacki, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (pawel.biesiacki@dokt.p.lodz.pl), the author presented this contribution at the conference.

[2] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (dariusz.grzelczyk@p.lodz.pl).

[3] Jerzy Mrozowski, Associate Professor: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (jerzy.mrozowski@p.lodz.pl).

[4] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (jan.awrejcewicz@p.lodz.pl).

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paper id: BIF378

Nonlinear Quantum Theory

Bjorn Birnir

Abstract: We model the dynamics of electrons in doped quantum wells driven by terahertz radiation and a superlattice biased by a dc voltage. We compute coherent, self-consistent electron states, density matrix equations of motion, and dipole absorption spectra. The model simultaneously accounts for intersubband transitions and many nonlinear phenomena that have been observed in these systems. We predict a bistable response for strong terahertz fields and bifurcations to coherent timeperiodic quantum states. These bifurcation include, period-doubling bifurcations, producing a subharmonic response, Hopf bifurcations producing an incommensurate frequency response, and a cascade of period doubling bifurcations to a strange attractor. These bifurcation have been difficult to measure in single quantum wells. Therefore we design super-lattice heterostructures of quantum wells where these bifurcations occur and are easier to measure.

1) Bjorn Birnir, Professor: University of California, Santa Barbara, Dept. of Math. Univ. of California, Santa Barbara, USA (birnirb@gmail.com), the author presented this contribution at the conference.

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paper id: VIB159

The Sommerfeld effect in a single DOF spring-mass-damper system with non-ideal excitation

Alfa Bisoi, Saurabh Kumar Bharti, Arun Kumar Samantaray, Ranjan Bhattacharyya

Abstract: In this paper, we provide an alternate method to study the behavior of a single degree of freedom damped oscillator subject to a non-ideal source of excitation. Increase in input power from non-ideal drive in resonance region may lead to increase the transverse vibrations without increasing the rotor spin, this phenomenon is known as Sommerfeld effect. Severe Sommerfeld effect can lead to persistent large synchronous whirl amplitudes and capture of rotor speed at the resonance frequency, which can damage the rotor, bearings, and other equipment. In particular, the Sommerfeld effect which refers to the nonlinear phenomenon causing sudden jumps of frequency and amplitude of oscillation near resonance is examined in this study. It is believed that explanation of this effect is best understood by considering a balance of the dissipated and the excitation energies per cycle of motion in steady state. The value of the critical parameter, in the present case the input voltage to a DC motor with eccentric rotating mass, is obtained beyond which jumps take place and the unachievable speed range either with coast up or coast down operation Transient solutions may show premature jumps, however, quasi static solution of the equations of motion predicts jumps very near the critical voltage. Finally, for a given set of system and motor parameters it is shown that beyond a certain value of the damping coefficient, the resonance is smoothly crossed.

[1)] Alfa Bisoi, Ph.D.: IIT Kharagpur, Department of Mechanical engineering, IIT, Kharagpur, West Bengal-721302, INDIA (alfabisoi@gmail.com), the author presented this contribution at the conference.

[2)] Saurabh Kumar Bharti, Ph.D.: IIT Kharagpur, Systems, Dynamics and Control Laboratory, Department of Mechanical Engineering, IIT Kharagpur – 721302, INDIA (saurabh2k8@gmail.com).

[3)] Arun Kumar Samantaray, Professor: IIT Kharagpur, Department of Mechanical engineering, IIT, Kharagpur, West Bengal-721302, INDIA (samantaray@mech.iitkgp.ernet.in).

[4)] Ranjan Bhattacharyya, Professor: IIT Kharagpur, Department of Mechanical engineering, IIT, Kharagpur, West Bengal-721302, INDIA (rbmail@mech.iitkgp.ernet.in).

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paper id: STA40

Lyapunov functions for almost sure exponential stability

Hjörtur Björnsson, Sigurdur Hafstein

Abstract: We present a generalization of results obtained by X. Mao in his book "Stochastic Differential Equations and Applications" (2008). When studying what Mao calls "almost sure exponential stability", essentially a negative upper bound on the almost sure Lyapunov exponents, he works with Lyapunov functions that are twice continuously differentiable in the spatial variable and continuously differentiable in time. Mao gives sufficient conditions in terms of such a Lyapunov function for a solution of a stochastic differential equation to be almost surely exponentially stable. Further, he gives sufficient conditions of a similar kind for the the solution to be almost surely exponentially unstable. Unfortunately this class of Lyapunov functions is too restrictive. Indeed, R. Khasminskii showed in his book "Stochastic Stability of Differential Equations" (1979/2012) that even for an autonomous stochastic differential equation with constant coefficients, of which the solution is stochastically stable and such that the deterministic part has an unstable equilibrium, there cannot exists a Lyapunov function that is differentiable at the origin. These restrictions are inherited by Mao's Lyapunov functions. We therefore consider Lyapunov functions that are not necessarily differentiable at the origin and we show that the sufficiency conditions Mao proves can be generalized to Lyapunov functions of this form.

[1] Hjörtur Björnsson, M.Sc. (Ph.D. student): University of Iceland, Dunhagi 5, 107 Reykjavík, ICELAND (hjb6@hi.is), the author presented this work at the conference.

[2] Sigurdur Hafstein, Professor: University of Iceland, Dunhagi 5, 107 Reykjavik, ICELAND (shafstein@hi.is).

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paper id: CON55

Control strategy in a case of a model based control of a parallel planar manipulator applied for rehabilitation

Krzysztof Bobrowski, Wiktoria Wojnicz, Krzysztof Lipinski

Abstract: In the paper, control system is proposed for a model based-control of a parallel planar manipulator. The main task of the manipulator is to help in rehabilitation of arm diseases. The necessity of circuital trajectory of the hand fixing point is considered in the paper. All geometrical and inertial parameters of the manipulator and the arm are considered as known. Thanks with the help of the multibody dynamics a model base control is proposed. Reaction of the system on a pain-crisis is considered. At a given angle of elbow position, a significant paint is considered and muscle contraction is considered. It disturb the required control strategy, and the trajectory may not be followed correctly. Two aspects are critical in the considered situation. Some necessity of a feed-forward control loop, to correct the trajectory smoothly (to prevent against the intensively forced motion and the pain continuation). Secondly, identification of symptoms of the muscle contraction and the necessary modification of the trajectory, to prevent against the pain repetition. Solution is proposed in the paper for these two aspects.

[1)] Krzysztof Bobrowski, M.Sc. (Ph.D. student): Gdańsk University of Technology, ul. Narutowicza 11/12, POLSKA (krzybobrowski@gmail.com).

[2)] Wiktoria Wojnicz, Ph.D.: Gdańsk University of Technology, ul. Narutowicza 11/12, POLAND (wiktoria.wojnicz@pg.gda.pl).

[3)] Krzysztof Lipinski, Ph.D.: Gdańsk University of Technology, ul. Narutowicza 11/12, POLSKA (klipinsk@pg.gda.pl), the author presented this work at the conference.

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Optimization of a semi-active fuzzy controller for seismic vibration reduction using a genetic algorithm

Manuel Braz César, Rui Barros

Abstract: As is well-known, intelligent control systems are capable to deal with uncertain systems in order to change the response in accordance with the operating conditions. This allows for the development of adaptive controllers for non-linear or uncertain engineering applications such as complex vibration problems. On the other hand, semi-active control of structures has being widely studied as an alternative to conventional vibration reduction techniques usually based on passive control systems. In this case, fuzzy logic based controllers seem to be quite appropriate to deal with the complex response of civil structures and the predictable non-linear behavior of semi-active control systems. However, the performance of a fuzzy logic controller depends on its control rules and membership functions, which can be difficult to tune or define using simple human reasoning. This paper presents an optimization procedure for tuning fuzzy control rules of a semi-active controller using a genetic algorithm (GA) in order to make the fuzzy logic control system behave as closely as possible to a predefined behavior. The proposed GA optimized fuzzy logic controller is evaluated by analyzing the performance of a semi-active control system in reducing seismic-induced vibrations of a three-story shear structure equipped with a magnetorheological (MR) damper operating as a passive and semi-active actuator.

[1)] Manuel Braz César, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (brazcesar@ipb.pt), the author presented this contribution at the conference.

[2)] Rui Barros, Associate Professor: Faculty of Engineering of the University of Porto, R. Dr. Roberto Frias, 4200-465 Porto, PORTUGAL (rcb@fe.up.pt).

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The experimental determination of bearings dynamic coefficients in a wide range of rotational speeds, taking into account the resonant speed and speeds at which there was a phenomenon of hydrodynamic instability

Łukasz Breńkacz, Grzegorz Żywica, Marta Drosińska-Komor, Natalia Szewczuk-Krypa

Abstract: Methods for the experimental determination of dynamic coefficients are commonly used for the analysis of various types of bearings, including hydrodynamic, aerodynamic and foil bearings. There are currently several algorithms that allow estimating bearing dynamic coefficients. Such algorithms usually use various excitation techniques applied to rotor–bearings systems. So far only a small number of scientific publications show how calculated dynamic coefficients of bearings change as speed rises. In the literature, there are no computation results that demonstrate changes in these coefficients either in a broad range of speeds(that would cover resonant speeds) or at speeds at which a phenomenon of hydrodynamic instability can be observed. This article fills the literature gap in question. For calculation purposes, the impulse response method based on an in-house algorithm (with a linear approximation using the least squares method) was applied. On its basis, the stiffness, damping and mass coefficients of a rotor–bearings system were calculated. It turns out that some of the obtained values of damping coefficients are negative at the resonant speed. Moreover, if the values are calculated at a speed at which the hydrodynamic instability phenomenon is present they are accompanied by considerably higher standard deviations. On the basis of our computation results and the literature review, capabilities and limitations of the method used for the experimental identification of dynamic coefficients of hydrodynamic bearings were discussed.

[1] Łukasz Breńkacz, Ph.D.: Institute of Fluid Flow Machinery, Polish Academy of Sciences, Fiszera 14, 80-283 Gdańsk, POLAND (lbrenkacz@imp.gda.pl), the author presented this contribution at the conference.

[2] Grzegorz Żywica, Ph.D.: Institute of Fluid Flow Machinery, Polish Academy of Sciences, Fiszera 14, 80-283 Gdańsk, POLAND (gzywica@imp.gda.pl).

[3] Marta Drosińska-Komor, M.Sc. (Ph.D. student): Faculty of Ocean Engineering and Ship Technology, Gdańsk University of Technology, G. Narutowicza 11/12, 80-233 Gdańsk, POLAND (mardrosi@pg.edu.pl).

[4] Natalia Szewczuk-Krypa, M.Sc. (Ph.D. student): Faculty of Ocean Engineering and Ship Technology, Gdańsk University of Technology, G. Narutowicza 11/12, 80-233 Gdańsk, POLAND (natszew1@pg.edu.pl).

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Time-varying spectral submanifolds: Analytic calculation of backbone curves and forced responses of nonlinear mechanical systems

Thomas Breunung, George Haller

Abstract: Spectral submanifolds (SSMs) have recently been shown to provide exact and unique reduced-order models for nonlinear unforced mechanical vibrations. Here we extend these results to periodically or quasiperiodically forced mechanical systems, obtaining analytic expressions for forced responses and backbone curves on modal (i.e. two-dimensional) time dependent SSMs. A judicious choice of the parameterization of these SSMs allows us to simplify the reduced dynamics considerably. We demonstrate our analytical formulae on numerical examples and compare them to results obtained from available normal form methods.

[1)] Thomas Breunung, M.Sc. (Ph.D. student): Institute for Mechanical Systems, ETH Zürich, Leonhardstrasse 21 LEE M 228, 8092 Zurich, SWITZERLAND (brethoma@ethz.ch), the author presented this contribution at the conference.

[2)] George Haller, Professor: Institute for Mechanical Systems, ETH Zürich, Leonhardstrasse 21 LEE M210, 8092 Zürich, SWITZERLAND (georgehaller@ethz.ch).

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Preliminary research and analysis on the possibility of using an acoustic wave as an information carrier on an approaching train

Rafał Burdzik, Ireneusz Celiński

Abstract: The concept of using sound as a source of information about approaching of people, animals, vehicles, etc., has been known for centuries and is due to the natural properties of the sense of hearing. There are many engineering attempts on the use of this phenomenon, which can be collectively referred to as the "ear of the Indian". Constant develop of measurement capabilities are causing more and more interesting applications of this phenomenon in the large scope of detection. This article presents the preliminary results of the sound pressure measurement in the immediate proximity of the rail to analyze and evaluate the use of acoustic wave as an information carrier on the approaching train. A number of in-situ experiments were conducted and case studies were compared. These studies are part of a larger research agenda in the field of vibroacoustic energy propagation in a solid structure as rail.

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[1] Rafał Burdzik, Associate Professor: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (rafal.burdzik@polsl.pl), the author presented this contribution at the conference.

[2] Ireneusz Celiński, M.Sc.: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (ireneusz.celinski@polsl.pl).

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paper id: EXP147

Comparative analysis of rail vibration structure in the aspect of identifying the excitation characteristics

Rafał Burdzik, Bogusław Nowak, Jacek Rozmus

Abstract: Dynamical phenomena occurred by the wheel-rail contact or railway vehicle whole-body movement are extremely important for the railway safety and reliability. The paper presents the results of the research on identification of the vibration environment of the railway infrastructure. In order to do this, the research on a test track equipped with typical devices of the railway infrastructure, such as crossing signalling devices, point machines was conducted. All of these devices can be considered as source of vibration. Other kind of forced vibration are result of rail vehicle and car vehicle passage. The natural propagation path of such vibration is rail. It was assumed that for the practical applications of rail vibration for safety system it can be useful to separate information on rail or car vehicle passing. This research aims at analysing the frequency forms of vibrations in respect of a possibility to separate signals in the actual environment in which they occur and where often several forced vibrations overlap. For the purpose of practical applications the vibration signals have been registered for three orthogonal axis thus the analysis were conducted separately for longitudinal transverse and vertical vibration.

[1] Rafał Burdzik, Associate Professor: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (rafal.burdzik@polsl.pl), the author presented this contribution at the conference.

[2] Bogusław Nowak, M.Sc.: DR-TECH Sp. z. o.o., Ks. Ignacego Rembowskiego 11, Imielin 41-407, POLAND (boguslaw@drtech.pl).

[3] Jacek Rozmus, M.Sc.: DR-TECH Sp. z. o.o., Ks. Ignacego Rembowskiego 11, Imielin 41-407, POLAND (jacek@drtech.pl).

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Analysis of the propagation of the vibration of the rail vehicle while driving with and without locomotive wheel slip

Rafał Burdzik, Łukasz Konieczny, Bogusław Nowak, Jakub Młyńczak, Jacek Rozmus

Abstract: Wheel-rail contact properties determine safety of rail vehicle, thus there are very wide scope of papers on this scientific problem. The number of papers focused on aspect of influence of wheel-rail contact on vibration is much less numerous. Thus the paper deals with vibration occurred by the wheel-rail contact while rail vehicle is passing by. The major source of railway rolling noise is the structural vibration of the wheel and rail which is generated by the combination of small-scale undulations on the wheel and rail contact surfaces. The profile irregularity of a railway line is one of the essential vibration sources for vehicles and track. The experiments were conducted on the test track. The track used was composed of two rails lying on wood sleepers joined by railpads. The scope of research contained measurement of axial vibration for the regular drive of train simulator (without locomotive wheel slip) and for the mixed drive process (including locomotive wheel slip). Such the situations can be considered as vibration generated by friction rolling and sliding.

[1] Rafał Burdzik, Associate Professor: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (rafal.burdzik@polsl.pl), the author presented this contribution at the conference.

[2] Łukasz Konieczny, Assistant Professor: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (lukasz.konieczny@polsl.pl).

[3] Bogusław Nowak, M.Sc.: DR-TECH Sp. z. o.o, Ks. Ignacego Rembowskiego 11, Imielin 41-407, POLAND (boguslaw@drtech.pl).

[4] Jakub Młyńczak, Ph.D.: Silesian University of Technology, Faculty of Transport, Krasinskiego Street 8, 40-019 Katowice, POLAND (jakub.mlynczak@polsl.pl).

[5] Jacek Rozmus, M.Sc.: DR-TECH Sp. z. o.o, Ks. Ignacego Rembowskiego 11, Imielin 41-407, POLAND (jacek@drtech.pl).

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paper id: BIF325

Nonlinear dynamics of external cavity semiconductor laser system with elements of a chaos

Vasily Buyadzhi, Alexander Belodonov, Dmitry Mironenko, Anna Buyadzhi

Abstract: There are presented results of complete numerical investigation of generating a chaos (scenario, topological and dynamical invariants etc) in single-mode laser with absorbing medium and external cavity semiconductor laser system with data on the Lyapunov's exponents (LE), correlation, embedding and Kaplan-York dimensions (D), Kolmogorov entropy (KE) and revealed a chaos scenario through period doubling. It has been carried out quantitative low- and high-D chaos dynamics generation studying in semiconductor GaAs/GaAlAs laser device with delayed feedback with governing (feedback strength, current injection). It is shown that the firstly arising periodic states turns into individual chaotic states and then global chaotic attractor with scenario through period-doubling bifurcation, which then significantly modified. There are firstly presented original data on the LE (+, +), correlation D (chaos – 2.2; hyperchaos – 7.4), embedding D (4 and 8), Kaplan-York D (1.8 and 7.1), KE (0.15-0.71).

[1] Vasily Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (buyadzhivv@gmail.com), the author presented this contribution at the conference.

[2] Alexander Belodonov, B.A.: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (belodonovas17@gmail.com).

[3] Dmitry Mironenko, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (dmitrymironenko777@gmail.com).

[4] Anna Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (buyadzhiaa@gmail.com).

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New mathematical approach to numerical modelling dynamics of the industrial city's atmospheric ventilation

Vasily Buyadzhi, Olga Khetselius, Alexander Belodonov, Alexander Glushkov, Andrey Svinarenko

Abstract: We present a new generalized mathematical approach to analysis and modelling an air ventilation in the atmosphere of industrial city, which is based on the Arakawa model, modified to calculate the current involvement of the ensemble of clouds, and hydrodynamical forecast model (with correct quantitative accounting for atmospheric turbulence). The method allows to calculate the convection parameters and shifting cumulus cloud ensemble from surrounung regions. An advanced mathematical methods for modelling an unsteady turbulence in the urban area are developed and presented too [1]. For the first time the methods of a plane complex field are applied to calculate the air circulation for the cloud layer arrays, penetrating into the territory of the industrial city. and discover new stochastic resonance effect. We also consider the mechanisms of transformation of the cloud system advection over the territory of the urban area. As illustration of a new approach we present the results of the PC experiments series on computing the air ventilation characteristics arising from the natural ventilation of the wind over the territory of a few industrial cities (Odessa, Hamburg, Trieste etc). 1. Glushkov A.V., Methods of a Chaos Theory to Complex Geo-Systems, 2012, Odessa, Astroprint; Glushkov A., Khetselius O., Buyadzhi V.V., New Methods of Mathematical Modelling in Earth and Environmental Sciences, 2016, Odessa, OSENU

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1) Vasily Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (buyadzhivv@gmail.com), the author presented this contribution at the conference.

2) Olga Khetselius, Professor: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (okhetsel@gmail.com).

3) Alexander Belodonov, B.A.: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (belodonovas17@gmail.com).

4) Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com).

5) Andrey Svinarenko, Professor: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (svinarenkoaa@gmail.com).

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paper id: VIB288

Jeffcott rotor bifurcation behaviour using different models of hydrodynamic bearings

Miroslav Byrtus, Štěpán Dyk

Abstract: The paper studies dynamical behaviour of Jeffcott rotor supported by a hydrodynamic bearings. It uses different analytical formulations for hydrodynamic bearing forces along with Jeffcott rotor. The model is nonlinear due to the presence of hydrodynamic bearings and can show different subharmonic behaviour like oil whip and oil whirl. Such a system is subjected to dynamical analysis aimed at detection of nonlinear phenomena like bifurcations and unstable behaviours with respect to basic system parameters. The comparison of dynamical responses and bifurcation points for different hydrodynamic bearings models is provided.

1) Miroslav Byrtus, Ph.D.: University of West Bohemia, Univerzitni 8, CZECH REPUBLIC (mbyrtus@rice.zcu.cz), the author presented this contribution at the conference.

2) Štěpán Dyk, M.Sc. (Ph.D. student): University of West Bohemia, Univerzitni 8, CZECH REPUBLIC (sdyk@kme.zcu.cz).

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paper id: MAT198

Symmetry effects over synchronization resilience in complex networks of coupled oscillators

Helder L Casa Grande, Celso B. N. Freitas, Elbert E. Nehrer Macau

Abstract: We study the conceptual Kuramoto model composed by oscillators coupled though a complex network, in random and scale-free flavors, with focus on the relation between the symmetries present in the network and the corresponding synchronization phenomena. More specifically, we investigate the effects of node/edge perturbations in the network yielding the reduction of symmetry quantifiers. By considering the subjacent change in the network of oscillators dynamics, we report remarkable impact on synchronization patterns observed in comparison with unperturbated networks. Besides, the question of whether there are such symmetry improving resilience of global synchronization states in the network is also addressed.

[1] Helder L Casa Grande, Ph.D.: INPE - Instituto Nacional de Pesquisas Espaciais, Av. dos Astronautas, 1.758, São José dos Campos - SP, 12227-010, BRAZIL (heldercgrande@gmail.com).

[2] Celso B. N. Freitas, Ph.D.: INPE - Instituto Nacional de Pesquisas Espaciais, Av. dos Astronautas, 1.758, São José dos Campos - SP, 12227-010, BRAZIL (cbnfreitas@gmail.com).

[3] Elbert E. Nehrer Macau, Professor: INPE - Instituto Nacional de Pesquisas Espaciais, Av. dos Astronautas, 1.758, São José dos Campos - SP, 12227-010, BRAZIL (elbert.macau@inpe.br), the author presented this contribution at the conference.

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paper id: EXP62

Multi-layer composite coating technology for high damping mechanical structural applications

Giuseppe Catania, Stefano Amadori

Abstract: Multi layer coating technology can be an effective tool to design composite materials with specifically designed damping behavior and some applications are recently known in the aerospace and in the automotive industry. Dynamic mechanical measurements were made on thin walled components, in the form of multi layered beam specimen, to investigate the composite dissipative properties. Conventional beam theories, can be unsuitable to accurately describe the complex damping behavior of multi layered beams and cannot take into account of contributions such as the frictional actions and slipping at the interface between layers. In this work, multi layered composite beams are modelled, by means of a modified, third order, zig zag model where the contribution of the stiffness of the coating layer materials and of the hysteretic actions at the layer interfaces is taken into account. Third order polynomial functions are adopted to describe the longitudinal displacement of the beam and the continuity of the shear stress across the multi layered beam depth is enforced. The number of kinematic variables used to define the beam motion may depend on the number of layers of the beam, and on the imposed kinematic and dynamic continuity conditions. Such a model is used to get optimal coating solutions with specific dissipative properties at the modelling stage. Some applications are presented and results are discussed.

[1] Giuseppe Catania, Associate Professor: Din, Ciri Mam, University of Bologna, 40136, ITALY (giuseppe.catania@unibo.it).

[2] Stefano Amadori, Ph.D.: CIRI-MAM, Department of Industrial Engineering, University of Bologna, Viale Risorgimento 2 430136 Bologna, ITALY (stefano.amadori4@unibo.it), the author presented this contribution at the conference.

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paper id: CON370

Suppression of aerothermal postbuckling and nonlinear flutter of composite laminated panels with time-dependent boundaries

Yuyang Chai, Fengming Li

Abstract: Investigations on active flutter and aerothermal postbuckling suppression for the nonlinear composite laminated panels with time-dependent boundaries are carried out using macro fiber composite (MFC) actuator and sensor. The von Karman strain-displacement relation in conjunction with the supersonic piston theory is applied in structural modeling. Nonlinear dynamic equations of motion for the structural system are established using Hamilton's principle and the assumed mode method. Time-domain method is used to investigate the active flutter and aerothermal postbuckling suppression of the nonlinear composite laminated panels. The displacement feedback control (DFC) is used to conduct the active flutter and postbuckling suppression. The nonlinear output controller consisting of a linear quadratic regulator (LQR) and a nonlinear state estimator of extended Kalman filter (EKF) is also used in designing the controller. Controlled vibration responses of the structural system under the two different controllers are compared. The results show that the developed LQR/EKF controller is more effective than the DFC controller in flutter and aerothermal postbuckling control of the panels with time-dependent boundaries in supersonic airflow.

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[1] Yuyang Chai, M.Sc. (Ph.D. student): School of Astronautics, Harbin Institute of Technology, Harbin, China, Room 1109, Zhengxin Building, No. 92 West Dazhi Street, Harbin 150001, CHINA (chaiyuyang0808@126.com), the author presented this contribution at the conference.

[2] Fengming Li, Professor: School of Astronautics, Harbin Institute of Technology, Harbin, China, Room 1109, Zhengxin Building, No. 92 West Dazhi Street, Harbin 150001, CHINA (fmli@hit.edu.cn).

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Passive control of a forced linear structure through addition of nonlinear oscillators in series - Continuous approach

Simon Charlemagne, Alireza Ture Savadkoohi, Claude Henri Lamarque

Abstract: A multi-degree-of-freedom system consisting of a linear main structure coupled to a chain of light nonlinear oscillators is investigated. We aim to develop tools to study mitigation of the vibratory energy of the main system, which is subjected to narrow-band harmonic solicitation, thanks to the nonlinear chain. A continuum approximation for the chain combined with a multiple time scales method is used to apprehend the complex dynamics of the overall system. At fast time scale, the discrete system of equations is transformed into a partial differential equation in time and space with boundary conditions. Fixed points solutions of this equation define the Slow Invariant Manifold (SIM), which gathers all possible asymptotic behaviors of the system. At slow time scale, equilibrium and singular points are detected around the SIM. The former describe periodic regimes and the latter are hints of strongly modulated responses, during which the system faces singularities and repeated bifurcations. Finally, these predictions are confronted with numerical simulations in order to validate this analytical approach. A good agreement is found. Experimental device has been designed and will support future works.

1) Simon Charlemagne, M.Sc. (Ph.D. student): Unis Lyon, ENTPE, LTDS UMR CNRS 5513, 3 Rue Maurice Audin, 69518 Vaulx-en-Velin Cedex, FRANCE (Simon.Charlemagne@entpe.fr).

2) Alireza Ture Savadkoohi, Ph.D.: Univ Lyon, ENTPE, LTDS UMR CNRS 5513, 3 Rue Maurice Audin, 69518 Vaulx-en-Velin Cedex, FRANCE (Alireza.TureSavadkoohi@entpe.fr).

3) Claude Henri Lamarque, Professor: Unis Lyon, ENTPE, LTDS UMR CNRS 5513, 3 Rue Maurice Audin, 69518 Vaulx-en-Velin Cedex, FRANCE (Lamarque@entpe.fr), the author presented this contribution at the conference.

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Numerical and analytical investigation of dynamics of the FDM-printed circular thin plate

Bogumił Chiliński, Jarosław Mańkowski

Abstract: The paper demonstrates modelling and analysis of the thin circular plate. There were used numerical and analytical methods for this purpose. The introduction is about the vibrations of thin circular plate made on FDM 3D printer. The influence of boundary conditions and constitutive equation on dynamics of the plate. Moreover, there were proposed analytical and numerical methods of analysis of such a system. Next chapter showed model of the vibrations of the thin plate. The solutions of this model were found and solved with FEA software. Preliminary discussion and analysis of the results of the numerical computations are included. Next part is about the concept of test bench. It is based on Bruel & Kjer impedance tube, Polytec laser vibrometer and white noise generator. The research of thin printed plates was done. Based on results of FEA analysis there was proposed couple of the infill pattern of the test elements. In the theoretical and experimental way the eigenfrequencies and modes of vibrations were found. Moreover, there is presented the analysis of nonlinear effects in considered system in this chapter. Last but one chapter presents comparison between experimental and theoretical results. Based on it the identification of the dynamic model was made. The summary of whole paper includes discussion on the obtained results and synthetic conclusions about vibrations of FDM-printer objects. Conclusions also show further application of this investigation.

[1] Bogumił Chiliński, Ph.D.: Institute of Machine Design Fundamentals of Warsaw University of Technology, Narbutta 84, 02-524, Warsaw, POLSKA (bogumil.chilinski@gmail.com).

[2] Jarosław Mańkowski, Ph.D.: Institute of Machine Design Fundamentals of Warsaw University of Technology, Narbutta 84, 02-524, Warsaw, POLSKA (bogumil.chilinski@gmail.com), the author presented this contribution at the conference.

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paper id: MAT262

Analysis of possibility of using the controlled granular torsional vibration damper in powertrain systems

Bogumił Chiliński, Robert Zalewski

Abstract: The paper presents the proposition of granular materials application as a semi-active element of the controlled torsional vibration damper and its further application in powertrains. The first part is related to working principle of tuned mass dampers in vibrating systems and practical solutions of such devices in powertrains. Moreover, the general model of powertrain with a granular torsional vibrations damper is discussed. The equations of motion of the investigated system are provided. Further, the detailed analysis of analytical and numerical methods is presented. Next section demonstrates the preliminary damper prototype with controlled granular elastic element (complex steel-granular system). In order to define basic mechanical properties of proposed solution the special laboratory stand was designed. The assumptions and the measuring system including various sensors are shown with more important parameters of the test bench. Finally, the acquired results of experiments are presented and discussed in details. The parametrical and nonlinear properties of such a damper were defined and their influence on the dynamic behaviour of the investigated system was revealed. In the final part of the paper the results of complex analysis are discussed and synthetic conclusions about the very interesting dynamic behavior of powertrain systems with granular torsional vibrations dampers and its further implications are provided.

[1] Bogumił Chiliński, Ph.D.: Institute of Machine Design Fundamentals of Warsaw University of Technology, Narbutta 84, 02-524 Warsaw, POLAND (bogumil.chilinski@gmail.com), the author presented this contribution at the conference.

[2] Robert Zalewski, Associate Professor: Institute of Machine Design Fundamentals of Warsaw University of Technology, Narbutta 84, 02-524, Warsaw, POLSKA (robertzalewski@wp.pl).

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Model based research on ICE engine powered by an alternative fuels

Adrian Chmielewski, Robert Gumiński, Tomasz Mydłowski, Artur Małecki, Krzysztof Bogdziński

Abstract: The paper presents 2 DOF dynamic model of the piston-crankshaft system of HONDA NHX 110. The piston-crankshaft system was combined with pressure curve, which was obtained from the experimental research, measured in the cylinder during the execution of the working cycle of ICE engine. In the article the theoretical and analytical dependences, which described heat generation in the cylinder, have been presented. Based on research results obtained from the experiment and simulation model the value of theoretical power and theoretical work value have been calculated. In the paper, the research results and simulation results at different angles of the ignition advance of ICE engine powered by compressed natural gas – CNG, biogas and mixture of bioethanol with gasoline – E85 have been analyzed and compared.

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[1] Adrian Chmielewski, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (a.chmielewski@mechatronika.net.pl), the author presented this contribution at the conference.

[2] Robert Gumiński, Assistant Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (rgumin@simr.pw.edu.pl).

[3] Tomasz Mydłowski, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (t.mydlowski@mechatronika.net.pl).

[4] Artur Małecki, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (a.malecki85@gmail.com).

[5] Krzysztof Bogdziński, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (k.bogdzinski@mechatronika.net.pl).

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Model based research on electrochemical battery connected with 3 diodes model of PV module – selected properties

Adrian Chmielewski, Robert Gumiński, Krzysztof Bogdziński, Jędrzej Mączak, Przemysław Szulim, Jakub Możaryn

Abstract: In the work a model of electrochemical battery connected with three diodes model of photovoltaic module is presented. To calculate selected parameters of the electrochemical battery model an iteration-approximation method have been employed. In herein work, while applying specific load cycle to the battery-PV module with control unit the power distribution of system was analyzed. The paper presents chosen curves of NiMH, Li-ion and LiFePO4 batteries obtained from the research and simulation model. Moreover, by using a simulation model the heat generation of the batteries have been calculated.

[1] Adrian Chmielewski, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (a.chmielewski@mechatronika.net.pl), the author presented this contribution at the conference.

[2] Robert Gumiński, Assistant Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (rgumin@simr.pw.edu.pl).

[3] Krzysztof Bogdziński, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (k.bogdzinski@mechatronika.net.pl).

[4] Jędrzej Mączak, Associate Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (jma@mechatronika.net.pl).

[5] Przemysław Szulim, Assistant Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (p.szulim@mechatronika.net.pl).

[6] Jakub Możaryn, Assistant Professor: Faculty of Mechatronics Institute of Automatic Control and Robotic Warsaw University of Technology, 02-525 Warsaw, POLAND (j.mozaryn@mchtr.pw.edu.pl).

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Experimental evaluation of Mathematical and Artificial Neural Network Modeling of Energy storage system

Adrian Chmielewski, Jakub Możaryn, Robert Gumiński, Przemysław Szulim, Krzysztof Bogdziński

Abstract: This article presents an experimental evaluation based on the mathematical model and the artificial neural network (ANN) model of an energy storage system. Because of a nonlinear description of charging/discharging dynamics in specific cycles and the coupling of the terminal voltage and temperatures of a battery, the recurrent artificial neural network structure is proposed. Both of the models, analytical and ANN were employed to predict a behaviour of chosen types of batteries: LiFePO4, Li-ion. The training and testing data were gathered at the laboratory stand in different working conditions. As a result we present the analysis of differences between proposed modeling approaches.

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[1] Adrian Chmielewski, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (a.chmielewski@mechatronika.net.pl), the author presented this contribution at the conference.

[2] Jakub Możaryn, Assistant Professor: Faculty of Mechatronics Institute of Automatic Control and Robotic Warsaw University of Technology, 02-525 Warsaw, POLAND (mozaryn@mchtr.pw.edu.pl).

[3] Robert Gumiński, Assistant Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (rgumin@simr.pw.edu.pl).

[4] Przemysław Szulim, Assistant Professor: Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524 Warsaw, POLAND (p.szulim@mechatronika.net.pl).

[5] Krzysztof Bogdziński, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive Construction Machinery Engineering, Institute of Vehicles, 02-524, POLAND (k.bogdzinski@mechatronika.net.pl).

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Dynamic load capacity of reinforced concrete deep beams with high-strength concrete

Waldemar Cichorski, Adam Stolarski

Abstract: The analysis of the influence of very high strength of concrete on the load carrying capacity of reinforced concrete deep beams loaded dynamically taking into account the physical nonlinearity of structural materials: concrete and reinforcing steel, is the aim of the paper. Modeling of dynamic properties of structural materials was carried out using the assumptions of the plastic flow theory. The model of the viscoelastic perfectly plastic material was applied for the reinforcing steel. The non-standard elastic - plastic material model, with regard to the dynamic strength and the material softening was applied for the concrete. The solution was obtained on the basis of the dynamic analysis method of the non-elastic behavior of reinforced concrete deep beams. The dynamic load carrying capacity of reinforced concrete deep beams was determined on the basis of the own efficient algorithms for solving equations of constitutive equations and incremental dynamic equilibrium equations of reinforced concrete structures. The system of equations of motion was solved by means of an implicit procedure of numerical iteration, known as the Newmark method. Use of this procedure enables the iterative solving of equations of motion by the modified Newton-Raphson method. Results of numerical solutions concerning the estimation of dynamic load carrying capacity of reinforced concrete deep beams made of high strength concrete for three values of concrete grades C100, C200 and C300 and reinforced with high strength reinforcing steel were presented.

[1)] Waldemar Cichorski, Ph.D.: Military University of Technology, Faculty of Civil Engineering and Geodesy, 2 Kaliskiego Str., 00-908 Warsaw-49, POLAND (waldemar.cichorski@wat.edu.pl).

[2)] Adam Stolarski, Professor: Military University of Technology, Faculty of Civil Engineering and Geodesy, 2 Kaliskiego Str., 00-908 Warsaw-49, POLAND (adam.stolarski@wat.edu.pl), the author presented this contribution at the conference.

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paper id: MTR200

Modeling, simulation and control of a pipe inspection mobile robot with an active adaptation system

Michał Ciszewski, Tomasz Buratowski, Mariusz Giegiel

Abstract: In this paper, a tracked inspection mobile robot with an active adaptation system is presented. It can be used for visual inspection of various pipelines. Mathematical modeling of pedipulator mechanisms that allow adaptation of the robot to different shapes and sizes of pipes is described with focus on forward and inverse kinematics methods, implemented in MATLAB software. Application of a custom trajectory planning algorithm for the pedipulators is shown with numerical and graphical validation. Co-simulations of the robot motion, prepared in V-REP and MATLAB software are performed for rough surfaces, horizontal pipes with connections and straight vertical pipes. A prototype of the robot with a model-based control system is tested and laboratory experiments are compared to the simulation results. Different motion scenarios of the robot are shown with focus on adaptation capabilities of the motion unit to work environment.

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[1] Michał Ciszewski, M.Sc. (Ph.D. student): AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Kraków, POLAND (mcisz@agh.edu.pl).

[2] Tomasz Buratowski, Associate Professor: AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Kraków, POLAND (tburatow@agh.edu.pl).

[3] Mariusz Giegiel, Professor: AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Kraków, POLAND (giergiel@agh.edu.pl), the author presented this contribution at the conference.

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A bifurcation study and explanation of the Sommerfeld effect

Eoin Clerkin, Rubens Sampaio

Abstract: The Arnold Sommerfeld effect is an intriguing resonance capture and release series of events originally demonstrated in 1902. A single event is studied using a two degree of freedom mathematical model of a motor with imbalance mounted to laterally restricted spring connected cart. For a certain power supplied, in general the motor rotates at a speed consistent with a motor on a rigid base. However at speeds close to the natural frequency of the cart, it seemingly takes on extra oscillations where for a single rotation it both speeds up and then slows down. Therefore in a standard experimental demonstration of the effect, as the supplied torque force is increased or decreased, this may give the illusion that the stable operation of the motor is losing and gaining stability. This is not strictly the case, instead small oscillations always present in the system solution are amplified near the resonant frequency. The imbalance in the motor causes a single resonance curve to fold back on itself forming two fold bifurcations which leads to hysteresis and an asymmetry between increasing and decreasing the motor speed. Although as outlined the basic mechanism is due the interplay between two stable and one unstable limit cycles, a more complication bifurcation scenario is observed for higher imbalances in the motor. The presence of a Z2 phase space symmetry tempers the dynamics and bifurcation picture. Quasiperiodic and chaotic dynamics is ascertained via the Lypunov exponent and Fourier transform spectra.

[1] Eoin Clerkin, Ph.D.: TU Darmstadt, Dolivostr. 15, Darmstadt 64293, GERMANY (clerkin@dyn.tu-darmstadt.de), the author presented this contribution at the conference.

[2] Rubens Sampaio, Professor: Departamento de Eng. Mecânica, PUC - Rio, Rua Marquês de São Vicente, 225 22451-900 Rio de Janeiro RJ, BRAZIL (rubens_sampaio@icloud.com).

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Bio-inspired energy control of an agricultural tree nursing station

João Coelho, Manuel Braz César, José Gonçalves

Abstract: Energy efficiency is a pressing problem that is addressed at several levels. At the political level, the European Union has set in motion several mechanisms to reduce the energy consumption and to promote renewable-based energy production systems. However, economic growth is tightly connected to energy consumption. Hence, in order to cope with all those constraints, it is necessary to find production methods whose energy requirements do not scale up so abruptly with the economic growth. This statement is transversal to any type of business including primary economic sectors such as agriculture. In this context, the present work deals with a newly devised strategy to improve the energy efficiency of an agricultural tree nursing station. This new solution replaces the actual resistor based heating system by an alternative one using recirculation of hot water heated by means of a set of thermodynamic panels. Several variables play an important role in the overall efficiency of this system. For example, changes in ambient temperature and air moisture content. Moreover, slow decreases in efficiency due to aging must also be considered. For this reason, a fixed parametric controller is not suitable for this application. In particular, this article presents the results obtained by means of a biologically inspired controller that is able to consistently learn from the environment and to change its behavior accordingly. The obtained results validate the robustness of the overall control system to the effect of such disturbances.

[1] João Coelho, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (jpcoelho@ipb.pt).

[2] Manuel Braz César, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (brazcesar@ipb.pt), the author presented this contribution at the conference.

[3] José Gonçalves, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (goncalves@ipb.pt).

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Effect of anisotropy on surface wave attenuation through fluid medium: a comparison between Rayleigh and Love type waves

Nathan Paul Craig, Harriet Grigg

Abstract: Surface wave propagation in anisotropic materials is common for biosensor based applications, in which contact between the device and a fluid layer is required. The attenuation of the propagating wave due to the fluid layer is different depending on the choice of the wave, due to the generation of pressure waves by out of plane displacements. In the isotropic case, the Rayleigh wave type experiences greater attenuation than the multi-layer Love wave type which only has a transverse displacement. In the case of an anisotropic wave the displacement axis no longer lines up with the direction of propagation. A generalised anisotropic Love wave propagating in a multi-layered structure comprised of anisotropic materials will no longer have a zero valued out of plane displacement. The effect of this anisotropy on Love waves is investigated by numerical analysis and compared to the Rayleigh wave type. The results show an increase in attenuation in generalised Love wave solutions for cases of interest to the applications mentioned, for which wave displacements are presented.

[1] Nathan Paul Craig, M.Sc. (Ph.D. student): School of Mechanical and Systems Engineering, Newcastle University, Stephenson Building, Claremont Road, Newcastle upon Tyne, NE1 7RU, UNITED KINGDOM (n.p.craig@newcastle.ac.uk), the author presented this contribution at the conference.

[2] Harriet Grigg, Assistant Professor: School of mechanical and systems engineering, Newcastle University, Stephenson Building, Claremont Road, Newcastle upon Tyne, NE1 7RU, UNITED KINGDOM (Harriet.Grigg@newcastle.ac.uk).

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paper id: CON2

Finite Element Analysis of optomechatronic choppers with rotational shafts

Eduard Sebastian Csukas, Virgil-Florin Duma

Abstract: Choppers are optomechatronic devices used for generating controlled lasers impulses. We have introduced and patented a novel type of choppers with rotational shafts which can be operated at much higher speeds than classical choppers with disks or with oscillatory elements. In this study we perform a Finite Element Analysis (FEA) using ANSYS of the fundamental issues of choppers with shafts, i.e. their structural stability and deformations – for their maximum possible rotational speed, of 120 krpm. The main steps of the FEA are pointed out. While different possible materials can be explored with regard to the maximum speed that the choppers is operated at, steel is considered in this study. The multi-parametric analysis is performed taking into account geometrical parameters of the device: radius and axial dimension of the shaft, shape, dimensions, and number of slits. The performances of the choppers with regard to their deformations and the highest possible rotational speeds can be obtained from the analysis. Due to space limitations, preliminary results regarding this analysis and the corresponding rules-of-thumb that can be extracted from it are briefly presented.

[1] Eduard Sebastian Csukas, M.Sc. (Ph.D. student): Polytechnic University of Timisoara, 1 Mihai Viteazu Ave., ROMANIA (csukas_eduard@yahoo.com), the author presented this contribution at the conference.

[2] Virgil-Florin Duma, Professor: Aurel Vlaicu University of Arad, 77 Revolutiei Ave., ROMANIA (duma.virgil@osamember.org), the author presented this contribution at the conference.

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Validation of a motor test for evaluation of postural control in dual-task for elderly people

Luiz Fernando Cuozzo Lemos, Ariel Dal Forno Mastella, Joane Severo Ribeiro, Igor Martins Barbosa, Samuel Klippel Prusch, Hyago Bernardes da Rosa, Eduarda Mattana Dias, Eduardo Porto Scisleski, Leticia Oliveira da Silva, Carlos Bolli Mota

Abstract: With advancing age, individuals have different morphological, functional and mechanical losses. Thus, several studies seek greater understanding about different parameters engines involving elderly. Among these, postural control and dual-task execution is widely studied in this population. However, most studies do not use or do not provide data concerning the validity of the tests used adjacent to the postural control. The main objective of the study was to determine the test-retest reliability, intra - examiner reproducibility, objectivity, sensitivity and validity of the instrument intended to be used in adjacent tests to postural control (dual-task). For this, it was evaluated the postural control of 35 elderly and 33 young adults through a AMTI force platform. Six conditions were evaluated, including four dual-task and the other in simple task (with and without the use of vision).The findings of this study show that the test has reliability, validity, reproducibility, sensitivity, and is valid as an additional test for postural control. The elderly were statistically worse than young adults both in postural control as the test values.

[1)] Luiz Fernando Cuozzo Lemos, Ph.D.: Federal University of Rio Grande do Sul; University Center Cenecista de Osório, Rua Felizardo, nº 750 - Jardim Botânico - Porto Alegre / RS, BRAZIL (luizcanoagem@yahoo.com.br), the author presented this work at the conference.

[2)] Ariel Dal Forno Mastella, B.A.: Federal University of Santa Maria, Av. Roraima nº 1000 Cidade Universitária Bairro Camobi Santa Maria - RS CEP: 97105-900, BRAZIL (arielmastella@hotmail.com).

[3)] Joane Severo Ribeiro, M.Sc.: Federal University of Santa Maria, Av. Roraima nº 1000 Cidade Universitária Bairro Camobi Santa Maria - RS CEP: 97105-900, BRAZIL (joaneribeiro@gmail.com).

[4)] Igor Martins Barbosa, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (igormartinsbarbosa2@gmail.com).

[5)] Samuel Klippel Prusch, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (Samuel_klippel@yahoo.com.br).

[6)] Hyago Bernardes da Rosa, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (hyagobrosa@gmail.com).

[7)] Eduarda Mattana Dias, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (dudamattanadias@hotmail.com).

[8] Eduardo Porto Scisleski, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (dudupspb@hotmail.com).
[9] Leticia Oliveira da Silva, B.A.: University Center Cenecista de Osório, Rua 24 de Maio, 141, Centro - Osório/RS, BRAZIL (leticia-os96@hotmail.com).
[10] Carlos Bolli Mota, Ph.D.: Federal University of Santa Maria, Av. Roraima nº 1000 Cidade Universitária Bairro Camobi Santa Maria - RS CEP: 97105-900, BRAZIL (bollimota@gmail.com).

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Wheel-surface interaction model development for all terrain vehicle dynamics simulation

Tomasz Czapla, Mariusz Pawlak

Abstract: The aim of the paper is the presentation of methodology generation for assessment of wheel-surface interaction models for various cases of rough terrain. The main achievement of the project is a scalable model of the wheel-soil interaction with consideration of nonlinear effects caused by plasticity and ground discontinuities. Experimental data used for model validation were collected with dedicated laboratory stand based on an all-terrain vehicle wheel and various terrain probes. The measurement includes time series containing traction and side wheel force. The numerical model of the wheel was created as shell and solid finite elements, the soil was modeled by three different methods: by finite elements, smoothed particle hydrodynamics (SPH) and discrete element method (DEM). The experiment and simulation results are intended to be used for black-box, simplified wheel model for all-terrain vehicle dynamics simulation.

1) Tomasz Czapla, Ph.D.: Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, POLAND (Tomasz.Czapla@polsl.pl), the author presented this contribution at the conference.

2) Mariusz Pawlak, Ph.D.: Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, POLAND (Mariusz.Pawlak@polsl.pl), the author presented this contribution at the conference.

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Wheel-surface model parameters estimation for all-terrain - experimental basis

Tomasz Czapla, Marcin Fice, Roman Niestrój

Abstract: The aim of the paper is to present the experimental basis for model parameters estimation for all-terrain vehicle dynamics simulation. Traction and side forces assessment methods and tire with the ground models for on-road vehicles are widely described. In case of off-road vehicles, there is variety of terrain characteristics and tire-surface interaction forms, including soil or sand deformation that are not adequately described by theoretical models. Experiment methodology includes test in various ground condition and different driving direction. Test data were acquired for dry and wet sand, soil, grass and asphalt for various tire pressure level. Traction and side forces were acquired and used to identify black-box model parameters of the wheel-ground interaction.

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[1] Tomasz Czapla, Ph.D.: Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, POLAND (Tomasz.Czapla@polsl.pl), the author presented this contribution at the conference.

[2] Marcin Fice, Ph.D.: Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, POLAND (Marcin.Fice@polsl.pl).

[3] Roman Niestrój, Ph.D.: Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, POLAND (Roman.Niestroj@polsl.pl).

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Inverse dynamics simulation of the snatch in weightlifting

Adam Czaplicki, Krzysztof Dziewiecki, Zenon Mazur, Wojciech Blajer

Abstract: The purpose of this paper is to present the results of an inverse dynamics analysis of the snatch modelled as a sagittal plane movement. A planar model of a weightlifter composed of 16 rigid segments (the lower trunk, thighs, lower legs, and feet) connected by 15 hinge joints was used in the computations. The equations of motion of the model were obtained using a projective technique. Kinematic data were recorded with a Vicon system with a sampling frequency of 200 Hz. The ground reaction forces were measured separately for the left and right limb on two force platforms. The inverse dynamics formulation then made it possible to assess the internal loads (the muscle forces and joint reactions), limited here to the lower limbs. The obtained results reveal that the snatch, a motor activity which tends to be geometrically symmetrical in the sagittal plane, is not necessarily characterised by symmetry of internal loads. The relatively high differences in the reactions in the joints and muscle forces in the left and right side of the body were identified. We are convinced that if coaches were to have information concerning the asymmetry of internal loads, this could have implications for adjusting the training, assessing whether or not the motor activity has been performed correctly, and helping the lifter eliminate habits that may cause injury.

[1)] Adam Czaplicki, Associate Professor: Józef Piłsudski University of Physical Education in Warsaw, Faculty of Physical Education and Sport in Biała Podlaska, Akademicka 2, POLAND (adam.czaplicki@awf-bp.edu.pl), the author presented this contribution at the conference.

[2)] Krzysztof Dziewiecki, Ph.D.: Kazimierz Pułaski University of Technology and Humanities in Radom , Faculty of Mechanical Engineering, Institute of Applied Mechanics and Energetics, Krasickiego 54, POLAND (krzysztof.dziewiecki@uthrad.pl).

[3)] Zenon Mazur, M.Sc.: Kazimierz Pułaski University of Technology and Humanities in Radom , Faculty of Mechanical Engineering, Institute of Applied Mechanics and Energetics, Krasickiego 54, POLAND (z.mazur@uthrad.pl).

[4)] Wojciech Blajer, Professor: Kazimierz Pułaski University of Technology and Humanities in Radom , Faculty of Mechanical Engineering, Institute of Applied Mechanics and Energetics, Krasickiego 54, POLAND (w.blajer@uthrad.pl).

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Charpy Impact Testing Machine in modeling of vehicle frontal crash with street lights

Wojciech Danek, Mariusz Pawlak

Abstract: Real tests of a crash of a vehicle with lighting column are quite expensive but necessary part of norm EN-126767:2008. During the process of lighting columns design is necessary to provide some modifications to receive sufficient safety class. To not repeat experiments and reduce the cost are done numerical simulations, and when finally good results are received, real crash test of a vehicle with real size street light can be done. But the problem is with validation of the numerical models (without experiment) and making good conclusion based on them. To check if something else than real car crash experiments can be used, a small model of the vehicle was created as a Charpy Impact testing machine. There can be changed the mass of pendulum, the location of striking edge and radius of striking edge. Important is also the location of a mass center of the obstacle with which the crash is to be observed. Experimental results from the testing machine were collected and compared with results from numerical simulations and made conclusions.

[1] Wojciech Danek, M.Sc. (Ph.D. student): Silesian University of Technology, Faculty of Mechanical Engineering, ul. Konarskiego 18a,44-100 Gliwice, POLAND (wojciech.danek@polsl.pl), the author presented this contribution at the conference.

[2] Mariusz Pawlak, Ph.D.: Silesian University of Technology, Faculty of Mechanical Engineering, ul. Konarskiego 18A, 44-100 Gliwice, POLAND (mariusz.pawlak@polsl.pl).

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Numerical-analytical algorithms for nonlinear optimal control problems on a large time interval

Yulia Danik, Mikhail Dmitriev, Dmitry Makarov

Abstract: Some nonlinear and discrete optimal control problems with phase constraints on a fixed but sufficiently large time interval are considered as singularly perturbed problems. In continuous-time case, the state equations are reduced to singularly perturbed equations on a finite time interval, and in discrete-time case the state equations have the form of systems with a small step. Using the technique for singularly perturbed systems, the formal asymptotic expansions by the corresponding small parameter are constructed which contain the structural information about the solution. That is usually sufficient for most applications to obtain an initial approximation to control in the global optimum neighborhood. The obtained algorithms can be applied to mathematical economics and technical objects control problems with phase and control constraints, and with turnpike effects in the trajectories, where the turnpike trajectories can be discontinuous. The use of traditional algorithms for these problems is inefficient due to the large increase of computational difficulty.

1) Yulia Danik, M.Sc. (Ph.D. student): Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, pr. 60-letiya Oktyabrya 9, 117312 Moscow, RUSSIA (juliet.d.e.777@mail.ru).

2) Mikhail Dmitriev, Professor: Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, pr. 60-letiya Oktyabrya 9, 117312 Moscow, RUSSIA (mdmitriev@mail.ru), the author presented this contribution at the conference.

3) Dmitry Makarov, Ph.D.: Federal Research Center, 117312, Moscow, pr. 60-letiya Oktyabrya, 9, RUSSIA (makarov@isa.ru).

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Application of Pade approximations to the solution of nonlinear control problems

Yulia Danik, Mikhail Dmitriev, Ekaterina Komarova, Dmitry Makarov

Abstract: In this paper the Pade-method of approximate solutions construction for various continuous control problems with a parameter, where it is possible to construct the control function asymptotics for small and large values of the parameter, is developed. As a result of constructing the asymptotic Pade interpolation (API), we obtain a control interpolation surface, where asymptotic approximations of the control are used as interpolation nodes. Such a dependence on parameters exists in numerous applications, where the large parameter value corresponds to large control gain coefficients, and small parameter values appear in case of weakly controlled systems, that is a family of controls with the varying gain is generated. For the case of a two-point API the constructed surface serves as a "bridge" that is asymptotically close to the exact control surface for the parameter domains for which the asymptotics are constructed. The properties of stability and optimality of the resulting feedback controls are studied for linear quadratic optimal control problems with a parameter perturbations. The results of numerical experiments are discussed.

[1] Yulia Danik, M.Sc. (Ph.D. student): Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, pr. 60-letiya Oktyabrya 9, 117312 Moscow, RUSSIA (juliet.d.e.777@mail.ru).

[2] Mikhail Dmitriev, Professor: Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, pr. 60-letiya Oktyabrya 9, 117312 Moscow, RUSSIA (mdmitriev@mail.ru), the author presented this contribution at the conference.

[3] Ekaterina Komarova, Ph.D.: Russian State Social University, Wilhelm Pieck street, 4, build.1, 129226 Moscow, RUSSIA (evkomarova@mail.ru).

[4] Dmitry Makarov, Ph.D.: Federal Research Center "Computer Science and Control" of Russian Academy of Sciences, pr. 60-letiya Oktyabrya 9, 117312 Moscow, RUSSIA (makarov@isa.ru).

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paper id: MAT258

Comparative analysis of tire models for simulation of longitudinal motion of lightweight wheeled mobile robots

Przemysław Dąbek, Maciej Trojnacki

Abstract: The paper is concerned with analysis of tire models from the point of view of their use in studies of dynamics of the lightweight wheeled mobile robots. The focus of the work is on longitudinal motion of a mobile robot on rigid ground. Emphasis is put on discussion of results yielded by the robot dynamics model depending on used tire model. The modeled robot is a four-wheeled lightweight skid-steered robot developed for the purpose of investigations of robot kinematics and dynamics. Models of robot kinematics and dynamics used during studies are only briefly described, because detailed treatment was provided in other works of the authors. Analysed tire models are presented in details. Models are implemented and solved using Matlab/Simulink software. Results of numerical analyses are compared with results of experiments. Models fidelity is described with quality indexes to better guide the assessment. In-depth discussion of the obtained results concludes the paper.

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[1] Przemysław Dąbek, M.Sc.: Industrial Research Institute for Automation and Measurements (PIAP), 02-486 Warsaw, Jerozolimskie 202 Ave., POLAND (pdabek@piap.pl), the author presented this contribution at the conference.

[2] Maciej Trojnacki, Associate Professor: Institute of Vehicles, Warsaw University of Technology, 02-524 Warsaw, Narbutta 84 St., POLAND (mtrojnacki@simr.pw.edu.pl).

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Developments of non-linear dynamics FEM simulation of the impact performance of road safety barriers with use of experimental validation of models

Irina Demiyanushko, Ilya Karpov, Beka Tavshavadze

Abstract: A computer simulation with application use of the non-linear finite element programs developed to computational research of vehicle (cars, buses) collisions with road barriers having various original designs. It is demonstrated that for obtainment of adequate results of vehicle impact action on complex barrier structures an experimental validation of models is needed which allows obtain the main characteristics of the structures by calculation. Simulation calculations performed using approach virtually substitute field tests of the structures. Features of wave processes at single and repeated impacts, and corresponding power interactions in elements of designs investigate.

[1] Irina Demiyanushko, Ph.D.: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (demj-ir@mail.ru), the author presented this work at the conference.

[2] Ilya Karpov, M.Sc.: Moscow Automobile and Road State Technical University, 125319, Moscow, Leningradskiyi prospect, RUSSIA (karpov@niimech.ru).

[3] Beka Tavshavadze, M.Sc.: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (tavshavadze@niimech.ru).

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paper id: MAT54

The dynamic behavior of the vehicle wheels under impact loads - FEM and experimental researches

Irina Demiyanushko, Aleksandr Vakhromeev, Evgeny Loginov, Violetta Mironova

Abstract: Results of the analysis of dynamic impact effect for vehicle light alloy wheels of various types, which may occur in various road situations (head-on crash, drift, collision with another car) are given. This study applied to simulate the impact behavior caused by a dynamic loading of vehicle wheels by impact testing according to the scheme of certification tests with static and dynamic strain measurement for definition of deformation fields and impact stresses. New approach to creation of FEM model of virtual impact tests of wheels with use of program complex of nonlinear dynamics Ls - Dyna is developed and validation of models by comparison with results of dynamic strain-gaging is carried out.

[1)] Irina Demiyanushko, Ph.D.: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (demj-ir@mail.ru), the author presented this work at the conference.

[2)] Aleksandr Vakhromeev, Associate Professor: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (ilka92@mail.ru).

[3)] Evgeny Loginov, M.Sc.: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (evgeny.m.loginov@gmail.com).

[4)] Violetta Mironova, Associate Professor: Moscow Automobile and Road State Technical University, 125139, Moscow, Leningradskiy prospect, 64, RUSSIA (violettmir@gmail.com).

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paper id: ASY329

Computational modelling of the nonlinear dynamic damage mechanics and plasticity evolution of reinforced concrete bridge beams by its dynamic interaction with variable forms of track irregularities and moving vehicles

Thiago de Oliveira Abeche, Roberto Dalledone Machado, Ana Paula Imai, Fernando Luiz Martinechen Beghetto, Luiz Antonio Farani de Souza, João Elias Abdalla Filho, Marcos Arndt

Abstract: By crossing either a highway or a railway bridge with any speed, the vehicles are subjected to the track irregularities. The movement of a vehicle on a bridge is already a dynamic action on the structure. However, the irregularities tend to excite the vehicle dynamically which in turns triggers additional vibrations in the bridge structure apart from those produced by their own movement. Depending of the speed that the vehicle crosses the irregularities, as their forms, these vibrations can even be amplified. When considering the damage mechanics on the concrete and the plasticity theory on the steel bars of a reinforced concrete bridge the physical problem becomes nonlinear dynamic. The dynamic interaction between the systems can expand these effects, modifying the structure and vehicle dynamic responses, as increasing the magnitude and the oscillations particularly at critical speeds of the vehicle, capable to provoke some resonance. Apart from the transient analysis, the nonlinear dynamic effects on the constitutive models alter the structure's natural frequencies of vibrations, consequently modifying both the modal analysis and the resonance phenomena. This work seeks to evaluate the nonlinear dynamic damage and plasticity evolution of a vehicle-irregularities-bridge dynamic interaction problem through computational simulation with nonlinear finite element method by presenting the theoretical foundations and basis of the ABXDNL 2.7 scientific research program developed in C++ programming language for nonlinear dynamic analysis by damage mechanics and plasticity theory.

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[1] Thiago de Oliveira Abeche, M.Sc. (Ph.D. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (t.abeche@gmail.com), the author presented this contribution at the conference.

[2] Roberto Dalledone Machado, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (roberto.dalledonemachado@gmail.com , rdm@ufpr.br).

[3] Ana Paula Imai, B.A. (M.Sc. student): Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Concentration Area in Materials and Structures, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (ana_imai@hotmail.com).

[4] Fernando Luiz Martinechen Beghetto, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (flbeghetto@utfpr.br).

[5] Luiz Antonio Farani de Souza, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (lasouza@utfpr.br).

[6] João Elias Abdalla Filho, Professor: Mechanical Engineering Graduate Program (PPGEM) of the Pontifical Catholic University of Paraná (PUCPR), Federal Tech. University of Paraná (UTFPR), Brazil & University of Colorado (CU-Boulder), USA, Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba — PR, Brazil and 428 UCB, 80309-0428, Boulder, CO, United States of America, BRAZIL AND USA (joao.filho@pucpr.br).

[7] Marcos Arndt, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (arndt@ufpr.br).

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Theoretical foundations and computational simulation of the nonlinear dynamic damage and plasticity evolution of vehicle, irregularities and bridge dynamic interaction through finite element and boundary element methods

Thiago de Oliveira Abeche, Roberto Dalledone Machado, Ana Paula Imai, Fernando Luiz Martinechen Beghetto, Luiz Antonio Farani de Souza, João Elias Abdalla Filho, Marcos Arndt

Abstract: A numerical model is oftentimes considered representative if capable to approach the analytical solution with the least amount of error in the process. The measure of this approximation is an effective test for mathematical models by simulation of linear problems in well-known regimes or initial states of nonlinear problems. Several engineering problems, however, do not have an analytical solution. For these, in order to reach a consistent solution, it is necessary to consider some significant physical effects of the experiment. For the dynamic interaction between vehicles, irregularities and reinforced concrete bridge structures, the damage mechanics and the plasticity are notable theories that can be coupled into the computational model for a more feasible analysis of the cracks' propagation on the concrete, the permanent deformation of the steel bars and their interference on the responses, changing the linear dynamic model into a complex nonlinear dynamic one with arduous convergence. Yet, a mathematical convergence not necessarily can represent a plausible physical solution. Moreover, the amount of nonlinear physical effects on the dynamic interaction systems can even make the problem more onerous, requiring greater computational efficiency, in CPU and memory demands, and improved numerical methods. This paper presents the theoretical foundations of the ABXDNL 2.7 scientific research program developed with finite element method and proposes an additional implementation with boundary element method in order to compare the nonlinear dynamic responses for both procedures.

[1] Thiago de Oliveira Abeche, M.Sc. (Ph.D. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (t.abeche@gmail.com), the author presented this contribution at the conference.

[2] Roberto Dalledone Machado, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (rdm@ufpr.br).

[3] Ana Paula Imai, B.A. (M.Sc. student): Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Concentration Area in Materials and

Structures, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (ana_imai@hotmail.com).

4) Fernando Luiz Martinechen Beghetto, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (flbeghetto@utfpr.br).

5) Luiz Antonio Farani de Souza, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (lasouza@utfpr.br).

6) João Elias Abdalla Filho, Professor: Mechanical Engineering Graduate Program (PPGEM) of the Pontifical Catholic University of Paraná (PUCPR), Federal Tech. University of Paraná (UTFPR), Brazil & University of Colorado (CU-Boulder), USA, Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba — PR, Brazil and 428 UCB, 80309-0428, Boulder, CO, United States of America, BRAZIL AND USA (joao.filho@pucpr.br).

7) Marcos Arndt, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (arndt@ufpr.br).

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Nonconservative instability of SWCNT: an alternative variational method via Cell- discretization method (CDM)

Maria Anna De Rosa, Nicola Maria Auciello, Maria Lippiello, Stefania Tomasiello

Abstract: Based on the nonlocal elasticity theory, this paper deals with the dynamic instability analysis of a cantilevered single-walled carbon nanotube (SWCNT) , with a concentrated mass, located at a generic position, accounting for the small scale effect, and subjected to a follower force at the free end. The governing equations of motion are derived using an alternative Hamilton's variational principle and the Cell-Discretization Method (CDM) is applied to obtain the solution of the theoretical problem. The CDM procedure is an alternative method to the well-known Finite Element Method (FEM) and Rayleigh-Ritz approach. The structure is reduced to a set of rigid bars linked together by means of elastic constraints, obtaining a multi-degree-of-freedom (MDOF) system. A comparative analysis is performed in order to verify the accuracy and validity of the proposed numerical method. The effects of the nonlocal parameter and dimensionless mass on the dynamic instability of SWCNT are shown and discussed in details. The effect of a sub-tangential follower force on the stability of cantilever single-walled carbon nanotube is studied. Evaluation schemes for flutter and divergence loads of the non-conservative system are described and the static buckling loads and natural frequencies of the nanotube will be compared through numerical examples against the ones available in literature.

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[1] Maria Anna De Rosa, Assistant Professor: University of Basilicata, 85100, ITALIA (maria.derosa@unibas.it).

[2] Nicola Maria Auciello, Assistant Professor: University of Basilicata, 85100, ITALIA (nicola.auciello@unibas.it).

[3] Maria Lippiello, Ph.D.: University of Naples "Federico II", 80134, ITALIA (maria.lippiello@unina.it).

[4] Stefania Tomasiello, Ph.D.: CORISA - University of Salerno, 84084, ITALIA (stomasiello@unisa.it), the author presented this contribution at the conference.

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Validation of unilateral impact models using numerical simulations, perturbation methods and experiments

Geraldo Francisco de Souza Rebouças, Ilmar Ferreira Santos, Jon Juel Thomsen

Abstract: Theoretical predictions obtained from the analysis of kinematic and kinetic formulations (coefficient of restitution and three impact force models) of vibro-impact oscillations are tested against experimental observations to compare the different models in terms of applicability and ease of use. A lumped mass cantilever beam with unilateral constraint and base excitation is used to provide experimental data. The different models are analyzed using numerical simulations and perturbation methods, such as averaging and non-smooth transformations, from which simple amplitude-frequency relations can be obtained. These relations are used to perform model parameter analysis, being fitted on experimental data in order to find appropriate parameter values.

[1] Geraldo Francisco de Souza Rebouças, M.Sc. (Ph.D. student): DTU Mekanik, 2800, DENMARK (gerreb@mek.dtu.dk), the author presented this contribution at the conference.

[2] Ilmar Ferreira Santos, Professor: DTU Mekanik, 2800, DENMARK (ifs@mek.dtu.dk).

[3] Jon Juel Thomsen, Associate Professor: DTU Mekanik, 2800, DENMARK (jjt@mek.dtu.dk).

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Homotopy analysis method applied for coupled time-periodic systems

Fadi Dohnal

Abstract: The homotopy analysis method is a semi-analytical technique to find an approximate solution of a nonlinear system of ordinary differential equation. The power of the method is that it does not need an artificial small parameter in contrast to perturbation theory. The method is applied to a coupled time-periodic system experiencing parametric combination resonances. The approximate semi-analytical result is benchmarked against well-established analytical expressions derived from perturbation theory such as the averaging method, the method of multiple scales, and the method of successive approximation.

[1)] Fadi Dohnal, Associate Professor: Division for Mechatronics Lienz, UMIT, Amlacher Str. 10, 9900 Lienz, AUSTRIA (fadi.dohnal@umit.at), the author presented this contribution at the conference.

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Maximum amplitude during passage through resonance at parametric anti-resonance

Fadi Dohnal

Abstract: Transient vibrations are introduced during run-up of a rotor when passing through its critical speeds which excite the corresponding vibration mode. Approximate analytical solutions for the maximum amplitude exist for constant acceleration and constant bearing characteristics. In the present study a modal energy transfer is triggered artificially by employing a parametric anti-resonance via a time-periodic bearing controller. Numerical simulations showed that this concept is capable of decreasing the maximum amplitude at the first critical speed. The present study derives and validates an analytical approximation for the maximum vibration amplitude at time-periodic bearings based on the complex error function and the averaging method. This result allows a physical interpretation of the parametric anti-resonance in the context of passage through resonance and reveals the physical parameters and its dependencies for engineering an efficient bearing controller.

[1] Fadi Dohnal, Associate Professor: Private University for Health Sciences, Medical Informatics and Technology (UMIT), Amlacher Str. 10, 9900 Lienz, AUSTRIA (fadi.dohnal@umit.at), the author presented this contribution at the conference.

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Two-frequency averaging in the problem of motion of a counter-rotating vertical axis wind turbine

Marat Dosaev, Liubov Klimina, Boris Lokshin, Vitaly Samsonov, Ekaterina Shalimova

Abstract: Motion of a small-scale Darrieus counter-rotating vertical axis wind turbine (VAWT) in a steady wind flow is studied. The system consists of two turbines that rotate in opposite directions. The shaft of one turbine is rigidly joined to the rotor of a generator and the shaft of the second turbine is rigidly joined to the stator. A closed few-parametrical mathematical model that takes into account changeable electrical load in the local circuit of a generator is constructed. The corresponding dynamical system is a two-frequency system. In order to describe operating modes of the model, it is averaged over two angles under the assumption that both frequencies are bounded away from zero. It is shown that passage through resonances has no crucial effect on the behavior of the system in the challenging range of the parameters of the model.

[1] Marat Dosaev, Associate Professor: LMSU Institute of Mechanics, 119192, Moscow, Michurinskiy pr-t, 1, RUSSIA (dosayev@imec.msu.ru).

[2] Liubov Klimina, Ph.D.: LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (klimina@imec.msu.ru), the author presented this contribution at the conference.

[3] Boris Lokshin, Associate Professor: LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (lokshin@imec.msu.ru).

[4] Vitaly Samsonov, Professor: LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (samson@imec.msu.ru).

[5] Ekaterina Shalimova, Ph.D.: LMSU Institute of Mechanics, 1, Michurinskiy pr-t, Moscow, 119192, RUSSIA (ekateryna-shalimova@yandex.ru).

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An approach to the mechanical modelling of contact problems in the application to friction stir welding

Nataliia Dubovikova, Erik Gerlach, Igor Zeidis, Klaus Zimmermann

Abstract: The joining process "Friction Stir Welding" (FSW) is an established solid state welding technique. Since its invention in 1991, a lot of papers are devoted to the understanding and improvement of this process. Most of them goes into details and consider special questions like the temperature-deformation distribution and the heat transfer process using numerical methods, like finite element method or finite difference method. From the mechanical point of view it makes sense to start with investigations on a high level of abstraction, using at first analytical considerations. This is a part of the real technological process, when the instrument is reached the touchdown point, but do not penetrate the material itself. It brings insight into the process on a level, where the system parameters are known and an experimental evaluation of theoretical results is possible. Consequentially, this kind of investigations leads in first approximation to contact problems in rigid body mechanics. Out of these considerations we analytically estimate power input of dry friction during rotation and translation in parallel. The stir process below the melting temperature of the material leads, as a consequence, to other forms of friction. As an extension of the presented work calculations with viscous friction are prepared for future investigations on the topic.

[1] Nataliia Dubovikova, Ph.D.: Technical University Ilmenau, FG TM, 98693 Max-Planck-Ring 12, Ilmenau, GERMANY (nataliia.dubovikova@tu-ilmenau.de), the author presented this work at the conference.

[2] Erik Gerlach, Ph.D.: Technical University Ilmenau, FG TM, 98693 Max-Planck-Ring 12, Ilmenau, GERMANY (erik.gerlach@tu-ilmenau.de).

[3] Igor Zeidis, Assistant Professor: Technical University Ilmenau, FG TM, 98693 Max-Planck-Ring 12, Ilmenau, GERMANY (igor.zeidis@tu-ilmenau.de).

[4] Klaus Zimmermann, Professor: Technical University Ilmenau, FG TM, 98693 Max-Planck-Ring 12, Ilmenau, GERMANY (Klaus.Zimmermann@tu-ilmenau.de).

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paper id: MTR348

Design study and development of mechatronic treadmill for gait reeducation

Slawomir Duda, Grzegorz Gembalczyk, Eugeniusz Świtoński

Abstract: The purpose of this article is to present a novel mechatronic system for gait reeducation which consists of two main components: body weight support system (BWS) and training treadmill. In addition, the device is equipped with sensors for measuring the rope tension, rope inclination angle and foot pressure on the ground. The transmission of control and measurement signals between the reeducation device and the computer with the control system is realized by means of three real time boards. This publication covers issues related to the process of device design, integration of all developed components and implementation of the treadmill speed control system. The treadmill is controlled by a feedback loop with a rope angle measurement but it requires a proper conversion of the continuous signal to a digital square wave signal of variable period. Due to the connection of the treadmill control signals to the buttons In the treadmill control panel and related limitations, developing an optimal treadmill speed control system was an interesting engineering problem.

[1)] Slawomir Duda, Associate Professor: Silesian University of Technology, Akademicka 2A, 44-100 Gliwice, POLAND (slawomir.duda@polsl.pl).

[2)] Grzegorz Gembalczyk, M.Sc. (Ph.D. student): Silesian University of Technology, Akademicka 2A, 44-100 Gliwice, POLAND (grzegorz.gembalczyk@polsl.pl), the author presented this contribution at the conference.

[3)] Eugeniusz Świtoński, Professor: Silesian University of Technology, Akademicka 2A, 44-100 Gliwice, POLAND (Eugeniusz.Switonski@polsl.pl).

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paper id: MTR1

Macro- and micro-scanners for laser applications: Non-linear characteristics and their impact on biomedical imaging

Virgil-Florin Duma

Abstract: We present some of our main results in the field of optomechanical laser scanners, built both as macro- and micro-devices. Several types of scanners are considered, from those that are the most utilized nowadays: with oscillatory mirrors (galvanometer scanners (GSs) or Micro-Electro-Mechanical Systems (MEMS)), with rotational polygonal mirrors (PMs) with different configurations), and with rotational mirrors (also named Risley prisms). The advantages and drawbacks of each solution are pointed out, in a comparative look. The optimization of oscillatory scanners with strongly non-linear scanning functions is made from the point of view of their duty cycle and of their capability to provide distortion-free images in biomedical applications, for example for Optical Coherence Tomography (OCT). The exact characteristics of rotational PMs are discussed, with regard to to their actual non-linearity with regard to approximate, linear functions. Risley prisms are presented, with their exact scan patterns that we have determined using mechanical design programs, in order to capture and model their non-linearity (while experimental works have validate these results). Conclusions are drawn regarding the application of such devices, especially for high-end ones, like OCT.

[1)] Virgil-Florin Duma, Professor: Aurel Vlaicu University of Arad, 77 Revolutiei Ave., ROMANIA (duma.virgil@osamember.org), the author presented this work at the conference.

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Interaction of bridge cables and wake behind in the vortex induced vibrations

Maciej Dutkiewicz, Irena Gołębiowska

Abstract: In the paper the interaction of wake and the cable with passive damper is analyzed. Vortex induced vibrations (VIV) are caused by vortex shedding, located behind the cable. VIV are especially important in the design and service of land constructions such as overhead transmission lines, suspended and stayed cable bridges and offshore structures such as pipelines, risers, mooring lines. On the basis of formulation of the fluid forces applied to the cable in the direction of lift, it is described the VIV model as forced model where force is independent of vertical displacements and depends on time only, the second model that is fluid elastic model where force depends on vertical displacement and time, and the third model that is coupled model where force is resulting from the coupling of cable and wake. The system of dynamical motion equations, coresponding to the coupled model, is supplemented by the modified van der Pol equation representing the oscillating lift force acting on the vibrating cable. The numerical simulations are performed for fixed aspect ratio B/D describing the section of the cable. The analyzed ellipse cylinder reflects the possible change of the cable's section due to the ice. The behavior of lift coefficient in time domain is presented. The spectra density analysis for lift force is drawn. In the study, the amplitudes of motion for cable and absorber for different damping parameter and derivatives of displacement in time domain are presented, as well as the dependence of lift force and cable motion.

[1] Maciej Dutkiewicz, Ph.D.: University of Science and Technology, Faculty of Civil, Architecture and Environmental Engineering, ul. Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (macdut@utp.edu.pl), the author presented this contribution at the conference.

[2] Irena Gołębiowska, Associate Professor: University of Science and Technology, Faculty of Civil, Architecture and Environmental Engineering, ul. Prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (macdut@utp.edu.pl).

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paper id: VIB44

Steady-state behaviour of the Jeffcott rotor comparing various analytical approaches to the solution of the Reynolds equation for plain journal bearing

Štěpán Dyk, Miroslav Byrtus, Luboš Smolík

Abstract: A planar 2DOF model of an unbalanced rigid disc on a massless shaft (Jeffcott rotor) is extended considering nonlinear forces in plain journal bearings. To express the fluid-film forces in the journal bearings, several approximate analytical solutions of the Reynolds equation are used, including widely used approximations for infinitely long and infinitely short journal bearing and a method using correction polynomial functions to extend the area of aspect ratios. The differences in steady-state response of such a rotor are studied. The influence of the approximate solution type, eccentricity ratio and aspect ratio is analysed. The aim is to find out the more effective approach to journal bearing description which could be further used in detailed dynamical analyses of both stable and unstable dynamic behaviour along with nonlinear phenomena like bifurcations and transitions to chaotic motions.

1) Štěpán Dyk, M.Sc. (Ph.D. student): NTIS, Faculty of Applied Sciences, University of West Bohemia, Univerzitni 8, 306 14, Pilsen, CZECH REPUBLIC (sdyk@ntis.zcu.cz), the author presented this contribution at the conference.

2) Miroslav Byrtus, Ph.D.: NTIS, Faculty of Applied Sciences, University of West Bohemia, Univerzitni 8, 306 14, Pilsen, CZECH REPUBLIC (mbyrtus@ntis.zcu.cz).

3) Luboš Smolík, M.Sc. (Ph.D. student): NTIS, Faculty of Applied Sciences, University of West Bohemia, Univerzitni 8, 306 14, Pilsen, CZECH REPUBLIC (carlist@ntis.zcu.cz).

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Transient dynamics of impacting beams with lost connection

Larysa Dzyubak, Atul Bhaskar

Abstract: The study of transient dynamics of impacting beams with lost connections is associated with problems of chaotic vibrations and noise generation in bolted and riveted structures with loose fastening. Analytical solutions, describing the transient dynamics of two cantilever beams under harmonic excitation with tips separated by clearance, are obtained. They are presented as a superposition of particular solutions that satisfy inhomogeneous boundary conditions, and the eigenfunctions series with time dependent coefficients and homogeneous boundary conditions. The switch conditions between impact and out-of-contact phases are based on expressions for shear forces and relative position of beam tips. The system of the impacting beams reveals complex dynamics, including chaotic behaviour. Transient dynamics surfaces, time histories of beams deflections, impact forces, coefficients of restitution, and phase planes are presented. Intensive impacts of beam tips are observed in both cases at zero and non-zero clearance.

[1] Larysa Dzyubak, Associate Professor: Department of Applied Mathematics, National Technical University, 2 Kyrpychova Str., 61002 Kharkiv, UKRAINE (dzyubak.larissa@interdiscipline.org), the author presented this contribution at the conference.

[2] Atul Bhaskar, Professor: Faculty of Engineering and Environment, University of Southampton, Southampton SO16 7QF, UNITED KINGDOM (a.bhaskar@soton.ac.uk).

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paper id: LIF195

Tumor growth and decay predictability based on chaotic attractors in the phase spaces

Larysa Dzyubak, Oleksandr Dzyubak, Jan Awrejcewicz

Abstract: In Radiation Oncology and Radiobiology the modeling of tumor growth and decay depending on set of system parameters is very important to improve the control of cancer treatment. In a simple approach, the multi-scale diffusion cancer-invasion model describes the interactions of the tumor cells, matrix-metalloproteinases, matrix-degradative enzymes and oxygen. This model demonstrates chaotic attractors. In this work we studied the control parameter planes 'number of tumor cells vs diffusion saturation level' depending on glucose level. The regions where interaction of the basic system indicators is predictable and unpredictable were found. Time histories of the regular damped/un-damped motion, chaotic attractors in the phase spaces of basic indicators of the system are presented. Qualitative analysis of the results can be used by professionals who deals with the tumor growth and decay simulation and who is involved in the treatment planning process.

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1) Larysa Dzyubak, Associate Professor: Department of Applied Mathematics, National Technical University, 2 Kyrpychova Str., 61002 Kharkiv, UKRAINE (dzyubak.larissa@interdiscipline.org), the author presented this contribution at the conference.

2) Oleksandr Dzyubak, Ph.D.: Ascension All Saint Cancer Center, 3809 Spring Street, Racine, WI 53405, USA (Dzyubak.Oleksandr@gmail.com).

3) Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, the Lodz University of Technology, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Numerical investigation on dynamic performance of a multi-storey steel structure model and comparison with experimental results

Tomasz Falborski, Barbara Sołtysik, Robert Jankowski

Abstract: Shaking table testing is the most commonly adopted method to simulate earthquake forces. This approach allows us to analyze the dynamic performance and provides a valuable insight into the dynamics of building structures, which helps to improve their future safety and reliability. The present study aims to conduct a numerical evaluation of dynamic response of a multi-storey steel structure model, which was previously examined during an extensive shaking table investigation. The experimental model was subjected to a number of different earthquake ground motions and mining tremors. In order to perform the numerical research, lumped-mass system was employed. The analyzed two-storey steel structure model was considered as a 2-DOF system with lumped parameters, which were determined by conducting free vibration tests. In order to solve the dynamic equation of motion, Newmark's average acceleration method was adopted. The results obtained showed that not only seismic excitations but also mining tremors may considerably deteriorate structural behaviour by inducting strong structural vibrations. The time-acceleration history plots computed for the multi-storey structure model idealized as a 2-DOF system are consistent with those recorded during the previously conducted shaking table investigation, which confirms high accuracy in assuming lumped parameters to characterize the analyzed two-storey steel structure model.

[1] Tomasz Falborski, Assistant Professor: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, ul. Narutowicza 11/12, 80-233 Gdansk, POLAND (tomfalbo@pg.gda.pl), the author presented this contribution at the conference.

[2] Barbara Sołtysik, M.Sc. (Ph.D. student): Gdansk University of Technology, Faculty of Civil and Environmental Engineering, ul. Narutowicza 11/12, 80-233 Gdansk, POLAND (barwiech@pg.gda.pl).

[3] Robert Jankowski, Professor: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, ul. Narutowicza 11/12, 80-233 Gdansk, POLAND (jankowr@pg.gda.pl).

14th INTERNATIONAL CONFERENCE

Dynamical Systems - Theory and Applications

December 11-14, 2017. Lodz, POLAND.

paper id: ENG237

Accumulation of the energy in mechanical resonance

Wiesław Fiebig

Abstract: Under resonance conditions, for example in a harmonic oscillator, the frequency of the exciting force should be close to the natural frequency of the oscillator. The vibration amplitude and total mechanical energy of the oscillating mass increase to a certain value, dependent on the level of damping. In the steady state conditions at resonance, the delivered energy in one cycle of vibrations is equal to the energy dissipated in the oscillator. The inertia force is compensated with the spring force. The accumulation of the energy at mechanical resonance is similar like in a flywheel. The energy stored in a harmonic oscillator at resonance due to the amplification of the amplitude, is many times higher than the energy delivered during one cycle of vibration. This energy can be received in the form of high amplitude impulses which occurs in a sequence. Finally it is explained how the energy stored in the mechanical resonance can be used, i.e. in machine drive systems.

[1)] Wiesław Fiebig, Professor: Wroclaw University of Science and Technology, Faculty of Mechanical Engineering, Lukasiewicza 7/9, 51-370 Wroclaw, POLSKA (wieslaw.fiebig@pwr.edu.pl), the author presented this contribution at the conference.

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paper id: ENG289

Modelling water hammer with quasi-steady and unsteady friction in viscoelastic conduits

Mateusz Firkowski, Mateusz Firkowski, Kamil Urbanowicz

Abstract: We consider the model of water hammer in viscoelastic pipelines. A mathematical model is presented. An additional term has been added to continuity equation to describe the retarded deformation of the pipe wall. The equation describing model has been solved using the method of characteristics and the finite difference method. To determine the unsteady wall shear stress we use a new effective method of solution which corresponds to Zielke (laminar flow) and Vardy-Brown (turbulent flow) classic solution. The obtained results are taken into account quasi-steady and unsteady friction. The comparison of numerical simulation and experimental is conducted.

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[1] Mateusz Firkowski, M.Sc. (Ph.D. student): West Pomeranian University of Technology Szczecin, al. Piastów 17, 70-310 Szczecin, POLAND (mateusz.firkowski@zut.edu.pl), the author presented this contribution at the conference.

[2] Mateusz Firkowski, M.Sc. (Ph.D. student): West Pomeranian University of Technology Szczecin, al. Piastów 17, 70-310 Szczecin, POLAND (mateusz.firkowski@zut.edu.pl), the author presented this contribution at the conference.

[3] Kamil Urbanowicz, Ph.D.: West Pomeranian University of Technology Szczecin, al. Piastów 17, 70-310 Szczecin, POLAND (kamil.urbanowicz@zut.edu.pl).

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Dynamical Systems - Theory and Applications

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paper id: VIB120

An energy trapped degenerate mode resonator

Barry J Gallacher, Jim Burdess, Zhongxu Hu, Harriet Grigg, Chen Fu, Carl Dale, Neil Keegan, John Hedley, Julia Spoors

Abstract: Trapped and quasi-trapped mode resonators have a long history. High frequency crystal filters often operate in a trapped shear mode configuration in order to exploit the high intrinsic mechanical quality factor and high stability. Similarly, the Quartz Crystal Microbalance (QCM) also operates in a trapped shear configuration for the same reasons. Thus far there is no evidence in the literature of degenerate trapped or quasi-trapped shear mode resonators. In trapped modes all components of the displacement field are highly localised and thus the energy associated with the resonance is conserved or "trapped". In contrast, quasi-trapped modes do radiate energy as one component of the displacement field in not localised. Localisation, including both quasi-trapping, of antisymmetric thickness shear waves is made possible due to surface loading on the plate caused by the mesa. The mesa is circular to maintain axisymmetry but this is not essential for localisation. Magnetic acoustic coupling provides the excitation method which permits the use of elastically isotropic material thus maintaining the desired degeneracy. In this body of work we experimentally confirm the trapped nature of the cyclic modes. The resonant dynamics are characterised by 3D laser vibrometry and also by electromagnetic sensing. The modeshapes for the degenerate pair are presented and demonstrate the localisation of the displacement field. These modes are quasi-trapped and offer a means of manufacturing environmentally robust mass sensors or gyroscopes.

[1] Barry J Gallacher, Ph.D.: Newcastle University, NE1 7RU, UK (b.j.gallacher@ncl.ac.uk), the author presented this contribution at the conference.

[2] Jim Burdess, Ph.D.: Newcastle, NE1 7RU, UK (j.s.burdess@ncl.ac.uk).

[3] Zhongxu Hu, Ph.D.: Newcastle University, NE1 7RU, UK (zhongxu.hu@newcastle.ac.uk).

[4] Harriet Grigg, Ph.D.: Newcastle University, NE1 7RU, UK (Harriet.Grigg@newcastle.ac.uk).

[5] Chen Fu, Ph.D.: Newcastle University, NE1 7RU, UK (Chen.Fu@newcastle.ac.uk).

[6] Carl Dale, Ph.D.: Newcastle University, NE1 7RU, UK (carl.dale@newcastle.ac.uk).

[7] Neil Keegan, Ph.D.: Newcastle University, NE1 7RU, UK (neil.keegan@newcastle.ac.uk).

[8] John Hedley, Ph.D.: Newcastle University, NE1 RU, UK (john.hedley@newcastle.ac.uk).

[9] Julia Spoors, Ph.D.: Newcastle, NE1 7RU, UK (julia.spoors@newcastle.ac.uk).

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paper id: CON143

Sensitivity investigations of the vehicle lane change manoeuvre with an automatic control system

Mirosław Gidlewski, Leszek Jemioł, Dariusz Żardecki

Abstract: The lane change automation is a fundamental problem of autonomous cars for low as well as high speeds. The lane change controller discussed in the paper has a mixed structure. In the open-loop structure it works as a set-point signal generator which generates three variables (signals) determining the lane change maneuver: a set-point input signal of steering system angle, and two set-point output signals describing vehicle's motion. In the closed-loop structure it works as a steering signal corrector which corrects on-line (by two Kalman regulators) the steering system angle signal. The set-point signals, as well as regulators' algorithms are based on a simple reference model (simplified "bicycle model"). In simulation investigations, the virtual object of control – the model of medium-duty truck is very detailed (MBS-type, 3D, nonlinear). This model had been verified experimentally. The paper presents information on the models, the method used, as well as example unpublished results of simulation based sensitivity investigations.

[1] Mirosław Gidlewski, Ph.D.: Automotive Industry Institute (PIMOT), University of Technology and Humanities in Radom, Jagiellońska 55, 03-301 Warszawa, POLSKA (miroslaw.gidlewski@uthrad.pl).

[2] Leszek Jemioł, M.Sc.: University of Technology and Humanities in Radom, Malczewskiego 29, 26-600 Radom, POLSKA (leszek.jemiol@uthrad.pl).

[3] Dariusz Żardecki, Professor: Military University of Technology (WAT), Automotive Industry Institute (PIMOT), Kaliskiego 2, 00-908 Warszawa 49,, POLSKA (dariusz.zardecki@wat.edu.pl), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: EXP290

The process of energy dissipation during front-side collision of passenger cars

Mirosław Gidlewski, Leon Prochowski, Tomasz Pusty

Abstract: A balance of the energy dissipated during a vehicle collision is often the basis for analysis of road accidents. In order to determine the important components of the balance, three tests with a right-angle collision of passenger cars of the same make and model were conducted (for the impacted vehicle either moving or being at a standstill). Analysis of the energy dissipation process during these collisions was conducted in two ways: – identification of the energy dissipation process during the deformation of the vehicle bodies and the post-impact vehicle motion; – with the use of the vehicle dynamics models offered by the V-SIM and PC Crash programs and then validate their parameters based on the crash tests mentioned above. During analysis of the dissipation process the following factors were taken into account: inter alia, processes of deformation of the vehicle bodies, post-impact motion of the vehicles involved, work of the forces of friction between the vehicles in the period when the vehicles remained in contact, and work of the tangential reactions developing within the tyre-road contact area. Based on the analytical calculation, model tests and conducted experiments the conclusions were formulated which can provide important support during the analysis of the course of complex road accidents and in the process of their reconstruction.

[1)] Mirosław Gidlewski, Ph.D.: University of Technology and Humanities in Radom, Malczewskiego 29, 26-600 Radom, POLAND (miroslaw.gidlewski@uthrad.pl).

[2)] Leon Prochowski, Professor: Military University of Technology (WAT), Kaliskiego 2, 00-908 Warszawa 49, POLAND (leon.prochowski@wat.edu.pl).

[3)] Tomasz Pusty, M.Sc.: Automotive Industry Institute (PIMOT), Jagiellońska 55, 03-301 Warszawa, POLAND (tomasz.pusty@wp.pl), the author presented this contribution at the conference.

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paper id: NUM32

Condition monitoring of the manipulator tool based on inertia forces analysis

Piotr Gierlak

Abstract: In the article the analysis of the problem connected with detecting damages of the manipulator tool is presented. The work aims at presenting the method of creating a classifier which on the basis of the available measurement data obtained by means of a force sensor assigns current balance state into one of two defined classes: 1st class – a tool in operable condition, 2nd class – a damaged tool. The tool used in the research is a brush of ceramic fibres. It is made of several dozen slender fibres covered with a protection sleeve. Each new tool along with the protection sleeve is balanced, but due to the fact that the tools are very fragile, it is sometimes damaged by breaking of fibers during machining process. The presented damages can be easily detected by an operator; nonetheless, the aim is to work out a diagnostic procedure which would function automatically on a robotized stand. The diagnostic procedure should be based on the relationship between the condition of a tool and a physical phenomenon which accompanies the condition. Then it is necessary to determine parameters of the phenomenon which can be measured and unambiguously connected with the condition of the tool. This phenomenon may be e.g. fictitious forces acting upon the tool in rotational motion. The herein discussed diagnostic method is based on the fact that the tool damage is connected with the shift of the centre of mass of the tool, which has impact on the value and location of resulting fictitious force, which along with the momentum deriving from it will be recorded by means of force/torque sensor.

[1] Piotr Gierlak, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (pgierlak@prz.edu.pl), the author presented this work at the conference.

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paper id: CON33

Control of dynamical system with non-continuous constraints

Piotr Gierlak

Abstract: The article presents the synthesis of control of dynamical system with constraints, that change in a non-continuous way. As an example of a dynamical system, a simple manipulator in contact with a flexible surface was selected. The manipulator has to apply a desired pressure to the surface to accomplish the given process. This surface is a natural constraint of the manipulator. This is the case in practice, for example in assembly tasks or in machining tasks with force control. The discontinuity of the constraints is that at some point of time, which is not strictly defined, the manipulator loses contact with the surface, i.e. it ceases to be bound by the constraints. This is the case in assembly processes, such as a peg-in-hole assembly, which may be realised by “dumb” searches on surface or in machining tasks - when the surface to be machined is imprecisely defined, and the end-effector of manipulator can lose contact with the surface. In the absence of contact with the environment, the desired force cannot be realised, so the controller increases the control, so that the speed of the robot increases sharply, until it reaches a dangerous impact on the environments. The paper presents the synthesis of the control algorithm in a such situation. An additional virtual damping force is added to the control signal to ensure that, in the absence of contact with the environment, the speed of the robot will reach a constant value, which can be reduced by the appropriate selection of the control gain.

[1] Piotr Gierlak, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (pgierlak@prz.edu.pl), the author presented this work at the conference.

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paper id: STA27

Computation of a Finsler-Lyapunov function using meshless collocation

Peter Giesl

Abstract: We study the stability of invariant sets such as equilibria or periodic orbits of a Dynamical System given by a general autonomous nonlinear ordinary differential equation (ODE). A classical tool to analyse the stability are Lyapunov functions, i.e. scalar-valued functions, which decrease along solutions of the ODE. An alternative to Lyapunov functions is contraction analysis. Here, stability is a consequence of the contraction property between two adjacent solutions (or incremental stability), formulated as the local property of a Finsler-Lyapunov function. This has the advantage that the invariant set plays no special role and does not need to be known a priori. In this talk, we numerically construct a Finsler-Lyapunov function by solving a first-order partial differential equation using meshless collocation. This method ensures that the partial differential equation holds at a set of given collocation points. If the equation is known to possess a smooth solution, error estimates are available. These error estimates provide bounds of the error between the true solution and the approximation in terms of the fill distance, measuring how dense the collocation points are. While meshless collocation has been used to compute classical Lyapunov functions, the computation of Finsler-Lyapunov functions is new and has the advantage that no information about equilibria or periodic orbits is required. In the talk we describe the method and present how it performs in examples.

[1)] Peter Giesl, Associate Professor: University of Sussex, Falmer, BN1 9QH, UNITED KINGDOM (p.a.giesl@sussex.ac.uk), the author presented this work at the conference.

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Dynamical Systems - Theory and Applications

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paper id: VIB324

Damage analysis and detection under varying environmental and operational conditions using a chaos theory methods

Alexander Glushkov, Vasily Buyadzhi, Eugeny Ternovsky, Anna Ignatenko

Abstract: One of the important problems in monitoring the engineering (vibrating) structures is problem of analysis, identification and prediction the presence of damages (cracks). Usually change of structural dynamic properties due to environmental, operational and other effects allows to determine the existence, location and size of damages. The work is devoted to carrying out and advancing effective computational approaches to modelling, analysis and prediction of a chaotic behaviour of structural dynamic properties of the vibrating structures. The code developed includes a set of such non-linear analysis and a chaos theory methods as the correlation integral approach, multi-fractal and wavelet analysis, average mutual information, surrogate data, Lyapunov's exponents and Kolmogorov entropy approach, spectral methods, nonlinear prediction (predicted trajectories, neural network etc) algorithms [2]. As illustration we present the results of the complete numerical investigation of a chaotic elements in time series for the simulated 3DOF system and an experimental cantilever beam (data from [2]). 1.A.V. Glushkov A.V., Methods of a Chaos Theory to Complex Geo-Systems, 2012, Odessa (2012). 2. A. Tjirkallis, A. Kyprianou, Mech.l Syst. Signal Process. 66-67, 282 (2016).

1) Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com), the author presented this contribution at the conference.

2) Vasily Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (buyadzhivv@gmail.com).

3) Eugeny Ternovsky, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (ternovskyev@gmail.com).

4) Anna Ignatenko, Associate Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (ignatenkoav13@gmail.com).

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Dynamical Systems - Theory and Applications

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Chaos bifurcations and strange attractors in environmental radioactivity dynamics of some geosystems

Alexander Glushkov, Yuliya Dubrovskaya, Vasily Buyadzhi, Eugeny Ternovsky

Abstract: The work is devoted to the development of the theoretical foundations of new universal complex chaos-dynamical approach to description of the deterministic chaos, bifurcations and strange attractors in dynamics of the environmental radioactivity systems. In particular, the atmospheric radon 222Rn concentration temporal dynamics is studied and computed. The nalysis methods include advanced versions of the correlation integral, fractal analysis, algorithms of average mutual information, false nearest neighbors, Lyapunov exponents, surrogate data, non-linear prediction schemes, predicted trajectories algorithms, spectral methods etc. to solve problems quantitatively complete modeling and analysis of temporal evolution of the atmospheric radon 222Rn concentration. There are firstly received data on topological and dynamical invariants for the time series of the 222Rn concentration, discovered a deterministic chaos phenomenon using detailed data of measurements of the radon concentrations at SMEAR II station of the Finnish Meteorological Institute in the Southern Finland (2000-2006) and Chester, New Jersey, USA (1978).
1. Glushkov A.V., Methods of a Chaos Theory to Complex Geo-Systems, 2012, Odessa, Astroprint; Glushkov A., Khetselius O., Buyadzhi V.V., New Methods of Mathematical Modelling in Earth and Environmental Sciences, 2016, Odessa, OSENU; 2. Rusov V.D., Glushkov A.V., etal, Bound Vol. of Obs. Montagne de Moussalla 12, 80 (2007); Adv. in Space Res. 42, 1614 (2008); J. Atm. and Solar-Terr. Phys. 72, 498 (2010).

[1] Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com), the author presented this contribution at the conference.

[2] Yuliya Dubrovskaya, Assistant Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (dubrovskayayv@gmail.com).

[3] Vasily Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (buyadzhivv@gmail.com).

[4] Eugeny Ternovsky, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (ternovskyev@gmail.com).

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paper id: BIF319

Nonlinear dynamics of relativistic backward-wave tube in self-modulation and chaotic regime

Alexander Glushkov, Valentin Ternovsky, Anna Buyadzhi, Dmitry Mironenko

Abstract: It has been performed quantitative modelling, analysis, forecasting dynamics relativistic backward-wave tube (RBWT) with accounting relativistic effects (relativistic factor g= 1.5-6.0), dissipation (factor D), a presence of space charge etc. There are computed the temporal dependences of the normalized field amplitudes (power) in a wide range of variation of the controlling parameters which are characteristic for distributed relativistic electron-waved self-vibrational systems: electric length of an interaction space N, bifurcation parameter proportional to (~current I) Pirse one J and relativistic factor g. The computed temporal dependence of the field amplitude (power) Fmax in a good agreement with theoretical estimates and experimental data by Ginzburg etal (IAP, Nizhny Novgorod) with using the pulsed accelerator "Saturn". The analysis techniques including multi-fractal approach, methods of correlation integral, false nearest neighbour, Lyapunov exponent's, surrogate data, is applied analysis of numerical parameters of chaotic dynamics of RBWT. There are computed the dynamic and topological invariants of the RBWT dynamics in auto-modulation(AUM)/chaotic regimes, correlation dimensions values (3.1; 6.4), embedding, Kaplan-York dimensions, Lyapunov's exponents (+,+) Kolmogorov entropy. There are constructed the bifurcation diagrams with definition of the dynamics self-modulation/chaotic areas in planes, namely, "J-g", "D-J".

[1] Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com).

[2] Valentin Ternovsky, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (ternovskyvb@gmail.com), the author presented this contribution at the conference.

[3] Anna Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (buyadzhiaa@gmail.com).

[4] Dmitry Mironenko, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (dmitrymironenko777@gmail.com).

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paper id: EXP269

Application of time-frequency methods for assessment of gas metal arc welding condition

Jacek Górka, Wojciech Jamrozik

Abstract: Gas Metal Arc Welding (GMAW) is a popular method of material joining, widely used for variety of critical industrial structures. Assuring high quality of joints is than a vital task. The welding is a highly dynamic and nonlinear process, thus application of time-domain or frequency-domain is often not suitable for evaluation of welded joints quality. To fully describe the correspondence between the geometry of welding arc, parameters that express the quality of joint, and welding arc current, being the most important steerable parameter of GMAW, time-frequency methods (TFM) of signal analysis should be applied. In the paper application of ensemble of STFT and EMD (Empirical Mode Decomposition)-based estimators to evaluate the stability of GMAW process, that results in the quality of joint. Proposed method of feature extraction was applied on a real data taken during several GMAW realizations with different conditions (changes in welding current, arc voltage, shield gas flow, wire feed speed, etc.). In the active experiment process parameters, as well as visible light images of welding arc were acquired. Performed investigations revealed that in comparison to traditional as well as separately used TFM, ensemble of TF estimators give better performance in GMAW condition assessment.

[1] Jacek Górka, Associate Professor: Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, POLSKA (jacek.gorka@polsl.pl).

[2] Wojciech Jamrozik, Ph.D.: Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, POLSKA (wojciech.jamrozik@polsl.pl), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: VIB333

Modeling of construction and nonlinear fluctuations of constructions using Chebyshev's polynomials

Sergey Yuryevich Gridnev, Yuriy Ivanovich Skalko

Abstract: For improvement of computing schemes of realization of practical problems of modeling of constructive and nonlinear fluctuations of building constructions Chebyshev's polynomials have been used for the solution of the differential equations in partial derivatives with discontinuous boundary conditions. The solution of such equations becomes complicated because of the unknown time of change of boundary conditions in advance, violations of stability of solution, accumulation of errors. The algorithm allowing overcoming the arising computing difficulties is proposed. The algorithm is stated in relation to a technique of modeling of constructive and nonlinear fluctuations of the floating bridge of continuous system with restrictive rigid support on the ends. Approach allows conducting virtual computing experiments according to the admission of various mobile loading on the floating bridge for assessment of its deformed state and adoption of reasonable design decisions.

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[1] Sergey Yuryevich Gridnev, Professor: Voronezh State Technical University, 394006, 84, 20-letya Oktyabrya str., RUSSIAN FEDERATION (oxtrans@gmail.com), the author presented this contribution at the conference.

[2] Yuriy Ivanovich Skalko, Associate Professor: Moscow Institute of Physics and Technology (State University), 9, Institutsky Lane, Dolgoprudny, Moscow region, Russia,141701, RUSSIAN FEDERATION (skalko@mail.mipt.ru).

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paper id: ENG349

Calculation of the transmission and reflection coefficients of the light falling on the cholesteric liquid crystals

Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: In this paper we study some aspects of optical phenomena occurring in liquid crystals. Especially, we calculate the transmission and reflection coefficients of the light falling on the considered optical system, i.e. a cholesteric liquid crystal bounded by two semi-infinite isotropic materials. For this purpose, we used own computer program, which realises the so-called 4x4 matrix method. As a result of the numerical investigations, we present some interesting curves of the reflection/transmission coefficients as a function of different parameters of the considered system. The main advantage of the applied technique is taking into account all four elementary waves of the light and their interferences in each elementary layer of the liquid crystal. The inclusion of both the incoming and reflected waves is of particular importance for cholesteric crystals, where, due to a periodic structure, the light wave interferences have significant influence on the intensity of the reflected light and the light passing through the considered optical system.

[1)] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl), the author presented this contribution at the conference.

[2)] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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paper id: ENG350

Modelling of optical phenomena in cholesteric liquid crystals bounded by a pair of optical polarizers

Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: In this paper we calculate the transmission and reflection coefficients of the light falling on the cholesteric liquid crystal bounded by a pair of two optical polarizers. To model optical phenomena inside the liquid crystal (i.e. propagation and interference of the light waves), we used a 4x4 matrix method implemented in C++. As a result of the performed numerical simulations, we obtained some interesting curves of the reflection/transmission coefficients as functions of different parameters of the considered system, as well as distributions of the reflection/transmission coefficient for different orientations of the bounded optical polarizers. By using the applied technique, we take into account all four waves of the light propagated in liquid crystal, which has a great influence on the calculated coefficients. The obtained numerical results can be useful for analysis of such optical systems, especially of liquid crystal displays.

[1)] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl), the author presented this contribution at the conference.

[2)] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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paper id: LIF345

A 5-link human biomechanical model simulating a human with the hip joint endoprosthesis in the process of doing deep knee bends

Dariusz Grzelczyk, Jan Awrejcewicz, Ievgen Levadnyi

Abstract: We study a 5-link biomechanical model of a human for calculating reaction forces in human joints, especially in the hip joint, during the process of doing deep knee bends. The proposed model, constructed based on a mechanical system consisting of five rigid bodies connected by four pivotal joints, which correspond to the knee, hip, shoulder and elbow joints, is simulated in Mathematica. Mechanical and geometrical parameters of the considered model are obtained on the basis of the three-dimensional scanned human body model created in Inventor, while kinematics of the model (time histories of the angles in the mentioned joints) are obtained from the experiment with the use of Optitrack motion tracking system. Experimental verification of the presented model is performed by comparing the simulation of reaction forces between the patient's legs and the ground with experimental data obtained from the force platform. Using the presented human model, it is possible to test different scenarios of the process of doing deep knee bends and choosing the case that generates relatively small reaction forces in the joints. The simulated time histories of reaction forces acting in the human hip joint can be used as dynamic time-varying load conditions suitable for strength analysis of the joint endoprosthesis implanted in the patient's body. Finally, the results obtained in this way provide some guidance for people (for instance with hip or knee joints replacement) in this typical sports activity.

[1)] Dariusz Grzelczyk, Ph.D.: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[2)] Ievgen Levadnyi, M.Sc. (Ph.D. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (evgenabaqus@gmail.com), the author presented this contribution at the conference.

[3)] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Biomechanical model of a human suitable for strength analysis of hip endoprosthesis during the process of getting up from a chair

Dariusz Grzelczyk, Ievgen Levadnyi, Jan Awrejcewicz

Abstract: In this paper we study the biomechanical model of a human. The model is suitable for estimation of reaction forces in the hip joint of a human with implanted hip endoprosthesis during the process of getting up from the chair. For this purpose, we consider a relatively simple mathematical model simulated in Mathematica software, based on a mechanical system consisting of three rigid bodies connected by two pivotal joints, which correspond to the knee and hip joints. Geometrical and mechanical properties of the model are estimated based on the three-dimensional scanned human body model created in Inventor, whereas kinematics of the model (time histories of the angles in individual joints) are obtained from experimental observations by using the Optitrack motion capture system. Experimental validation of the analysed model is conducted by comparing the obtained simulation of reaction forces between the patient's legs and the ground with experimental data obtained from the force platform. The simulated time histories of reaction forces acting in the human hip joint are used as dynamic time-varying load conditions for strength analysis of the hip endoprosthesis in the patient's body, performed in Abaqus. Based on the results of numerical and experimental investigations, it is possible to test different scenarios of getting up from the chair and choose the case that would not damage the implanted endoprosthesis. In this way, the obtained results provide some guidance for people with hip replacement in this typical everyday activity of the patient.

[1] Dariusz Grzelczyk, Ph.D.: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[2] Ievgen Levadnyi, M.Sc. (Ph.D. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (evgenabaqus@gmail.com), the author presented this contribution at the conference.

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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The octopod robot and its dynamical model during walking on the flat and susceptible ground

Dariusz Grzelczyk, Bartosz Stańczyk, Jan Awrejcewicz

Abstract: The paper is devoted to the system controlling the movement of the octopod robot legs as well as simulation of the octopod dynamical model during walking on the flat and susceptible ground with damping. Numerous types of different multi-legged walking robots can be found in engineering applications, however, eight-legged robots (octopod robots) have become popular recently. The proposed dynamical model of the mentioned multi-legged robot allows to determine the reaction forces between the ground and the octopod's legs forming a support polygon, as well as balance of its body on the soft ground. In addition to the dynamic parameters of the considered robot, also displacement and velocity curves are determined. The walking process of the robot is visualised in Mathematica software. The obtained results indicate different ground reaction forces acting on the robot legs as well as fluctuation of the robot for different types of controls.

[1] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[2] Bartosz Stańczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (bartosz.stanczyk@p.lodz.pl), the author presented this contribution at the conference.

[3] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Modelling and numerical analysis of the prototype of a hydraulic actuator suitable for control of an exoskeleton supporting human walking during the rehabilitation process

Dariusz Grzelczyk, Olga Szymanowska, Jan Awrejcewicz

Abstract: This paper is focused on the modelling and numerical analysis of the hydraulic actuator suitable for control of an exoskeleton system supporting human walking during the rehabilitation process. The main advantage of the proposed hydraulic system is the separation of the large power supply from the exoskeleton system and the transmission of power via a thin hydraulic pipe. Correctness of operation of the proposed prototype of a hydraulic actuator is visualized as a computer animation created in Mathematica software. From the automation point of view, the considered system is a closed loop feedback system with a classical PID controller. Two types of input excitation are used, i.e. kinematic excitation and force excitation. As a kinematic input excitation, we consider time histories of angles in chosen human joints observed by means of Optitrack system during a normal walking process. The parameters of the PID controller are chosen so that the time histories of the output signal are as close to the time histories of the input signal as possible. The obtained numerical results also show the possibility of implementing the proposed hydraulic actuator in other engineering applications. For instance, it can be used in prosthetic hands, surgical equipment or other systems requiring high stiffness and precision combined with good recurrence of movements in linear or rotational motion.

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[1] Dariusz Grzelczyk, Ph.D.: Lodz University of Technology, Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[2] Olga Szymanowska, M.Sc. (Ph.D. student): Lodz University of Technology, 1/15 Stefanowski St., 90-924 Lodz, POLAND (olga.szymanowska@dokt.p.lodz.pl), the author presented this contribution at the conference.

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, 1/15 Stefanowski St., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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A 3-link biomechanical model of a human for simulating a forward fall

Dariusz Grzelczyk, Paweł Biesiacki, Jerzy Mrozowski, Jan Awrejcewicz

Abstract: In this study we consider a 3-link biomechanical model of the human for simulating a forward fall. The model includes bending in the upper extremities, i.e. in the elbow joints. The proposed model is constructed based on a planar mechanical system with a non-linear impact law modelling the biomechanical relations between the ground and hands of the faller. Individual parts of the human body are modelled as rigid bodies connected by the rotary sprig-damper elements which correspond to the human joints. Before the impact to the ground, the analysed system is kinematically forced in the joints corresponding to the shoulder and elbow, and, as a result, the considered system is reduced to the single-degree-of-freedom system. After impact to the ground, the mentioned joints are characterized by the spring-damper elements, and thus the system has three degrees of freedom. Parameters of the model are obtained based on the three-dimensional scanned human body model created in Inventor, while kinematics of the model (time histories of the angles in shoulder and elbow joints) are obtained from experimental observation with the optoelectronic motion analysis system. Experimental validation of the proposed model is conducted by means of comparing the simulation of impact force between the hands and the ground with experimental data from the force platform obtained for falls from a low height. Finally, the obtained ground reaction forces can be useful for further finite element transient state analysis of the numerical model of the human upper extremity.

[1] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (dariusz.grzelczyk@p.lodz.pl), the author presented this contribution at the conference.

[2] Paweł Biesiacki, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (pawel.biesiacki@dokt.p.lodz.pl).

[3] Jerzy Mrozowski, Associate Professor: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (jerzy.mrozowski@p.lodz.pl).

[4] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, 90-924, ŁÓDŹ (jan.awrejcewicz@p.lodz.pl).

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Simulation of the octopod robot controlled by different Central Patterns Generators

Dariusz Grzelczyk, Bartosz Stańczyk, Olga Szymanowska, Jan Awrejcewicz

Abstract: In this paper we focus on kinematic and dynamic simulation of the octopod robot during its walking on a flat and hard surface. The robot legs are kinematically excited by different well-known mechanical non-linear oscillators as well as new (proposed) ones, working as Central Pattern Generators (CPGs). Time histories of kinematic and dynamic parameters of the octopod locomotion process are obtained, while the walking process of the robot is visualised in Mathematica software. In particular, we considere fluctuations of the robot gravity centre in different directions, ground reaction forces between the robot legs and the ground as well as friction coefficient which is required to prevent the legs from sliding on the ground. Eventually, some advantages of the proposed CPGs are outlined, i.e. the lack of the acceleration and deceleration of the robot gravity centre, minimisation of the ground reaction forces between the robot and the ground as well as low energy consumption of the robot during walking.

[1] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[2] Bartosz Stańczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (bartosz.stanczyk@p.lodz.pl), the author presented this contribution at the conference.

[3] Olga Szymanowska, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (szymanowska.olga@gmail.com).

[4] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Distributed generation facilitates synchronization in power-grid models of second-order Kuramoto oscillators

José Mario Vicensi Grzybowski, Elbert Einstein Nehrer Macau, Takashi Yoneyama

Abstract: Electrical power grids are large scale distributed dynamical systems whose functional structure involve a great number of subsystems. The stability and robustness of such systems are closely related to the individual characteristics of the oscillators, to the couplings among them and to the topology of the network through which they are connected. Towards the simplified modeling of power grid dynamics, it is usual to consider a formal analogy between the swing equation of the electrical machine and the second-order Kuramoto oscillator. In this paper, we consider the second-order Kuramoto model along with recently developed analytical expressions for the critical coupling strength associated with the transition to complete frequency locking to evaluate the effect of increased distribution of generation upon network synchronizability. The study was based on analytical and numerical studies of the behavior of the critical coupling strength to the onset of complete frequency synchronization. The results indicate that distributed generation can significantly reduce the critical coupling coefficient for the onset of complete frequency synchronization in power-grid models of second-order Kuramoto oscillators, thus facilitating synchronization. Further, increasing decentralization is observed to make the network fitter to handle random failures and regain stability after small perturbations.

[1] José Mario Vicensi Grzybowski, Ph.D.: Federal University of Fronteira Sul, Rod RS 135 km 72 Erechim RS, BRAZIL (zzmariovic@yahoo.com.br).

[2] Elbert Einstein Nehrer Macau, Ph.D.: INPE, Av. dos Astronautas, 1728, S.J. dos Campos, BRAZIL (elbert.macau@inpe.br), the author presented this contribution at the conference.

[3] Takashi Yoneyama, Ph.D.: ITA, Pça, Marechal Eduardo Gomes, 50, S.J. dos Campos SP, BRAZIL (takashi@ita.br).

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Development and experimental investigation of the resonant vibratory systems

Volodymyr Gursky, Igor Kuzio, Vitaliy Korendiy

Abstract: The problems of synthesis and substantiation of elasticity parameters of the resonant vibratory module with electromagnetic drive and one flat spring are considered. At first, the harmonic systems with oscillation frequencies of 50 Hz and 100 Hz were investigated. Then, various asymmetric piecewise linear characteristics of elasticity were carried into effect on one flat spring using auxiliary intermediary fixed cylindrical supports. Due to this, the corresponding vibroimpact operation modes were obtained. The resonant system characterized by improved functioning efficiency were carried into effect using the new technique of optimization synthesis of elasticity parameters. The resonant systems being investigated were implemented in practice. The basic experimental investigation of their kinematic, dynamic and energetic parameters were carried out. The principal result of investigation consists in confirmation of the improved dynamic efficiency of vibroimpact systems with impulse electromagnetic excitation designed according to the new technique. The proposed systems may be used in technological processes of materials compaction and screening, of surface treatment of machine parts and in processes associated with nanotechnology.

[1] Volodymyr Gursky, Ph.D.: Lviv Polytechnic National University, Department of Mechanics and Automation Engineering, 12 Bandera street, Lviv, Ukraine, 79013, UKRAINE (vol.gursky@gmail.com), the author presented this work at the conference.

[2] Igor Kuzio, Professor: Lviv Polytechnic National University, Head of Department of Mechanics and Automation Engineering, 12 Bandera Street, Lviv, Ukraine, 79013, UKRAINE (ikuzio@polynet.lviv.ua).

[3] Vitaliy Korendiy, Ph.D.: Lviv Polytechnic National University, Department of Mechanics and Automation Engineering, 12 Bandera Street, Lviv, Ukraine, 79013, UKRAINE (vitaliy.nulp@gmail.com).

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Study of dynamical systems by fast numerical computation of Lyapunov functions

Sigurdur Hafstein, Asgeir Valfells

Abstract: In this paper we discuss a computational method of numerically searching for Lyapunov functions for nonlinear systems and demonstrate its efficacy. The method is built upon applying various theoretical Lyapunov functions, given by integrating some specific positive functions along solution trajectories in the state space, to the vertices of a simplical complex. Then we assign the remaining values by convex interpolation over the simplices. The benefits of explicitly constructing the candidate functions in this manner are twofold. Firstly it is computationally inexpensive, growing linearly with the number of vertices we calculate a candidate function on, and secondly the freedom in choosing a positive function allows us flexibility to not be overly constrained by the shape of the attractor. Finally we will demonstrate the method on several examples. Most notably we will see that the constructed Lyapunov functions give us lower bounds on basins of attraction that are significantly larger than those found by other methods in the literature.

[1] Sigurdur Hafstein, Professor: University of Iceland, Dunhagi 5, Reykjavik 107, ICELAND (shafstein@hi.is), the author presented this work at the conference.

[2] Asgeir Valfells, B.A. (M.Sc. student): Reykjavik University, Menntavegur 1, 101 Reykjavik, ICELAND (avalfells@gmail.com).

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Influence of mass chromosome distribution in equatorial plane on oscillatory energy of mitotic spindle trough biomechanical oscillatory model of mitotic spindle

Anđelka Hedrih, Katica (Stevanovic) Hedrih

Abstract: Distribution of chromosomes in equatorial plane of mitotic spindle, chromosome territories (CT) and dynamics of chromosome movements towards centrosomes could carry additional epigenetic information. CT within cell nucleus manifest spacious, temporal and cell specificity. The aim of this work is to study haw different mass distribution of chromosomes in equatorial plane influence distribution of potential and kinetic energy in the system dynamics of mitotic spindle. For this purposes an oscillatory model of mitotic spindle is developed. Mitotic spindle was considered as a system of coupled oscillators where one oscillatory pair consists of centrosome, microtubule and related chromosome that are interconnected with its homolog pair. In biomechanical oscillatory model of mitotic spindle centrosomes are presented as mass particles that represent two rheonomic centres of oscillations. Microtubules are presented with standard light visco-elastic element. Homologue chromosomes are represented as mass particles that are interconnected with standard light massless elastic spring. Analytical expression for potential and kinetic energy as well as for total mechanical energy of oscillating pair of homologue chromosomes is given. Influence of mass chromosome distribution in equatorial plane on oscillatory energy of mitotic spindle is discussed. Different distribution of energy in the system of mitotic spindle could represent additional level of codding information that is transferred into the next cell generation and could be of interests in process of cell differentiation.

[1] Anđelka Hedrih, Ph.D.: Department of Mechanics, Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia, Kneza Mihaila 36, 11 000 Belgrade, SERBIA (handjelka@hm.co.rs), the author presented this contribution at the conference.

[2] Katica (Stevanovic) Hedrih, Professor: Department of Mechanics, Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia, Kneza Mihaila 36, 11 000 Belgrade, SERBIA (khedrih@sbb.rs).

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Energy dissipation, free and forced modes in dynamics of two classes of fractional order systems

Katica (Stevanovic) Hedrih

Abstract: Generalized functions of fractional order dissipation of energy in the discrete system and in multi-body system with interconnections by discrete continuum fractional order layers are defined. Energy dissipation in dynamics of two analogous classes of the fractional order systems are analyzed. Fractional order modes of the free and forced oscillations in dynamics of those two analogous classes of the fractional order systems are identified as eigen independent free as well as forced fractional order modes. Also, using formulas of transformation of a system of independent generalized coordinates and eigen main coordinates of considered classes of fractional order system dynamics relation between total mechanical energy (sum of kinetic and potential energies) and generalized function of fractional order energy dissipation on one eigen main fractional order mode is derived. On the basis of these relations, two theorems of energy fractional order dissipation of a class of the fractional order system with finite number of degrees of system are defined and proofed. A number of electrical fractional order oscillators and analogous mechanical fractional order oscillators with one, two or three degrees of freedom are described. For each of these analogous system expressions of kinetic and potential energies and generalized function of total system energy dissipation are formulated with corresponding analogies and corresponding physical explanations. Corresponding analogous energy analysis for each of analogous pairs is done. A number of energy change theorems are defined.

[1] Katica (Stevanovic) Hedrih, Professor: Department of Mechanics, Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia, Kneza Mihaila 36, 11 000 Belgrade, SERBIA (khedrih@sbb.rs), the author presented this contribution at the conference.

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Partial fractional order differential equations of transversal vibrations of an axially moving hybrid multi-belt system on the nonlocal theory

Katica (Stevanovic) Hedrih

Abstract: On the basis of nonlocal theory of elasticity, constitutive relation between bending moment and transversal displacement and transversal force in belt cross section and transversal displacement for fractional properties of belt like beam material are derived. On the basis of previous derived constitutive relations based on the nonlocal theory, system of corresponding number of partial fractional order differential equations of transversal vibrations of an axially moving hybrid multi-belt fractional order system is derived. Solution in the special cases is presented. Key words: axially moving hybrid multi-belt system, nonlocal theory, belt like beam, fractional order properties.

[1)] Katica (Stevanovic) Hedrih, Professor: Department of Mechanics, Mathematical Institute of Serbian Academy of Sciences and Arts, Belgrade, Serbia, Kneza Mihaila 36, 11 000 Belgrade, SERBIA (khedrih@sbb.rs), the author presented this contribution at the conference.

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Numerical simulations of transient pipe flow with fluid-structure interaction based on the fourteen equation model of the phenomenon

Sławomir Henclik

Abstract: The classic theory of water hammer (WH) is based on the assumption of one dimensional (1D) liquid pipe flow and rigid or more like, quasi-rigid pipeline. Two hyperbolic partial differential equations (PDE) of the first order are used for modeling of the elastic pressure waves propagating in the liquid through the pipeline system. For elastic structures the dynamic fluid structure interaction (FSI) should be taken into account for an adequate and more accurate modeling of the transients. The four equation model of WH-FSI is the result of taking into account longitudinal pipe motion governed by additional two PDEs. This model gives satisfactory results in many technical scenarios. However if significant 3D motion of pipe reach is possible or when precise modeling of the system behavior is required additional ten equations governing lateral and rotational pipe vibrations are considered. These fourteen equations constitute the standard model of WH-FSI which is considered in the paper. The method of characteristics can be used to develop a numerical solution of this model. At a junction of individual sub-pipes the specific boundary conditions are taken into account. The specially important is the BC at an elastic pipe support. This standard model is implemented in a computer code developed by the author and used for numerical simulations. In the paper the model is shortly presented and computed results are discussed and concluded.

[1)] Sławomir Henclik, Ph.D.: Institute of Fluid Flow Machinery, Polish Academy of Sciences, ul. J. Fiszera 14, 80-231 Gdańsk, POLAND (shen@imp.gda.pl), the author presented this contribution at the conference.

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The influence of dynamic fluid-structure interaction and energy dissipation on pressure waves in transient pipe flow

Sławomir Henclik, Adam Adamkowski

Abstract: The undesired effects accompanying transient pipe flows are caused mainly by pressure waves and surges which propagate through the pipeline system. In general, reduction of pressure amplitudes can be expected if elastic potential energy of weakly compressible liquid is transferred to another form or dissipated. The classic water hammer (WH) theory assumes that the pipe structure is quasi-rigid and fluid structure interaction (FSI) is considered to be a quasi-static effect. For such an approach the main natural possibility of WH energy dissipation is produced by the friction between the pipe-wall and the liquid. For better modeling of these losses various unsteady friction models have been developed and used within the classic WH theory. When the pipe is elastic or it is fixed to the foundation with elastic supports then, the dynamic interaction between the pipeline structure and the liquid appears. For this case, the energy outflow from liquid to the structure occurs and it can be dissipated there, which produces additional possibility of pressure amplitudes reduction. Pipe wall friction models should be also adopted to the FSI case. These behaviors are discussed in the paper based on numerical and experimental results. The latter were acquired during experiments at a special laboratory pipeline. Numerical records were computed with the use of an own computer program developed on the basis of the four equation model of WH-FSI and the boundary condition formulated and solved at the viscoelastic pipe support.

[1] Sławomir Henclik, Ph.D.: Institute of Fluid Flow Machinery, Polish Academy of Sciences, ul. J. Fiszera 14, 80-231 Gdańsk, POLAND (shen@imp.gda.pl), the author presented this contribution at the conference.

[2] Adam Adamkowski, Professor: Institute of Fluid Flow Machinery, Polish Academy of Sciences, ul. J. Fiszera 14, 80-231 Gdańsk, POLAND (aadam@imp.gda.pl).

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paper id: OPT210

Application of zero-sum differential game in two-wheeled mobile robot control

Zenon Hendzel, Paweł Penar

Abstract: The solution of zero-sum differential game is equivalent to optimal control with worst case disturbance, which is solution of Hinf control problem. The solution of zero-sum differential game is avalilable only for linear object. In nonlinear object case, solution is approximated. In this paper, differential game theory has been utilised for the purpose of motion tracking control of a two-wheeled mobile robot. Adopted zero-sum diffferential game aproximation method is using an actor-critic structure, which is based on the reinforcement learning idea. Neural network was used for implementation of adaptive structure of actor-critic algorithm. Adopted solution has been tested in numerical simulations and verified on real object.

[1] Zenon Hendzel, Professor: Rzeszow University of Technology, Al. Powstańców Warszawy 8, 35-959 Rzeszów,, POLAND (zenhen@prz.edu.pl).

[2] Paweł Penar, M.Sc. (Ph.D. student): Rzeszow University of Technology, Al. Powstańców Warszawy 8, 35-959 Rzeszów, POLAND (pawelpq@gmail.com), the author presented this contribution at the conference.

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paper id: MAT250

Dynamic analysis of a rotating electrical machine rotor-bearing system by optimal auxiliary functions method

Nicolae Herisanu, Vasile Marinca

Abstract: Rotating electrical machines are widely used in engineering and industry applications due to their reliability. The machines under study are subjected to a parametric excitation caused by an inertial thrust and a forcing excitation caused by an unbalanced force of the rotor while the entire system is being supported by nonlinear bearings with nonlinear stiffness characteristics and damping properties. The nonlinear suspension makes the analytical study very difficult, leading to strong nonlinear differential equations, which are hard to be solved through classical methods. Supplementary problems could arise in case of some horizontal rotating machines, when the gravity effect is not negligible for certain stiffness conditions. Also, the misalignment could occur in the electrical machine after some amount of running. In our paper, a new analytical approach, namely the Optimal Auxiliary Functions Method (OAFM) is employed to solve the problem of an electrical machine supported by nonlinear bearings characterized by nonlinear stiffness of Duffing type and the entire system is subjected to a parametric excitation due to the axial thrust and a forcing excitation caused by an unbalanced force of the rotor. This study contains an effective and easy to use procedure which is independent of the presence of small or large parameters in the nonlinear equations. The approximate analytical solution is in very good agreement with the numerical simulation results, which prove the reliability of this procedure.

[1] Nicolae Herisanu, Professor: University Politehnica Timisoara, Bd. Mihai Viteazu, 1, 300222 Timisoara, ROMANIA (n_herisanu@yahoo.co.uk), the author presented this contribution at the conference.

[2] Vasile Marinca, Professor: University Politehnica Timisoara, Bd. Mihai Viteazu, 1, 300222 Timisoara, ROMANIA (v_marinca@yahoo.co.uk).

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Computer aided modeling system of structural steels mechanical properties

Rafał Honysz

Abstract: This paper presents authorship software, which use artificial intelligence algorithms for structural steels mechanical properties estimation and optimisation. On the basis of production parameters, such as chemical composition, parameters of heat and plastic treatment and elements of geometrical shape and size presented system has the ability to calculate and optimise the mechanical properties of examined structural steel and introduce them as raw numeric data or in graphic as influence charts. Possible is also to examine dependences among the selected steel property and chosen production parameters. All examinations were verified in real material science laboratory.

[1)] Rafał Honysz, Ph.D.: Politechnika Śląska w Gliwicach, Konarskiego 18A 44-100 Gliwice, POLSKA (rafal.honysz@polsl.pl), the author presented this contribution at the conference.

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Comparative analysis of damage evolution on rectangular and I-shape cross section bridge's beams by computational modelling of the nonlinear dynamic

Ana Paula Imai, Roberto Dalledone Machado, Thiago de Oliveira Abeche, Fernando Luiz Martinechen Beghetto, Luiz Antonio Farani de Souza, João Elias Abdalla Filho, Marcos Arndt

Abstract: The reinforced concrete is adopted as a strucutural system for several sorts of constructions. However, when submitted to certaind loads, it can have its integrity decreased. For the highway bridges' case, the dynamic loads generated from the passage of vehicles on it can amplify the loss of integrity, both for the concrete and for the reinforcement. For a more feasible analysis, one of the effects to be noted is the damage mechanics, which allows the representation of the concrete's crack propagation. Similarly, a more representative approach of the reinforcement is achieved by the account of the plasticity of the steel. Those phenomena enhance the model complexity, transforming it in a nonlinear dynamics problem. Sometimes, the structural designer chooses an I-shape beam in order to save resources. However, due to the fact that the design standards consider an amplified linear static condition, the effects of the dynamic loads and the nonlinearities of the constitutive material's models may change the solid's expected behavior. This work seeks to analyze the nonlinear dynamic responses in both a rectangular and a I-shape beam, with equivalent size and reinforcement rate, and compare the concrete's damage evolution for those cases. The beams are modeled trough Finite Elements Method, using the ABXDNL 2.7 program and additional routines developed in C++ programming language. It is adopted a constitutive nonlinear dynamic damage model based on the regarded Mazars' damage model, which also regards the effects of the inversion of mechanical solicitations due to vibrations.

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[1] Ana Paula Imai, B.A. (M.Sc. student): Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Concentration Area in Materials and Structures, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (ana_imai@hotmail.com), the author presented this contribution at the conference.

[2] Roberto Dalledone Machado, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (roberto.dalledonemachado@gmail.com , rdm@ufpr.br).

[3] Thiago de Oliveira Abeche, M.Sc. (Ph.D. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in

Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (t.abeche@gmail.com).

[4] Fernando Luiz Martinechen Beghetto, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (flbeghetto@utfpr.br).

[5] Luiz Antonio Farani de Souza, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (lasouza@utfpr.br).

[6] João Elias Abdalla Filho, Professor: Mechanical Engineering Graduate Program (PPGEM) of the Pontifical Catholic University of Paraná (PUCPR), Federal Tech. University of Paraná (UTFPR), Brazil & University of Colorado (CU-Boulder), USA, Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba — PR, Brazil and 428 UCB, 80309-0428, Boulder, CO, United States of America, BRAZIL AND USA (joao.filho@pucpr.br).

[7] Marcos Arndt, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba, BRAZIL (arndt@ufpr.br).

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Comparison between normative codes and nonlinear dynamics computational simulation of reinforced concrete bridges

Ana Paula Imai, Roberto Dalledone Machado, Thiago de Oliveira Abeche, Fernando Luiz Martinechen Beghetto, Luiz Antonio Farani de Souza, João Elias Abdalla Filho, Marcos Arndt

Abstract: Most of the normative codes increase the design loads and decrease the materials' resistances, in order to design structures that bear requirements superior than the actually needed. Although most problems are solved by static models, almost every structures are submitted to dynamic loads, and when those are of low intensity when compared to the permanent static ones, their effects can be neglected. Besides that, the codes suggest an elastic behaviour for the materials on the structural analysis. As for the bridges' case, the dynamic loads are the predominant type on these structures. The specific codes for bridges allow to simplify the dynamic effects, originated from the passage of vehicles, transforming it on static loads multiplied by an impact coefficient. Additionally, when these structures are under loads that may cause the beginning of the concrete's cracking, the elastic analysis do not represent the appropriate behaviour of the bridge. Those simplifications may not be able to ensure the structural safety due to the change on the structural piece's behaviour when occurs loss of the material's integrity and it is submitted to dynamic loads. This work intends to evaluate the normative codes, and compare it to a nonlinear dynamic model through the the ABXDNL 2.7 program with additional routines developed in C++ programming language, which considers the interaction between the dynamic loads and the material's cracking may amplify the structural responses via Finite Element Method.

[1] Ana Paula Imai, B.A. (M.Sc. student): Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Concentration Area in Materials and Structures, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (ana_imai@hotmail.com), the author presented this contribution at the conference.

[2] Roberto Dalledone Machado, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (rdm@ufpr.br).

[3] Thiago de Oliveira Abeche, M.Sc. (Ph.D. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (t.abeche@gmail.com).

[4] Fernando Luiz Martinechen Beghetto, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (flbeghetto@utfpr.br).

[5] Luiz Antonio Farani de Souza, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (lasouza@utfpr.br).

[6] João Elias Abdalla Filho, Professor: Mechanical Engineering Graduate Program (PPGEM) of the Pontifical Catholic University of Paraná (PUCPR), Federal Tech. University of Paraná (UTFPR), Brazil & University of Colorado (CU-Boulder), USA, Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba — PR, Brazil and 428 UCB, 80309-0428, Boulder, CO, United States of America, BRAZIL AND USA (joao.filho@pucpr.br).

[7] Marcos Arndt, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (arndt@ufpr.br).

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Experimentally verified mathematical model of the polymer plasticization process in injection molding

Jacek Iwko, Ryszard Steller, Roman Wroblewski

Abstract: Mathematical model of polymer plasticization in reciprocating screw injection molding machine is presented. It takes into account all characteristic features of a real injection machine, such as periodical action of the three-zones-screw, to-and-fro screw motion with controlled stroke, static and dynamic melting. Methods of calculation of the most important flow characteristics such as solid bed profile, pressure and temperature profiles, mass flow rate, power requirement, screw torque and energy consumption were analyzed. According to the mathematical model, a computer program was developed. Based on the computer program, simulation studies of injection molding process had been made. Next, the experimental research, evaluating the theoretical model from the accuracy and usefulness point of view, were made. Important output quantities: temperature and pressure profiles, the power demand of the plasticizing system, the torque of the screw and the screw rotation time were measured. These tests were performed on a specially designed research position. Simulation results were compared with experimental data measured for some most popular polymers and different operating parameters of the injection machine. Experimental studies have indicated the need to introduce some corrections to the mathematical model. Several modifications had been made to the model, mainly related to methods of stress determining in the polymer layer. Finally, the output characteristics of the plasticization process in injection molding are now correctly determined, with an average error less than 10%.

[1] Jacek Iwko, Ph.D.: Wroclaw University of Technology, Wroclaw 50370, POLAND (jacek.iwko@pwr.edu.pl), the author presented this work at the conference.

[2] Ryszard Steller, Professor: Wroclaw University of Technology, Wroclaw 50370, POLAND (ryszard.steller@pwr.edu.pl).

[3] Roman Wroblewski, Ph.D.: Wroclaw University of Technology, Wroclaw 50370, POLAND (r.m.wroblewski@pwr.edu.pl).

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Optimal control of automotive multivariable dynamic systems

Jacek Jackiewicz

Abstract: Nowadays, two distinctive features of challenging control engineering problems are commonly taken into consideration in design of mechatronics and dynamic systems, namely operation ranges, of such systems with nonlinear effects, are not always near to equilibrium states, and moreover their controllers have to cope with high levels of uncertainties due to lack of knowledge on the all system parameters in spite of the fact that physical modeling allows to identify their particular nonlinear effects. However, usage of nonlinear physical modeling in real-time control systems can be computationally very demanding. Hence, it seems to be suitable to use robust control methods based on linearised models with adaptive model updating and with some uncertainties, although strong nonlinearities can reduce the effectiveness of control methods, as well as of adaptive control algorithms. The controller gains can be often updated by using the estimated parameters. In this contribution the adaptive control systems for automotive applications based on indirect (or self-tuning) controller strategies are discussed. Indirect (or self-tuning) optimal controller strategies are fixed by means of memetic algorithms.

[1] Jacek Jackiewicz, Associate Professor: Institute of Technology, Faculty of Mathematics, Physics & Technical Sciences, Kazimierz Wielki University, Chodkiewicza 30, 85-064 Bydgoszcz, POLAND (jacek.jackiewicz@ukw.edu.pl), the author presented this contribution at the conference.

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Use of dynamic neural network for modelling mechanical properties of GMA welded joints

Wojciech Jamrozik, Jacek Górka

Abstract: Industry demands application of novel materials in order to achieve high quality of products, that are characterized by valid mechanical properties. The same is required for welded joints. In the area near the joint, where heat influences the properties of base material (Heat Affected Zone, HAZ), it is most favourable to change the introduce changes as small as possible only in a narrow area. During the welding process, current, voltage, shielding gas flow rate, welding speed and wire feed rate were considered as the process parameters while tensile strength and yield strength were taken as the process output. Additionally non-measurable variables, describing welded joint geometry, were used in delay lines make state estimations based on predicted states and actual measured states. To compare obtained results baseline models were created using feedforward neural networks. Performed studies revealed that high accuracy of mechanical properties estimation in comparison to real measured values can be achieved using dynamic neural networks.

[1] Wojciech Jamrozik, Ph.D.: Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, POLSKA (wojciech.jamrozik@polsl.pl), the author presented this contribution at the conference.

[2] Jacek Górka, Associate Professor: Silesian University of Technology, ul. Konarskiego 18a, 44-100 Gliwice, POLSKA (jacek.gorka@polsl.pl).

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Development of a computational based reference dynamics model of a flexible link manipulator

Elżbieta Jarzębowska, Krzysztof Augustynek, Andrzej Urbaś

Abstract: Development of a new derivation method of a reference dynamics model of a flexible link manipulator is presented in the paper. The model including flexibility can map dynamics and performance of lightweight and fast manipulators correctly and may serve their motion analysis and control design in the presence of kinematic or programmed constraints, which are assumed to be position or first order nonholonomic. The reference dynamics model is derived using the formalism of joint coordinates and homogeneous transformation matrices. This approach allows generating dynamics equations of a manipulator without formulating additional material constraint equations. The constraints present in the reference dynamics model are the programmed ones only. The flexibility of a link is modelled using the rigid finite element method. The main advantage of this method is its ability of application of the rigid-body approach to modeling dynamics of multi-body systems with flexible links.The novelty of the presented method relies on the combination of dynamics modeling of flexible system models with the programmed constraints satisfaction problem for them. The computational algorithm underlying the derivation method presented in the paper is based on Generalized Programmed Motion Equations (GPME) approach. The reference dynamics model derivation is demonstrated for a flexible link manipulator model.

1) Elżbieta Jarzębowska, Associate Professor: Warsaw University of Technology, Plac Politechniki 1, 00-661 Warszawa, POLAND (elajarz@meil.pw.edu.pl).

2) Krzysztof Augustynek, Ph.D.: University of Bielsko-Biała, Willowa 2, 43-309 Bielsko-Biała, POLAND (kaugustynek@ath.bielsko.pl), the author presented this contribution at the conference.

3) Andrzej Urbaś, Ph.D.: University of Bielsko-Biała, Willowa 2, 43-309 Bielsko-Biała, POLAND (aurbas@ath.bielsko.pl).

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Optimization of geometry of cavitational tunnel by using CFD method

Robert Jasionowski, Waldemar Kostrzewa

Abstract: The liquid flow through a various kind of installation or devices is still not fully clarified issue. The liquid flow is assisted by a stream swirling, local pressure drops or changes of flow rates or temperature. CFD methods have been already implemented for few years to analyze phenomena related to the liquid flow. In this work Autodesk CFD Design Study Environment 2018 was used to simulate a new geometry of cavitational tunnel – a laboratory stand for examinations of cavitational resistance of structural materials. The introduced change of geometry allows multiplying the area of local pressure drop (i.e. the area of cavitation phenomenon). Obtained results of will serve in future (after building the new laboratory stand) to verify CFD simulations in a real testing conditions. The new tunnel geometry developed in CFD simulations should shorten evaluation time, what in turn, will give direct economic benefits (i.e. lower exploitation rate of the laboratory stand as well as lower costs of electrical energy).

[1] Robert Jasionowski, Ph.D.: Maritime University of Szczecin, Institute of Basic Technical Sciences, 2-4 Willowa Street, 71-650 Szczecin, POLAND (r.jasionowski@am.szczecin.pl), the author presented this contribution at the conference.

[2] Waldemar Kostrzewa, Ph.D.: Maritime University of Szczecin, Institute of Basic Technical Sciences, 2-4 Willowa Street, 71-650 Szczecin, POLAND (w.kostrzewa@am.szczecin.pl).

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paper id: CON37

Motion analysis of the mobile platform with four wheel drive

Anna Jaskot, Bogdan Posiadała

Abstract: The problem of motion of the mobile platform with four wheel drive under the unsteady conditions have been formulated and analyzed. The mobile platform is equipped with four independently driven and steered electric drive units. The description of dynamics of the platform has been proposed. The relations between friction forces in longitudinal and transverse directions in reference to the active forces have also been included. Based on the obtained motion equations, the analysis of the motion parameters for different configurations of the wheel positions has been provided. The forced and free motion of the platform has been considered. The formulated initial problem has been numerically solved by using the Runge-Kutta method of the fourth order. The sample simulation results for different configurations of the platform elements during its motion and the conclusions have been included.

1) Anna Jaskot, M.Sc. (Ph.D. student): Czestochowa University of Technology, Intitiute of Mechanics and Machine Design Fundamentals, ul. Dąbrowskiego 73, 42-201 Częstochowa, POLAND (jaskot@imipkm.pcz.pl), the author presented this work at the conference.

2) Bogdan Posiadała, Professor: Czestochowa University of Technology, Intitiute of Mechanics and Machine Design Fundamentals, ul. Dąbrowskiego 73, 42-201 Częstochowa, POLAND (b.posiadala@imipkm.pcz.pl).

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Irreversibility of mechanical and hydrodynamic instabilities

Alejandro Jenkins, Carlos D. Díaz-Marín

Abstract: The literature on dynamical systems has, for the most part, considered self-oscillators (i.e., systems capable of generating and maintaining a periodic motion at the expense of an external energy source with no corresponding periodicity) either as applications of the concepts of limit cycle and Hopf bifurcation in the theory of differential equations, or else as instability problems in feedback control systems. Here we outline a complementary approach, based on physical considerations of work extraction and thermodynamic irreversibility. We illustrate the power of this method with two concrete examples: the mechanical instability of elastic discs that spin at super-critical speeds, and the hydrodynamic Kelvin-Helmholtz instability of the interface between fluid layers with different tangential velocities. Our treatment clarifies the necessary role of frictional or viscous dissipation (and therefore of irreversibility), while revealing an underlying unity to the physics of many irreversible processes that generate mechanical work and an autonomous temporal structure (periodic, quasi-periodic, or chaotic) in the presence of an out-of-equilibrium background.

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[1] Alejandro Jenkins, Professor: University of Costa Rica, School of Physics, 11501-2060, COSTA RICA (alejandro.jenkins@ucr.ac.cr), the author presented this contribution at the conference.

[2] Carlos D. Díaz-Marín, B.A.: University of Costa Rica, School of Mechanical Engineering, 36-2060, COSTA RICA (cdiaz95@hotmail.es).

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Estimation of the instantaneous speed free (power) turbine

Józef Jonak, Anna Machrowska

Abstract: The paper presents the results of the instantaneous speed free (power) turbine (TN) turbine engine reconstruction based on the vibration signal (tacho - less methods). Method validation was done by comparing the results with those obtained on the basis of the signal from the tachometer generator. For slight fluctuations in speed convergence achieved satisfactory results. Knowledge of the instantaneous speed under varying operating conditions of machines is important for building systems monitoring and diagnostics using vibration signals . Existing methods were mainly based on the determining rotational speed parameter obtained through the use of the tachometer. This is especially true in the already functioning aerospace drive systems, due to a number of procedural constraints or lack of space for installation required system components (particularly encoder). These restrictions mean that recently very rapidly are developed tacho - less methods of estimation of the instantaneous frequency, i.e. based on the vibration signals recorded using accelerometers or velocity sensors.

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[1] Józef Jonak, Professor: Politechnika Lubelska, ul. Nadbystrzycka 36, 20-618 Lublin, POLSKA (j.jonak@pollub.pl), the author presented this contribution at the conference.

[2] Anna Machrowska, M.Sc. (Ph.D. student): 20-618 Lublin, ul. Nadbystrzycka 36, 20-618 Lublin, POLSKA (a.machrowska@pollub.pl).

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Estimates of asymptotic solution of linear-quadratic optimal control problems with cheap controls of two different orders of smallness

Margarita Kalashnikova, Galina Kurina

Abstract: This paper is devoted to a linear-quadratic optimal control problem with a performance index containing two different powers of a small parameter at quadratic forms with respect to controls. Problems of such type arise, for instance, as a result of applying the convolution method to problems with three performance indices, where the cost of one cheap control is negligible in comparing with another one. Estimates of the proximity of the solution of the original problem to an approximate asymptotic solution are obtained for the control, trajectory, and performance index. The used asymptotic solution has been constructed with the help of the so-called direct scheme method consisting of immediate substituting of a postulated asymptotic expansion of a solution into the transformed problem condition and determining optimal control problems for finding terms of the asymptotic expansion. The transformed problem is obtained from the original one as a result of variables change. It is a singularly perturbed optimal control problem with three-tempo state variables in a singular case. The constructed asymptotic solution contains regular and boundary functions of four types. It is also proved that a value of the performance index does not increase when higher order asymptotic approximations to the optimal control are used. The illustrative example is given.

[1] Margarita Kalashnikova, M.Sc.: Voronezh State University, 1 Universitetskaya pl., 394018 Voronezh, RUSSIA (margarita.kalashnikova@mail.ru).

[2] Galina Kurina, Professor: Federal Research Center "Computer Science and Control" of Russian Academy of Sciences;Voronezh State University, pr. 60-letiya Oktyabrya 9, 117312 Moscow; 1 Universitetskaya pl., 394018 Voronezh, RUSSIA (kurina@math.vsu.ru), the author presented this contribution at the conference.

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paper id: CON317

Prevention of structural pounding between mid-rise buildings using MR dampers

Elif Cagda Kandemir-Mazanoglu

Abstract: In this paper MR dampers are proposed to prevent structural pounding between two adjacent mid-rise buildings. MR dampers are modeled as modified Bouc-Wen model. Semi-active control algorithms such as Lyapunov controller, clipped optimal controller etc. are formulated for the use of dampers between buildings. Parametric study by varying control algorithms are presented to evaluate damper capacities and location so that the one-sided structural pounding under severe earthquake vanishes. The buildings are considered as lumped mass model whereas the pounding occurs only between floor levels. Contact points between the colliding surfaces are assigned as nonlinear elastic spring, i.e. Hertz model. Central difference method is conducted to obtain time responses. The algorithms are compared in terms of damper capacity and efficiency.

[1)] Elif Cagda Kandemir-Mazanoglu, Assistant Professor: Usak University, 1 Eylul Campus Engineering Faculty Civil Engineering Department 64200 Usak, TURKEY (elif.kandemir@usak.edu.tr), the author presented this contribution at the conference.

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Dynamics and modelling of a middle ear with SMA prothesis

Krzysztof Kecik, Rafal Rusinek

Abstract: The important problem of a middle-ear research involves the development of prostheses replacing parts of ossicular chain. The new technologies and materials causing application novel surgical reconstruction techniques. A numerical simulation middle-ear models are developed in order to get a better insight into dynamic behaviour and functionality of the reconstructed human ear. The application of prosthesis made of shape memory alloys (SMAs) looks promising from medicine approach. SMAs are special class of metallic alloys that have a shape memory. Generally, the materials are deformed at low temperature and next recover to their original shape upon heating. We propose a non-linear two degrees of freedom model of the middle ear with a shape memory prosthesis. The prosthesis model is based on phase-kinetics approach. The SMA model uses martensite and austenite fraction and an exponential function to describe shape memory alloy hysteresis behaviour. The analyse of stiffness of a SMA prosthesis on the structural response can predict the system's behaviour within certain acceptable vibration level. Acknowledgments: This study was founded by the National Science Centre (Poland) according to decision no. DEC-2014/13/B/ST8/04047.

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[1] Krzysztof Kecik, Associate Professor: Lublin University of Technology, 20-618 Lublin, Nadbystrzycka 38, POLAND (k.kecik@pollub.pl), the author presented this contribution at the conference.

[2] Rafal Rusinek, Associate Professor: Lublin University of Technology, 20-618 Lublin, Nadbystrzycka 38, POLAND (r.rusinek@pollub.pl).

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Stability of a rectangular plate under dynamic load generated by unhomogeneous magnetic field

Piotr Kędzia, Krzysztof Magnucki, Mikołaj Smyczyński, Iwona Wstawska

Abstract: The subject of the theoretical study is a rectangular plate under dynamic in-plane load generated by magnetic field. The plate is made of polyethylene (PE) and on the two opposite edges of the plate there are pockets filled with ferrofluid. Both pockets are the same fixed width and are placed inside the magnetic field coils systems. These systems are build of Helmholtz and Golay coils and generate nonhomogeneous magnetic field. Homogeneity and strength of magnetic field depends on the radii of the coils. Magnetic field acts on ferrofluid in the pockets and induce load on the two opposite edges of the plate. If the magnetic field is more homogeneous, the compression load is induced. In other cases tensile local load occurs (compression load dominates). The analytical model of the plate with consideration of nonlinear geometrical relations is formulated, inclusive of the kinetic energy, elastic strain energy and the work of the load. The equation of motion is derived based on the Hamilton's principle. The critical load of the plate is described for the static load and the equation of motion for dynamical problem is numerically solved. The equilibrium paths for the example plate are determined for different configurations of the coils systems.

[1] Piotr Kędzia, Ph.D.: Poznan University of Technology, Faculty of Mechanical Engineering and Management, Piotrowo St. 3, 60-965 Poznan, POLAND (piotr.kedzia@put.poznan.pl), the author presented this contribution at the conference.

[2] Krzysztof Magnucki, Professor: Institute of Rail Vehicles, TABOR, Warszawska Street 181, 61-055 Poznan, POLAND (krzysztof.magnucki@tabor.com.pl).

[3] Mikołaj Smyczyński, Ph.D.: Poznan University of Technology, Faculty of Mechanical Engineering and Management, Piotrowo St. 3, 60-965 Poznan, POLAND (mikolaj.smyczynski@put.poznan.pl).

[4] Iwona Wstawska, M.Sc. (Ph.D. student): Poznan University of Technology, Faculty of Mechanical Engineering and Management, Piotrowo St. 3, 60-965 Poznan, POLAND (iwona.wstawska@put.poznan.pl).

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Chaos, bifurcations and strange attractors in dynamics of the Earth system low-frequency scale atmospheric processes: Atmospheric circulation, teleconnection and atmospheric radio-waveguides

Olga Khetselius, Yuliya Bunyakova, Alexander Glushkov, Iryna Cherkasova

Abstract: The paper is devoted to description of the deterministic chaos, bifurcations and strange attractors in dynamics of the Earth system low-frequency scale atmospheric processes. We presented a new approach to computing dynamics based on using the energy and angle moment balance relations and new scheme for calculation of the macro-turbulence regime in typical atmospheric processes, which are known as atmospheric circulation forms. The balance analysis allows to predict the large-scaled atmospheric transformations and teleconnection phenomena and to give their quantitative description. We carried out a series of the computer experiments at the Pacific ocean region in order to study global mechanisms in the atmospheric models and check the seasonal sequences of the conservation (or disbalance) of the Earth atmosphere angle momentum and to provide new predictors for the long-termed and super long-termed forecasts of the low frequency atmospheric processes. The Pasific ocean computerexperiments data are presented and analysed. [1]. Glushkov A.V. etal Water resources in Asia Pasific Region.- Kyoto, Japan .-2003.-P.1355-1358; Nonlinear Proc. in Geophys. 11, 285 (2004); [2]. Glushkov A.V., Methods of a Chaos Theory to Complex Geo-Systems, 2012, Odessa, Astroprint; Glushkov A., Khetselius O., Buyadzhi V.V., New Methods of Mathematical Modelling in Earth and Environmental Sciences, 2016, Odessa, OSENU

[1] Olga Khetselius, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (okhetsel@gmail.com), the author presented this contribution at the conference.

[2] Yuliya Bunyakova, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (bunyakovayuya@gmail.com).

[3] Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com).

[4] Iryna Cherkasova, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (cherkasovais17@gmail.com).

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Dynamical Systems - Theory and Applications

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paper id: MAT321

New chaos-dynamical approach to forecasting evolutionary dynamics of complex geosystems: City's atmospheric pollutants dynamics

Olga Khetselius, Yuliya Bunyakova, Anna Romanova, Alexander Glushkov

Abstract: We present new computational complex approach to studying and forecasting evolutionary dynamics of comlex geosystems (city's atmopsheric pollution), based on the combined using the non-linear analysis methods and chaos theory such as the wavelet analysis, multi-fractal formalism, mutual information approach, correlation integral analysis, false nearest neighbour algorithm, Lyapunov exponent's analysis, surrogate data method, stochastic propagators method, memory and Green's functions approach [1]. We identify the concentration space-temporary evolution dynamics for CO_2, CO, NO_2, SO_2 in the atmosphere of industrial cities in order to reveal the a chaos in the hourly time series at several sites in Amsterdam, Gdansk and Odessa during the 2003-2009. We present new prediction computational model to forecasting the atmospheric pollutants evolutionary dynamics (new "Geomath" technology). To determine time delays, the concept of mutual information is used;. To determine attractor dimensions, it is used the correlation integral method and false nearest neighbours algorithm. To refine the data, we use surrogate data sets. The data on he Lyapunov's exponents and other topological and dynamical invariants are listed. 1. Khetselius O., BunyakovaY., Proc.of 8th Int. Carbon Dioxide Conf.-Jena, Germany (2009); A.V. Glushkov A.V., Methods of a Chaos Theory to Complex Geo-Systems, 2012, Odessa (2012).

1) Olga Khetselius, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (okhetsel@gmail.com), the author presented this contribution at the conference.

2) Yuliya Bunyakova, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (bunyakovayuya@gmail.com).

3) Anna Romanova, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, UKRAINE (romanovaanvya@gmail.com).

4) Alexander Glushkov, Professor: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (glushkovav@gmail.com).

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Optimal starting control for a nonlinear resonating free piston generator

Tom Kigezi, Julian Dunne

Abstract: Combustion-driven free-piston engines (FPEs) are currently being considered for various applications including electric vehicle range extenders and domestic CHP systems. FPEs have none of the kinematic restrictions of a slider-crank mechanism used in a conventional engine and can offer much higher efficiency, better power-weight ratio, and simpler construction. The main difficulty is one of control which is why considerable effort over the past decade has been devoted to dynamic modelling and control studies. FPEs use some sort of bounce chamber to match the huge combustion forces which often take the form of a gas spring but a novel resonating free piston generator uses a stiff mechanical spring. The dynamic model of an FPE is typically highly nonlinear, self-excited, and stochastic. A particular requirement in certain applications is to start from rest with minimum energy drawn from some external power source. This requirement can be met by path planning using nonlinear optimal control followed by an appropriate tracking strategy. In this paper, the optimal start problem is examined using an appropriate model for the nonlinear generator dynamics which is first stated in terms of various objective functions including minimization of the control effort and the starting energy needed. Solutions are then obtained and tested using a nonlinear tracking strategy to assess the energy savings that can be achieved. The objective of the paper is to compare the performance of analytical LQ optimal control with numerical nonlinear optimal control.

[1] Tom Kigezi, M.Sc. (Ph.D. student): University of Sussex, Falmer Brighton. BN1 9QT U.K., UK (T.Nsabwa-Kigezi@sussex.ac.uk).

[2] Julian Dunne, Professor: University of Sussex, Falmer Brighton. BN1 9QT U.K., UK (j.f.dunne@sussex.ac.uk), the author presented this contribution at the conference.

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paper id: EXP295

Welding numerical simulation in thermal cycle acquisition errors identification

Tomasz Kik, Bernard Wyględacz

Abstract: In acquisition of highly variable thermal cycles present in welding processes errors caused by plethora of physical phenomena impact drastically measured data, especially when heat cycles must be measured not on material surface. This mistakes cause analysis of recorded thermal cycles often lead to false conclusions. Modern non-linear FEM software enables accurate thermometallurgical calculations of highly variable thermal cycles. Aim of this paper is identification of errors caused factors like: hole drilled to place thermocouple on set depth, wrong contact point and plane of thermocouple, limited contact patch between material and condenser welded thermocouple. Additionally, solutions for systematic error correction in FEM model will be proposed that could enable comparison between measured and calculated thermal cycles.

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[1] Tomasz Kik, Assistant Professor: Silesian University of Technology, Faculty of Mechanical Engineering, Department of Welding, Konarskiego 18A, 44-100 Gliwice, POLSKA (tomasz.kik@polsl.pl), the author presented this contribution at the conference.

[2] Bernard Wyględacz, M.Sc. (Ph.D. student): Silesian University of Technology, Faculty of Mechanical Engineering, Department of Welding, Konarskiego 18A, 44-100 Gliwice, POLSKA (bernard.wygledacz@polsl.pl).

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Application of numerical simulations on 10GN2MFA steel multilayer welding

Tomasz Kik, Jaromir Moravec, Iva Novakova

Abstract: 10GN2MFA steel is used to produce wire and manufacturing of steam generators, pressure compensators, collectors and other equipment for nuclear power plants. In this area, there is no place to do any mistakes during manufacturing or carrying out extensive tests and producing a lot of prototypes. It is the main reason why we used modern software for numerical simulation of welding and heat treatment processes also on the very early stage of development. The aim of this paper is to describe how can welding processes be optimized by means of the numerical simulations mainly with respect to the structural changes, stresses and hardness distribution in the Heat Affected Zone (HAZ). On the real multilayer weld how to arrange whole experiment in order to obtain not only relevant input data but also verification data will be described. Additional aim of this paper is to propose mathematical description of the computational model that is usable for simulation computations of welding and heat treatment of real structure components.

[1)] Tomasz Kik, Assistant Professor: Silesian University of Technology, Faculty of Mechanical Engineering, Department of Welding, Konarskiego 18A, 44-100 Gliwice, POLSKA (tomasz.kik@polsl.pl), the author presented this contribution at the conference.

[2)] Jaromir Moravec, Professor: Technical University of Liberec, Liberec, Czech Republic, Studentska 2, Liberec, 461 17, CZECH REPUBLIC (jaromir.moravec@tul.cz).

[3)] Iva Novakova, Assistant Professor: Technical University of Liberec, Liberec, Czech Republic, Studentska 2, Liberec, 461 17, CZECH REPUBLIC (iva.novakova@tul.cz).

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Methods of normal local stabilization and associated dynamical polysystems

Aleksandr Kirillov

Abstract: The problem of nonlinear systems stabilization is studied. The admissible controls are piecewise constant. Several notions of local stabilizability are considered. Roughly speaking, the point M (not necessary equilibrium) is normally locally stabilized if for any T>0 there exists such neighborhood of M that any point, belonging to this neighborhood, can be steered, in a time less than T, to any neighborhood of M and remains there. The constructive algorithms of normal local stabilization for autonomous and nonautonomous systems are presented. These algorithms are based on a special sequence of contracting cylinders containing a trajectory. Also, under some additional assumptions, this method permits to steer, in a finite time, any point to an arbitrary neighborhood of a given point. The domain of attraction of a given point is constructed. The robustness of algorithms, in some sense, is proved. Besides, several modifications of normal local stability are considered. For a control system with a finite set of admissible controls, the associated dynamical polysystem acting on a compact bounded manifold is introduced. The behavior of its trajectories, particularly, the periodicity and final periodicity, is studied. The relation between a control system and associated dynamical polysystems is considered. Several problems are formulated.

[1)] Aleksandr Kirillov, Professor: Institute of Applied Mathematical Research of Karelian Research Centre Russian Academy of Sciences, IAMR KarRC RAS 11, Pushkinskaya str. Petrozavodsk Karelia 185910, Russia, RUSSIA (krllv1812@yandex.ru), the author presented this work at the conference.

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Amplitude dependent damping of hybrid composites – experimental determination and energetic interpretation

Matthias Klaerner, Mario Wuehrl, Lothar Kroll, Steffen Marburg

Abstract: Composites with either fibre reinforcement or metal layers offer a wide range of adjusting the material behaviour by manipulating parameters such as material selection, layup and fibre orientation. These material combinations require additional modelling efforts in numerical simulations and show a non-linear dynamic behaviour. For applications of high acoustic sensitivity, hybrid composites with metal faces sheets and very thin shear-sensitive plastic cores have been developed. These materials offer significant damping properties but react non-linear depending on frequency, temperature and vibration amplitude. Experimental setups as well as mechanical models consider frequency and temperature sensitivity but usually neglect amplitude sensitivity. In this study, the amplitude dependency of the vibration damping of metal-plastic composites has been proven experimentally using free vibrations of cantilever beams. The derived decay curves have been analysed due to appropriate mathematical formulations of the amplitude dependency. Moreover, an energy based damping model is used to interpret the damping behaviour classified by material and stress state. Thus, the amplitude dependency of composites can be retraced to the dominant strain energy components with the help of numerical simulations. This results in a more precise modelling of composite dynamics and a better forecast of vibration and sound radiation of complex hybrid parts.

[1] Matthias Klaerner, M.Sc. (Ph.D. student): Chemnitz University of Technology, Reichenhainer Str. 31-33, 09126 Chemnitz, GERMANY (matthias.klaerner@mb.tu-chemnitz.de), the author presented this contribution at the conference.

[2] Mario Wuehrl, B.A. (M.Sc. student): Chemnitz University of Technology, Reichenhainer Str. 31-33, 09126 Chemnitz, GERMANY (mario.wuehrl@mb.tu-chemnitz.de).

[3] Lothar Kroll, Professor: Chemnitz University of Technology, Reichenhainer Str. 31-33, 09126 Chemnitz, GERMANY (lothar.kroll@mb.tu-chemnitz.de).

[4] Steffen Marburg, Professor: Technische Universität München, 85748 Garching, GERMANY (steffen.marburg@tum.de).

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Modeling of dynamics of a counter-rotating horizontal axis wind turbine

Liubov Klimina, Boris Lokshin, Vitaly Samsonov, Yury Selyutskiy, Ekaterina Shalimova

Abstract: The closed dynamical model of a counter-rotating HAWT is constructed. It is supposed that one propeller carries a rotor of an electric generator, and the other one carries a stator of the generator. The generator is connected into a local electric circuit by means of running contacts. The electromechanical interaction between the rotor and the stator is described with a linear function on a relative angular speed of the rotor. Aerodynamic torques acting upon the propellers are described using a quasi-steady approach. Flow speed in the wake of the front propeller is estimated with the use of the Betz theory. Stationary modes are studied. A trapped power coefficient is estimated depending on such parameters of the model as the external resistance in the electric circuit of the generator and the wind speed. In particular, it is shown that in the case of two similar propellers, rather high trapped power coefficient is achieved when the rear propeller is "leading" i.e. produces more power than the front one. Such an operation mode is preferable if the electric load is sufficiently high.

[1] Liubov Klimina, Ph.D.: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (klimina@imec.msu.ru), the author presented this contribution at the conference.

[2] Boris Lokshin, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (blokshin@imec.msu.ru).

[3] Vitaly Samsonov, Professor: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (samson@imec.msu.ru).

[4] Yury Selyutskiy, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (seliutski@imec.msu.ru).

[5] Ekaterina Shalimova, Ph.D.: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (ekateryna-shalimova@yandex.ru).

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paper id: STA80

On dynamics of a Savonius rotor-based wind power generator

Liubov Klimina, Anna Masterova, Yury Selyutskiy, Shyh-Shin Hwang, Ching-Huei Lin

Abstract: A stand-alone wind power generator based on the Savonius rotor is considered. An empirical approach is proposed for describing the aerodynamic torque basing on available data from physical and computational experiments. Existence and attraction properties of equilibrium positions and steady motions in the system are studied. Numerical simulation of behavior of a one-stage and a three-stage Savonius wind turbine is performed for different values of parameters (including external load). Domain of attraction of a stable equilibrium position of the single-stage rotor in the space of initial conditions is constructed for different system parameters. Dynamics of a Savonius rotor-driven wheeled cart is studied.

[1] Liubov Klimina, Ph.D.: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (klimina@imec.msu.ru).

[2] Anna Masterova, M.Sc. (Ph.D. student): Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (masterovaanya@yandex.ru), the author presented this contribution at the conference.

[3] Yury Selyutskiy, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, Michurinsky prosp.,1, 119192, Moscow, RUSSIA (seliutski@imec.msu.ru).

[4] Shyh-Shin Hwang, Associate Professor: Department of Mechanical Engineering, Chien Hsin University of Science and Technology, 229, Jianxing Rd., Zhongli Dist., Taoyuan City 32097, TAIWAN (stanhwang@uch.edu.tw).

[5] Ching-Huei Lin, Associate Professor: Department of Electrical Engineering, Chien Hsin University of Science and Technology, 229, Jianxing Rd., Zhongli Dist., Taoyuan City 32097, TAIWAN (chlin@gapps.uch.edu.tw).

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Process-oriented approach to the design of Cyber-Physical Systems

Lech Knap, Jędrzej Mączak, Michał Trojgo

Abstract: Cyber-Physical Systems (CPS) are the systems that link cyberspace with the physical world by means of a network of interrelated elements (sensors and actuators) and computational engines. The paper is focused on the problem of lack of the uniform method of CPS systems description. The task of designing the complex CPS system requires the creation of multi disciplinary project teams. As far as the cooperation of specialists in one area already is often difficult in itself one can easily imagine what problems arise with the cooperation of specialists from totally different fields. In this paper a new, task-oriented, method of designing the CPS systems is proposed. The method is based on the process approach and continuous improvement of the design. This new method should be considered as an extremely versatile and useful in the design and construction of the CPS systems. The proposed method of the description of the CPS systems is based on the assumption that the task to be realized by the system is nothing more than the goal of one or more processes that should be implemented in the system. Processes, in turn, are collections of activities carried out by resource groups (components) and the tasks performed by one resource (a single element of the CPS). Activities and tasks can be carried out both in series and in parallel. Division for operations and tasks allows you to use the description of the process at different levels of detail in accordance with the requirements of the design phase of the CPS.

[1] Lech Knap, Assistant Professor: Institute of Vehicles, Warsaw University of Technology, Narbutta 84, 02-524 Warszawa, POLAND (l.knap@simr.pw.edu.pl), the author presented this contribution at the conference.

[2] Jędrzej Mączak, Associate Professor: Institute of Vehicles, Warsaw University of Technology, Narbutta 84, 02-524 Warszawa, POLAND (jma@mechatronika.net.pl).

[3] Michał Trojgo, M.Sc. (Ph.D. student): Institute of Vehicles, Warsaw University of Technology, Narbutta 84, 02-524 Warszawa, POLAND (m.trojgo@mechatronika.net.pl).

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Useage of Kalman filter to estimate the state vector of the 6D measuring arm

Agnieszka Kobierska, Paweł Żak, Paweł Poryzała, Leszek Podsędkowski

Abstract: The paper presents the method of determining the global orientation of links of the measuring arm by gauging the angles of the links relatively to the vector of the gravitational field using inertial sensors. A method of using Kalman filter to average the results is presented as a test on seven-links measuring arm equipped with accelerometers placed on each of the links and analysis of measurement results in terms of repeatability. The ability of creating kinematic chain is demonstrated. Instead of determining the position of the final link on the basis of the measurement of angles in relation to previous links from the end to the base of the arm, it is possible to define links global orientation by measuring angles of links in reference to the vectors of the gravity field, in global coordinate system.

[1] Agnieszka Kobierska, Ph.D.: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLSKA (agnieszka.kobierska@p.lodz.pl), the author presented this contribution at the conference.

[2] Paweł Żak, Ph.D.: Lodz University of Technology, Stefanowskiego 1/15 Łódź, POLSKA (pawel.zak@p.lodz.pl).

[3] Paweł Poryzała, Ph.D.: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLSKA (pawel.poryzala@p.lodz.pl).

[4] Leszek Podsędkowski, Professor: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLSKA (lpodsedk@p.lodz.pl).

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Application of analysis of a time-frequency acoustic signal after detecting flat places on the rolling surface of a tram wheel

Pawel Komorski, Tomasz Nowakowski, Grzegorz Szymanski, Franciszek Tomaszewski

Abstract: Public rail transportation is one of the most attractive modes of transportation in larger European agglomerations. Comfort is a very important factor on the basis of which passengers choose their mode of transportation. Vibroacoustic phenomena generated during a ride have a significant impact on the comfort of both the passengers and the nearby city dwellers. Particularly important is a correct interaction between the rolling surface of a wheel and the rail. Imperfections on rolling surfaces of wheels and rails – flat places in particular- contribute to the increased level of noise and vibrations. They are the cause of impulses of vibroacoustic phenomena, particularly intrusive to the passengers and city dwellers. Another aspect confirming the necessity of detection of flat places on tram wheels is minimizing tram exploitation costs. Moreover, early detection of the problem increases the dependability of the transportation process. Those are essential factors to rail vehicles and rail infrastructure managers. The article presents the problematic aspects of detection of flat places on tram wheels using time-frequency analysis of acoustic signals. A number of pass-by tests were conducted during real life exploitation. The objects of research are light rail vehicles exploited in Poznan. Some of them were characterized by flat places on tram wheels. The research aimed to apply the wrought method for detection of flat places on tram wheels.

[1] Pawel Komorski, M.Sc. (Ph.D. student): Poznan University of Technology, Department of Rail Vehicles, 5 M. Skłodowska-Curie Square, 60-965 Poznan, POLAND (pawel.komorski@put.poznan.pl), the author presented this contribution at the conference.

[2] Tomasz Nowakowski, M.Sc. (Ph.D. student): Poznan University of Technology, Department of Rail Vehicles, 5 M. Skłodowska-Curie Square, 60-965 Poznan, POLAND (tomasz.nowakowski@put.poznan.pl).

[3] Grzegorz Szymanski, Assistant Professor: Poznan University of Technology, Department of Rail Vehicles, 5 M. Skłodowska-Curie Square, 60-965 Poznan, POLAND (grzegorz.m.szymanski@put.poznan.pl).

[4] Franciszek Tomaszewski, Professor: Poznan University of Technology, Department of Rail Vehicles, 5 M. Skłodowska-Curie Square, 60-965 Poznan, POLAND (franciszek.tomaszewski@put.poznan.pl).

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paper id: CON96

The control of the set artillery-rocket in conditions impact of random disturbances

Zbigniew Koruba

Abstract: In today's battlefield, there is a constant need to increase combat capabilities, including speed, target detection range, target identification capabilities, and shooting effectiveness by short-range Set Artillery-Rocket. (SAR).The challenge is to be able to successfully fire such kits in response to interference not only from the cannon side, but also from the moving platform on which the cannon and homming missiles are mounted. In addition, the set is a variable mass system, because in a short time it can be fired from a few to dozens or even hundreds of missiles - so we are dealing with a strongly nonlinear system with variable parameters (non-stationary). The work presents how to control such a set. In case SAR is mounted on a moving base and there is both process and measurement noise, it is neces to restore the states variables and filter data of SAR This is why the extended Kalman filter is used, along with the LQR regulator. As a result of this synthesis, it was received LQG regulator of SAR, which was used to the tracking of target according to the line of sight. Some results of numerical simulation tests are presented in graphical form.

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1) Zbigniew Koruba, Professor: Kielce University of Technology, 25-314 Kielce, 7 Aleja Tysiąclecia PP St., POLAND (ksmzko@tu.kielce.pl), the author presented this contribution at the conference.

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paper id: MTR193

Development of a prototype dynamic weighing system for single bucket excavator

Andrzej Kosiara, Jakub Chołodowski

Abstract: Some earthmoving works performed by single bucket excavators require on-line weighing of winning transported by excavator’s bucket. First commercially available weighing systems for single bucket excavators were called static systems. So as to properly estimate winning mass the machine equipped them had to be kept in a standstill condition for a few seconds. Consequently, productivity of the machine was low. Recently dynamic weighing systems have been introduced. They enable for precise weighing of winning collected in the bucket while swinging excavator’s house as well as moving its boom, arm or bucket. Thus, they do not influence productivity of the machine. Such systems are commercially available nowadays. Development of reliable dynamic weighing systems requires certain problems to be resolved. Firstly, the influence of acceleration acting at excavator’s bodies and winning has to be taken into account. Values of pressure inside cylinders supporting excavator’s boom, which are usually used as input signals for winning mass computation, significantly differ in dynamic and static conditions. So as to provide satisfactory weighing performance, friction within hydraulic cylinders cannot be also omitted. A prototype dynamic weighing system for single bucket excavator developed in The Department of Off-Road Vehicle Engineering (Wrocław University of Technology) will be presented in the article. While estimating winning mass the system allows for acceleration acting at excavator bodies as well as hydraulic cylinders friction.

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[1] Andrzej Kosiara, Ph.D.: Wrocław University of Science and Technology, the Department of Off-Road Machine and Vehicle Engineering, Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, POLAND (andrzej.kosiara@pwr.wroc.pl).

[2] Jakub Chołodowski, M.Sc. (Ph.D. student): Wrocław University of Science and Technology/The Department of Off-Road Machine and Vehicle Engineering, ul. Łukasiewicza 7/9, 50-371 Wrocław, POLAND (jakub.cholodowski@pwr.wroc.pl), the author presented this contribution at the conference.

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paper id: BIF362

Dynamics of mechanical oscillators with double physical pendulums and forced by stick-slip vibrations

Angelika Kosińska, Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: In this work we investigate dynamical behavior of a mechanical oscillator with double physical pendulum and driven by a stick-slip induced vibrations. The mentioned oscillator consists of the body placed on a moving belt, mechanical coupling associated with the body load pressing the belt in both vertical and horizontal direction depending on the body movement, as well as a double physical pendulum. Interesting dynamic behaviors can be found in the system, even when it is simplified to a single degree of freedom. As a result, due to many degrees of freedom of the analyzed mechanical system, strong non-linearity and discontinuity as well as novel non-linear dynamical phenomena can occur, both near and beyond the resonance. Dynamics of the system is investigated by employing standard numerical methods dedicated for non-linear systems (including both qualitative and quantitative techniques) as well as original animations of the analyzed system created in Mathematica software. The obtained, illustrated, and discussed numerical results can be potentially applied to other similar real mechanical systems.

[1] Angelika Kosińska, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (800717@edu.p.lodz.pl), the author presented this contribution at the conference.

[2] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Technical University of Lodz, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (dariusz.grzelczyk@p.lodz.pl).

[3] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Technical University of Lodz, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (awrejcew@p.lodz.pl).

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Non-linear dynamics of flexibly suspended spring pendulum embedded in gravity and electric fields

Angelika Kosińska, Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: In this paper we study non-linear behavior of vertically and flexibly suspended spring pendulum embedded in both gravity and electric fields. Due to strong non-linearity of the analyzed three-degree-of-freedom mechanical system, some interesting non-linear behaviors are observed and discussed. The motion of the system for different parameters is considered by employing standard numerical methods dedicated for non-linear systems, including both qualitative and quantitative methods as well as own original animations of the system dynamics, created in Mathematica software. The investigated energy transition between fixed points and other non-linear behaviors of the considered system can be potentially applied to other similar systems such as, for instance, real electro-mechanical systems.

[1] Angelika Kosińska, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (800717@edu.p.lodz.pl), the author presented this contribution at the conference.

[2] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (dariusz.grzelczyk@p.lodz.pl).

[3] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Technical University of Lodz, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (awrejcew@p.lodz.pl).

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Resonance and non-linear behavior of a flexibly suspended mechanical system with geometrical non-linearity and excited by rotating physical pendulum

Angelika Kosińska, Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: We investigate dynamical behavior and resonance phenomena of a flexibly suspended (both in horizontal and vertical direction) mechanical oscillator including geometrical non-linearity and kinematically excited by a rotating physical pendulum. Since interesting dynamic behaviors can be found in the system even when it is simplified to a single degree of freedom, due to strong non-linearity and discontinuity, novel non-linear dynamical phenomena can occur in the analyzed system, both near and beyond the resonance. We study dynamics of the considered system by employing standard numerical methods as well as both qualitative and quantitative techniques useful for analysis of non-linear systems. In addition, we use own original animations of the considered system, simulated in Mathematica. The illustrated and discussed results can be potentially applied to other similar real mechanical systems.

[1] Angelika Kosińska, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (800717@edu.p.lodz.pl), the author presented this contribution at the conference.

[2] Dariusz Grzelczyk, Ph.D.: Department of Automation, Biomechanics and Mechatronics, Technical University of Lodz, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (dariusz.grzelczyk@p.lodz.pl).

[3] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Technical University of Lodz, 90-924 Łódź, ul. Stefanowskiego 1/15 (bud. A22), POLAND (awrejcew@p.lodz.pl).

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Dynamical Systems - Theory and Applications

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paper id: BIF275

Dynamic of system with hysteresis

Robert Kostek

Abstract: In this article characteristics of real elastic elements are studied experimentally and modelled. Usually elastic elements and materials are modelled with a purely elastic spring and purely viscous damper. This can leads to linear Kelvin–Voigt model or a non-linear modification of this body. Nevertheless, real elements like vibro-isolators and contact joints, shows far more complex response to acting forces than Kelvin–Voigt model. Real elements show kind of memory and changes of parameters. This topic is associated with modelling dissipation energy and hysteresis loop. The dissipation energy is particularly important in resonance.

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1) Robert Kostek, Ph.D.: University of Science and Technology in Bydgoszcz, pok.212 bud. 2.3 Al. Prof. S.Kaliskiego 7, 85-796 Bydgoszcz, POLAND (robertkostek@o2.pl), the author presented this contribution at the conference.

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paper id: BIF273

Resonanes of rolling bearing

Robert Kostek

Abstract: In this article vibrations of rolling bearing are studied. These vibrations are parametric because stiffness of bearing is a function of rolling element position, thus is a function of time. These vibrations are non-linear as well, because characteristic of Hertzian contact is non-linear. This leads to various natural frequencies depending on value of amplitude and rolling element position. Moreover superharmonic and parametric resonances can be observed. This leads finally to many resonance peaks, bistability, bifurcations and chaotic motion. These phenomena make machinery diagnostics difficult, because many factors influence natural frequencies and amplitude of vibrations. In consequence larger amplitude does not mean larger clearance or any defect.

[1)] Robert Kostek, Ph.D.: University of Science and Technology in Bydgoszcz, pok.212 bud. 2.3 Al. Prof. S.Kaliskiego 7, 85-796 Bydgoszcz, POLAND (robertkostek@o2.pl), the author presented this contribution at the conference.

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A FEM model of Transversal Artificial Muscle deformation

Katarzyna Koter, Łukasz Frączczak, Leszek Podsędkowski

Abstract: Pneumatic Artificial Muscles have found application in many sectors of industry. However, their large dimensions make them useless in medical robotics. Therefore, Transversal Artificial Muscles were designed. This innovative construction is characterized by much smaller dimensions and high strength relative to the total volume change. Also, they allow obtaining a linear displacement by changing a diameter of a muscle without changing its length. This paper presents modelling of Transversal Pneumatic Muscles using Finite Element Method. The model simulates the deformation of muscles and the motion achieved by changing the values of pressure supplied to the muscle. Research compares different variants of the muscle, varying in length, diameters or wall thickness. Theoretical assumptions were verified using numerical methods to select muscle of best characteristics. Also, in the paper there is shown comparison of FEM simulation and experimental results of research.

1) Katarzyna Koter, M.Sc. (Ph.D. student): Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLAND (katarzyna.koter@p.lodz.pl), the author presented this contribution at the conference.

2) Łukasz Frączczak, Ph.D.: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLAND (lukasz.fracczak@p.lodz.pl).

3) Leszek Podsędkowski, Professor: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLAND (lpodsedk@p.lodz.pl).

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paper id: MAT116

On some exact solutions for a forced response of nonlinear oscillators

Ivana Kovacic

Abstract: This work presents a theoretical concept for obtaining exact solutions for a forced response of a wide class of externally excited nonlinear oscillators. This includes Duffing-type (hardening, softening, bistable, pure cubic) oscillators, quadratic oscillators as well as purely nonlinear oscillators whose power of nonlinearity can be any positive real number. For that purpose, the external excitation is designed in a special way as having the appropriate form related to the free response of these oscillators, i.e. it is modeled in terms of Jacobi elliptic and Ateb functions. The concept also enables one to design the external excitation of a nonlinear oscillator in such a way that it responds as a completely different type of nonlinear oscillator or as a linear one. In addition, it is demonstrated how certain known approximate solutions for harmonically excited oscillators in primary and secondary resonances can be derived from these exact solutions.

[1)] Ivana Kovacic, Professor: University of Novi Sad, Faculty of Technical Sciences, Centre of Excellence for Vibro-Acoustic Systems and Signal Processing, Trg D. Obradovica 6, 21000 Novi Sad, SERBIA (ivanakov@uns.ac.rs), the author presented this contribution at the conference.

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paper id: ASY252

Energy transport in the locally resonant unit cell model with self excitation

Margarita Kovaleva, Nina Ryazan, Yuli Starosvetsky

Abstract: Present work is devoted to the analysis of resonant energy transport emerging in the strongly nonlinear, locally resonant, 2D unit-cell model. The system under consideration comprises an outer mass with the internal inclusion (e.g. rotator) subject to the 2D, external self-excitation. In the current study, we revealed the emergence and bifurcations of highly nonlinear, nonstationary regimes manifested by the unidirectional energy localization as well as the complete, bidirectional energy transport controlled by the internal inclusion. We show that bifurcations of these highly nonstationary regimes can be analysed on the phase plane using the singular asymptotic analysis

[1] Margarita Kovaleva, Ph.D.: N.N.Semenov Institute of Chemical Physics, 119991 Moscow, Kosygin st, 4, RUSSIA (margo.kovaleva@gmail.com), the author presented this contribution at the conference.

[2] Nina Ryazan, M.Sc.: Faculty of Mechanical Engineering, Technion, Haifa, Israel, Technion , Haifa 32000, ISRAEL (nina.liora.rayzan@gmail.com).

[3] Yuli Starosvetsky, Assistant Professor: Faculty of Mechanical Engineering, Technion, Haifa, Israel, Technion , Haifa 32000, ISRAEL (staryuli@tx.technion.ac.il).

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paper id: EXP256

Dynamic measurements of three steel towers erected in different locations

Dariusz Kowalski, Tomasz Domagała, Robert Jankowski

Abstract: Dynamic response of steel structures, such as towers, depends both on external excitation as well as on dynamic structural parameters. The threat of excessive vibrations due to dynamic loads is therefore related not only to high level of dynamic excitation but also to the fact of tuning the natural frequency of the structure with the frequency of excitation. The aim of the present paper is to show the results of dynamic field measurements conducted for three steel towers erected in northern Poland. The structures have the height of 20 m and were erected in different locations according to the same typical design project. The steel towers are exposed to different wind loads. There are also differences in soil conditions related to geotechnical aspects. Moreover, the towers were constructed in different production plants in different periods of time. The time of operation of the structures in their locations is also different. The field measurements were focused on determination of the dynamic parameters of structures in order to assess the discrepancy between the structural responses incorporating the soil-structure interaction. Additionally, the study was extended to the comparison between the field results for real structures and the results of numerical analyses conducted for structural model created at the design stage. The results of the study clearly indicate that the influence of soil conditions on the dynamic parameters of the towers can be substantial and may lead to significant differences in the structural response under wind load.

[1] Dariusz Kowalski, Ph.D.: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (kowdar@pg.gda.pl).

[2] Tomasz Domagała, B.A. (M.Sc. student): Gdansk University of Technology, Faculty of Civil and Environmental Engineering, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (tomaszdomagala92@wp.pl).

[3] Robert Jankowski, Professor: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (jankowr@pg.gda.pl), the author presented this contribution at the conference.

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paper id: EXP292

Excessive vibrations of aluminium tower as a result of its reconstruction

Dariusz Kowalski, Tomasz Domagała, Robert Jankowski

Abstract: The problems of vibrations of slender flexible civil engineering structures, such as metal towers, has been a subject of intensive research for a number of years. Most of the studies, however, concern steel structures and the results for the aluminium towers, which are much lighter, are very limited. In this paper, the results of dynamic response of aluminium tower located in the forest area close to the sea shore are presented. The measurements were conducted for the 40 years old structure which has recently been reconstructed by extending its height by a few meters which was necessary because of growth of nearby trees. The tower has very small weight with relation to its height. It is equipped with working platforms, which have a surface of a few square meters, allowing for three persons to occupy them in order to conduct maintenance works of technical devices installed of the tower's top. The results of the study clearly show that the reconstruction of the analyzed aluminium tower has resulted in appearance of excessive structural vibrations observed under wind loading. The investigation has also allowed us to identify the exploitation errors related to the installation of measuring devices as well as indicated the need for change of service procedure for the mast installed at the top platform.

[1] Dariusz Kowalski, Ph.D.: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (kowdar@pg.gda.pl).

[2] Tomasz Domagała, B.A. (M.Sc. student): Gdansk University of Technology, Faculty of Civil and Environmental Engineering, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (tomaszdomagala92@wp.pl).

[3] Robert Jankowski, Professor: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (jankowr@pg.gda.pl), the author presented this contribution at the conference.

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paper id: EXP226

Vibrations of steel towers induced by service staff

Dariusz Kowalski, Tomasz Domagała, Robert Jankowski

Abstract: The maintenance procedure of steel towers require periodical inspections of each structure and the installed equipment, which is conducted by trained service staff. Such inspections are usually conducted during relatively mild weather without major blows of wind. Even so, however, additional movement of people on the structure may induce excessive vibrations negatively felt by the service staff. The aim of the present paper is to show the results of field measurements focused on the dynamic response of steel towers under human-induced vibrations observed during maintenance works. The measurements were conducted on a number of towers which were erected according to the same design project. Additionally, another tower was also tested, for which vibrations were described by the service staff members as especially large. All the analyzed structures were erected in different locations of the northern Poland. The measurements were carried out under different wind load conditions what was related to the specific time of maintenance works. The measurements allowed us to identify the level of vibrations due to climbing of people along the structure as well as due to their movement at the top. The results of the study show that the influence of such kind of vibrations on human perceptions can be significant leading, in some cases, to the situation when the inspection works were very difficult or even impossible to be completed

[1] Dariusz Kowalski, Ph.D.: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (kowdar@pg.gda.pl).

[2] Tomasz Domagała, B.A. (M.Sc. student): Gdansk University of Technology, Faculty of Civil and Environmental Engineering, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (tomaszdomagala92@wp.pl).

[3] Robert Jankowski, Professor: Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Metal Structures and Construction Management, 80-233 Gdańsk, ul. G. Narutowicza 11/12, POLAND (jankowr@pg.gda.pl), the author presented this contribution at the conference.

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paper id: VIB109

Approximate spectral identification of dynamical systems

Jan Kozanek, Stepan Chladek, Jaroslav Zapomel, Lucie Svamberova

Abstract: Usually, as the input data of the identification methods in the frequency domain, the corresponding pairs of the “unit harmonic force excitation” – “steady state harmonic response” are considered. This paper deals with approximate spectral identification of linear dynamical systems by (non-harmonic) time response on initial displacement (or velocity) with the help of Fourier transform. Basic analytical relationships and identification alternatives are analyzed. Formulas are completed with some examples and results of numerical simulations and dynamical experiments.

[1)] Jan Kozanek, Ph.D.: Institute of Thermomechanics ASCR, Dolejskova 5, 182 00 Prague 8, CZECH REPUBLIC (kozanek@it.cas.cz), the author presented this contribution at the conference.

[2)] Stepan Chladek, M.Sc.: Institute of Thermomechanics AS, Dolejskova 5, 182 00 Prague 8, CR (chladek@it.cas.cz).

[3)] Jaroslav Zapomel, Professor: Institute of Thermomechanics AS, Dolejskova 5, 182 00 Prague 8, CR (jaroslav.zapomel@vsb.cz).

[4)] Lucie Svamberova, B.A. (M.Sc. student): Institute of Thermomechanics AS, Dolejskova 5, 182 00 Prague 8, CR (lucie.svamberova@seznam.cz).

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paper id: CON300

Exoskeleton – control by pressure sensors – practical solution

Mateusz Krain, Bartłomiej Zagrodny, Jan Awrajcewicz

Abstract: Exoskeleton – control by pressure sensors – practical solution Mateusz Krain, Bartłomiej Zagrodny, Jan Awrejcewicz Abstract: This work is connected with practical solution of exoskeleton control. Authors propose an approach to exoskeleton design, and its control namely creating a simple, portable control program which does not use problematic input signals such as electromyography. Instead the system utilizes solely specially designed pressure sensors, which are more resistant to failure and distortion. The research was performed initially on a LabView model, and next experimentally on a 1-DOF elbow joint test exoskeleton. The paper presents results of the research, practical implementation of the system to a simplified exoskeleton and comparison between theoretical and experimental results. Finally, conclusion on research and obtained conclusions are shown with its advantages and disadvantages.

1) Mateusz Krain, B.A. (M.Sc. student): Technical University of Lodz, Mechanical Faculty, 90-924, POLAND (mateusz.krain@gmail.com), the author presented this contribution at the conference.

2) Bartłomiej Zagrodny, Ph.D.: Technical University of Lodz, Department of Automation, Biomechanics and Mechatronics, 90-924, POLAND (bartlomiej.zagrodny@p.lodz.pl).

3) Jan Awrajcewicz, Professor: Technical University of Lodz, Department of Automation, Biomechanics and Mechatronics, 90-924, POLAND (awrejcew@p.lodz.pl).

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paper id: OPT122

Design of illumination and lighting visualisation by simulation methods

Ruzena Kralikova, Miroslav Badida, Lydia Sobotova, Anna Badidova

Abstract: This article deals with designing internal artificial lighting as part of the working nvironment, which is subject to certain rules, derived from the nature of lighting.Good lighting exerts an impact on visual comfort, which contributes to overall psychological well-being, and indirectly also to the quality and productivity of performance, to reliability and to visual performance. Using computer simmulation methods we can obtain the best possibility of a lighting concept. Lighting visualisation enables to create light effects room in advance. Currently the development of computer graphics software products exist to enable a comprehensive design and calculation of the parameters of lighting systems, which would reflect light effects that arise in artificial and day lighting. For the purposes of this paper, as to the possibilities utilisation simulations of light - technical parameters are presented simulations of the lighting design of mechanical engineering workshop created in the software DIALux.

[1)] Ruzena Kralikova, Associate Professor: Technical University of Kosice, Faculty of Mechanical Engineering, Letna 9, 040 01 Kosice, SLOVAKIA (ruzena.kralikova@tuke.sk), the author presented this contribution at the conference.

[2)] Miroslav Badida, Professor: Technical University of Kosice, Faculty of Mechanical Engineering, Letna 9, 040 01 Kosice, SLOVAKIA (miroslav.badida@tuke.sk), the author presented this contribution at the conference.

[3)] Lydia Sobotova, Associate Professor: Technical University of Kosice, Faculty of Mechanical Engineering, Letna 9, 040 01 Kosice, SLOVAKIA (lydia.sobotova@tuke.sk), the author presented this contribution at the conference.

[4)] Anna Badidova, M.Sc. (Ph.D. student): Technical University of Kosice, Faculty of Mechanical Engineering, Letna 9, 040 01 Kosice, SLOVAKIA (anna.badidova@tuke.sk), the author presented this contribution at the conference.

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paper id: ENG126

Dynamics of the size-dependent flexible beams embedded into temperature field

Anton V. Krysko, Jan Awrejcewicz, Ilya Kutepov, Vadim A. Krysko

Abstract: The present paper investigates nonlinear dynamics of the Bernoulli-Euler flexible curved beams in a stationary temperature field on the basis of the momentous theory of elasticity. The main theoretical contribution of the momentous theory of elasticity is based on introduction of an additional material constant of a higher order besides two classical Lamé constants. The geometric nonlinearity is applied by Kármán model. The influence of temperature field is taken into account according to the Duhamel-Neumann theory, and no restrictions are imposed on distribution of temperature field along height of the beam. Equations of motion of the Bernoulli-Euler flexible beams governed by PDEs regarding displacements are reduced to the Cauchy problem and solved by the methods of Runge-Kutta type. The temperature field is determined from the solution of the heat equation by FDM. The reliability of the obtained results is based on the Runge principle. After receiving a reliable signal qualitative studies are performed. The high-order mode of system's vibration does not allow to determine chaotic regime in a reliable way. For this reason, the sign of the largest Lyapunov exponent is determined, and in order to find the degree of randomness, we study the spectrum of all Lyapunov exponents. In order to investigate the reliability of the obtained signs of the Lyapunov exponents, a serval methods have been employed. Acknowledgement: This work has been supported by the Grant RFBR 16-08-01108a, RFBR 16-01-00721a, as well as the Grant RFBR research project № 16-31-60027

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[1] Anton V. Krysko, Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University and Cybernetic Institute, National Research Tomsk Polytechnic University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (anton.krysko@gmail.com), the author presented this contribution at the conference.

[2] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[3] Ilya Kutepov, Ph.D.: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ilyakutepov@yandex.ru).

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru).

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paper id: ASY131

Analysis of the nonlinear dynamics of flexible two-layer beams, with account for their stratification

Vadim A. Krysko, Jan Awrejcewicz, Irina V. Papkova, Olga A. Saltykova

Abstract: The mathematical model of a two-layer beam set taking into account the geometric nonlinearity on the basis of well-known kinematic hypotheses of the first (Euler-Bernoulli), the second (Timoshenko) and the third approximations (Reddy-Pelekh-Sheremetyev) is presented. We show also that it possible to construct mathematical models, when each layer is described by its own hypothesis. Three problems are addressed. Problem 1 - each of beams is described by the first approximation of the kinematic hypothesis. Problem 2 - each of the beams is described by the second approximation. Problem 3 - each of the beams is described by the third approximation. An external spatially distributed harmonic load acts on the beam package. The lamination of the beam structure along the entire length can occur. The stratification will lead to a change in the design algorithm scheme. In order to get reliable results, it is necessary to solve the problem taking into account two types of nonlinearity, i.e. geometric and constructive ones. A lot of attention in the work is paid to the reliability of the results. The methods for calculating such systems as systems with an infinite number of degrees of freedom have been developed. The convergence of the finite differences method is studied and the convergence of Runge-Kutta type methods is investigated. Furthermore, the value of the largest Lyapunov exponent employing three different algorithms (Wolf, Kantz and Rosenstein) is estimated. Acknowledgements: This work has been supported by the Grant RSF № 16-11-10138

1) Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru), the author presented this contribution at the conference.

2) Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

3) Irina V. Papkova, Assistant Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ikravzova@mail.ru).

4) Olga A. Saltykova, Associate Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION, and Cybernetic Institute, National Research Tomsk Polytechnic University, Lenin Avenue, 30, 634050 Tomsk, RUSSIAN FEDERATION (olga_a_saltykova@mail.ru).

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paper id: CON110

Sliding control of a gyroscopic scanning and tracking system mounted on a moveable base

Izabela Krzysztofik

Abstract: The basic tasks of the self-propelled anti-aircraft missile set are performed by the weapon module. An important element of the weapon module equipment is the system for searching and tracking the target. Its purpose is to determine the location of the line of sight (LOS). Target detecting and tracking systems are subject to disturbances caused by vehicle movements on uneven ground. In this paper, the LOS stabiliser and controller is a gyroscopic system and high precision of operation is required of it. Therefore, the control system and parameters of the controller itself must be carefully selected. A sliding controller has been designed and implemented in a gyroscopic scanning and tracking system mounted on a combat vehicle. Simulations of dynamics of a controlled gyroscopic system were performed in Matlab/Simulink environment. The selected research results are presented in graphical form.

[1)] Izabela Krzysztofik, Assistant Professor: Kielce University of Technology, 7 Al. Tysiąclecia PP St., 25-314 Kielce, POLAND (pssik@tu.kielce.pl), the author presented this contribution at the conference.

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paper id: CON72

Passive vibration control of a cantilever column by a piezoceramic actuator

Krzysztof Kuliński, Jacek Przybylski

Abstract: Piezoceramic elements and components possessing significant bending rigidity resulting from high elastic modulus are easy to be implemented into engineering structures to enhance their static or dynamic performance. The most often integration methods are bonding and embedding actuators in one- or two-dimensional structures. A different configuration for passive vibration control of columns with a monolithic piezoelectric rod is proposed. In this configuration the actuator is externally attached to the column at their ends. Being offset from the host structure, the transducer generates flexural displacements which are much greater than can be obtained by embedded or surface bonded actuators. The main purpose of this work is to determine the influence of the piezoelectric force on both the flexural displacement and the transversal vibrations of a system composed of the cantilever host column and the piezoceramic rod. A partially follower force is eccentrically applied at the free end causing its deflection. The electric field generates an internal piezoelectric stretching or compressing force to counteract deflection and keep the column straight under the external load. The internal force affects the natural frequency of the structure. Due to the geometrical nonlinearity, the solution to the problem has been made by using the perturbation method. The vast number of numerically obtained results makes possible to study the dynamic characteristics of the system controlled by the piezoelectric force with regard to different geometry of the structure.

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[1] Krzysztof Kuliński, M.Sc. (Ph.D. student): Częstochowa University of Technology, Institute of Mechanics and Machine Design Fundamentals, Instytut Mechaniki i Podstaw Konstrukcji Maszyn, Dąbrowskiego 73, 42-201 Częstochowa, POLAND (krzysztku@gmail.com), the author presented this contribution at the conference.

[2] Jacek Przybylski, Professor: Częstochowa University of Technology, Institute of Mechanics and Machine Design Fundamentals, Instytut Mechaniki i Podstaw Konstrukcji Maszyn, Dąbrowskiego 73, 42-201 Częstochowa, POLAND (jacek.pr@imipkm.pcz.pl).

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Free vibration of multilayered shallow shells perforated by clamped holes of different forms

Lidiya Kurpa, Andrey Osetrov, Galina Timchenko

Abstract: Perforated shells are widely used as construction elements in chemical, atomic and other fields of machinery. Analysis of natural frequencies and eigenmodes of perforated shells is important task leading to accurate modeling of dynamic behavior, estimation of resource and vibro-resistance under external dynamic loads. In present work meshless approach based on the R-functions theory and on a combined usage of it with variational Ritz's method is proposed. The mathematical statement of the problem is based on the first order shear deformation multilayered shallow shells theory, taking shear deformations in account. In contrast to the known works, devoted to the study of multilayer shells with holes, we assume that perforations can have complex shapes and their contour is clamped. In this case, R-functions can be effectively used to construct coordinate functions. Boundary conditions on inner contours can be taken into account exactly due to R-functions incorporated in solution structures, which are invariant with respect to the form of perforations. Thus, the solution procedure can be done without overall change for different types of plan-forms of a shell. If the number of perforations is more than two, then, to obtain an accurate solution, spline approximation of the undetermined components is used. The analysis of the following factors influence on natural frequencies and modes of shells vibrations was carried out: type and angles of layers lamination, boundary conditions, and shape of perforated holes, curvature and thickness of shells.

[1] Lidiya Kurpa, Professor: NTU KhPI, Applied mathematics department, NTU KhPI, Kyrpychova str. 2, 61002, Kharkiv, UKRAINE (kurpa@kpi.kharkov.ua).

[2] Andrey Osetrov, Associate Professor: NTU KhPI, Applied mathematics department, NTU KhPI, Kyrpychova str. 2, 61002, Kharkiv, UKRAINE (andy.osetrov@gmail.com), the author presented this contribution at the conference.

[3] Galina Timchenko, Associate Professor: NTU KhPI, Applied mathematics department, NTU KhPI, Kyrpychova str. 2, 61002, Kharkiv, UKRAINE (gntimchenko2000@gmail.com).

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Free vibration analysis of laminated functionally graded shallow shells by the R-functions method

Lidiya Kurpa, Tetyana Smatko, Jan Awrejcewicz

Abstract: The R-functions theory and Ritz approach are applied for analysis of free vibration laminated shallow shells with different types of curvatures and complex planform. Shallow shells are considered as sandwich ones of the different types: a) face sheets of the shallow shells made of functionally graded material (FGM) and core is isotropic material; b) face sheets of the shallow shells are isotropic, but core is made of FGM. It is assumed that FGM layers are made of a mixture of metal and ceramics and effective material properties of layers are varied accordingly to Voight's rule. Formulation of the problem is carried out using the refined geometrically nonlinear theory of shallow shells of the first order (Timoshenko's type). The different types of boundary conditions including clamped, simply supported, free edge and their combinations are studied. The proposed method and created computer code have been examined on test problems for shallow shells with rectangular planform. In order to demonstrate the possibility of the developed approach new results for laminated FGM shallow shells with complex planform are presented. Effects of the different material distributions, mechanical properties of the constituent materials, lamination scheme, boundary conditions and geometrical parameters on natural frequencies are shown and analyzed.

[1] Lidiya Kurpa, Professor: NTU, 2 Kyrpychova Str., 61002, Kharkiv, UKRAINE (L.kurpa@mail.ru), the author presented this contribution at the conference.

[2] Tetyana Smatko, Associate Professor: NTU, 2, Kyrpychova Str., 61002, Kharkiv, UKRAINE (ktv_ua@yahoo.com).

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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A comparison of different time-frequency signal decomposition techniques to chatter detection in cylindrical plunge grinding process

Paweł Lajmert, Małgorzata Sikora, Bogdan Kruszyński

Abstract: In the paper a problem of chatter vibration detection in cylindrical plunge grinding process is investigated. This problem is frequently considered theoretically. However, the theoretical analysis do not always agree with experiments. First, stability diagram is created based on the developed dynamical model of the grinding process and impact tests of the grinding wheel and the workpiece support system. Next, the grinding tests were conducted in which grinding depth of cut and the workpiece peripheral speed were changed to find a stability limit and chatter growth rate. Based on the force and vibration measurements the stability estimation problem is investigated using different time-frequency signal processing techniques, i.e. short-time Fourier transform, Wavelet transform, Hilbert-Huang transform and Hilbert vibration decomposition methods. Finally, using statistical features resulting from the proposed signal decomposition techniques a system for chatter detection and grinding results prediction is presented using selected data learning algorithms.

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[1] Paweł Lajmert, Ph.D.: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (pawel.lajmert@p.lodz.pl), the author presented this contribution at the conference.

[2] Małgorzata Sikora, Ph.D.: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (malgorzata.sikora@p.lodz.pl).

[3] Bogdan Kruszyński, Professor: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (bogdan.kruszynski@p.lodz.pl).

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A time-domain dynamic simulation of cylindrical plunge grinding process

Paweł Lajmert, Małgorzata Sikora, Bogdan Kruszyński, Dariusz Ostrowski

Abstract: In the paper a time-domain dynamical model of cylindrical plunge grinding process is presented, which is able to simulate the self-excited vibrations due to the regenerative effect on the workpiece and grinding wheel surface. The model includes a finite-element model of the workpiece, two degree of freedom model of grinding wheel headstock and a model of wheel-workpiece geometrical interactions. The parameters of the grinding wheel and the workpiece support system were estimated based on impact tests. The model allows to study the influence of different factors, i.e. workpiece and machine parameters as well as grinding conditions on the stability limit and chatter vibration growth rate. At the end the model is experimentally verified with real grinding conditions.

[1)] Paweł Lajmert, Ph.D.: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (pawel.lajmert@p.lodz.pl), the author presented this contribution at the conference.

[2)] Małgorzata Sikora, Ph.D.: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (malgorzata.sikora@p.lodz.pl).

[3)] Bogdan Kruszyński, Professor: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (bogdan.kruszynski@p.lodz.pl).

[4)] Dariusz Ostrowski, Ph.D.: Technical University of Lodz, Institute of Machine Tools and Production Engineering, Stefanowskiego 1/15 str, 90-924 Łódź, POLSKA (dariusz.ostrowski@p.lodz.pl).

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Trajectory estimation of UAV flight using Integrated Navigation System

Damian Ledziński, Sandra Śmigiel, Marcin Malinowski, Piotr Bełdowski

Abstract: The Unmanned Aerial Vehicle (UAV) is used in industrial applications, such as transportation systems, emergency, etc. Due to the higher demands of autonomous systems, a more precise navigation is needed. UAVs are highly sensitive to environment variables, such as highly urbanized area, or higher solar activity. One of the challenges is maintaining the accuracy in various conditions. Presented work compares the filtration methods -- namely Kalman filtrations to improve the accuracy of flight trajectory estimation. The model based on Inertial Navigation System (INS) integrated with Global Navigation Satellite Systems (GNSS) in loosely coupled configuration has been applied to navigate a real world system.

[1)] Damian Ledziński, Ph.D.: UTP University of Science and Technology in Bydgoszcz, Faculty of Telecommunications, Computer Science and Electrical Engineering, al. prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (damian.ledzinski@utp.edu.pl), the author presented this contribution at the conference.

[2)] Sandra Śmigiel, M.Sc. (Ph.D. student): UTP University of Science and Technology in Bydgoszcz, Faculty of Mechanical Engineering, al. prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (sandra.smigiel@utp.edu.pl).

[3)] Marcin Malinowski, Ph.D.: UTP University of Science and Technology in Bydgoszcz, Faculty of Civil and Environmental Engineering and Architecture, al. prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (marcin.malinowski@utp.edu.pl).

[4)] Piotr Bełdowski, M.Sc. (Ph.D. student): UTP University of Science and Technology in Bydgoszcz, Institute of Mathematics and Physics, al. prof. S. Kaliskiego 7, 85-796 Bydgoszcz, POLAND (piotr.beldowski@utp.edu.pl).

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The influence of anti-roll bar in the dynamics of full car control

Wagner Barth Lenz, Angelo Marcelo Tusset, Rodrigo Tumolin Rocha, Frederic Conrad Janzen, Adriano Kossoski, Jose Manoel Balthazar, Airton Nabarrete

Abstract: This paper presents the control strategy of a nonlinear full-car model using magnetorheological (MR) damper. The control strategy is used in two-step design. First, the LQR control is design and formulated in order to control the nonlinear suspension. The nonlinear suspension is composed by the anti-roll bar, nonlinear springs and dampers. The second one is defined by Lugre model which calculates the value of the voltage to have the same force as the control requested. To study the impact of the anti-roll bar, numerical simulations were carried out with and without the anti-roll bar. The results showed that the efficiency of the control did not decreased by the addition of the anti-roll bar, however the control need less interaction with the suspension, then less power was used to control the motion.

[1)] Wagner Barth Lenz, B.A. (M.Sc. student): UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (wagner_barth@hotmail.com).

[2)] Angelo Marcelo Tusset, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (tusset@utfpr.edu.br).

[3)] Rodrigo Tumolin Rocha, Ph.D.: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (digao.rocha@gmail.com).

[4)] Frederic Conrad Janzen, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (fcjanzen@utfpr.edu.br).

[5)] Adriano Kossoski, B.A. (M.Sc. student): UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (adrianoutf@gmail.com).

[6)] Jose Manoel Balthazar, Professor: ITA, Aeronautics Technological Institute (ITA), São José dos Campos, SP, BRAZIL (jmbaltha@gmail.com), the author presented this contribution at the conference.

[7)] Airton Nabarrete, Assistant Professor: Aeronautics Technological Institute, Marechal Eduardo Gomes Square, 50 - Vila das Acacias, São José dos Campos - SP,, BRAZIL (nabarret@ita.br).

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Influence of the fixation region of a hip stem on the behaviour of the “bone–implant” system

Ievgen Levadnyi, Dariusz Grzelczyk, Jan Awrejcewicz

Abstract: In this paper, the stress state of the femoral bone and stem prosthesis is studied using the finite element method, and considering different types of prosthesis fixation in the medullary canal of the femur under action of functional loads. To obtain reliable results of the performed finite element analysis, model generation of both the femur and the endoprosthesis of real size and shape, physico–mechanical properties of the material and the values of the functional load, is used. The finite element analysis of the stress-strain state shows that for diaphyseal fixation the area of contact between the surface of the stem and the bone is too small. As a result, this type of fixation causes large stresses in the stem what further leads to fatigue fracture of the implant. In the case of diaphyseal fixation type, stress concentration arises in the distal femur and leads to a risk of stress–shielding effect or bone fracture. An increase in the area of contact between the implant and the bone raises the stiffness of the "bone–implant" system, and the values of tensile and compressive stresses in the implant are reduced. For metaphyseal fixation, stress is evenly distributed in bone and no excessive concentrations are observed. In this case, values of stresses in implants do not exceed the endurance limit of the metal of which the implants are made, what ensures a margin of safety. Finally, the presented numerical method can be used to consider the influence of structural changes and clinical technique of installing endoprostheses in the femoral canal on the durability of implants.

[1] Ievgen Levadnyi, M.Sc. (Ph.D. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (evgenabaqus@gmail.com), the author presented this contribution at the conference.

[2] Dariusz Grzelczyk, Ph.D.: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (dariusz.grzelczyk@p.lodz.pl).

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Finite element analysis of the dynamic characteristic of prosthetic feet and design optimisation

Shudong Li, James Ren, Yan Zhang, Yaodong Gu, Mark Lake

Abstract: Abstract: The dynamics of prosthetic feet is a very important factor for the energy storage and return as well as biomechanical index such as comfort and compliance. It also directly influences the structural integrity and service life of the prosthetics under varying movement phases and loading conditions. Many different types of feet prosthetics have been developed to suit different condition and there is an increasing demand on subject specific prosthetic design, which must balance the static and dynamic characteristics of feet prosthetics and materials factors such as weight. This paper present the work on developing a comprehensive parametric finite element modelling based program for predicting response of feet prosthetics under different loading conditions relevant to the foot biomechanics in both normal locomotives and typical abnormal situations (such inversion or eversion landings. The mechanical and dynamic characteristics of different feet prosthetics are investigated and the effect of key materials and design parameters are established. The dynamic deformation and energy of prosthetic feet under different lading conditions was established and critically compared. The use of different optimisation program for the selection of the elements of the foot and the materials used for the design and optimisation is discussed.

[1] Shudong Li, M.Sc. (Ph.D. student): Faculty of Engineering and Technology,Liverpool John Moores University, L3 3AF, UK (lishudong@outlook.com), the author presented this contribution at the conference.

[2] James Ren, Professor: Faculty of Engineering and Technology, Liverpool John Moores University, L3 3AF, UK (X.J.Ren@ljmu.ac.uk).

[3] Yan Zhang, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, the Lodz University of Technology, Poland, 90-457, POLAND (zhangyannub@gmail.com).

[4] Yaodong Gu, Professor: Faculty of Sports Science, Ningbo University, 315211, UK (guyaodong@nbu.edu.cn).

[5] Mark Lake, Ph.D.: School of Sport and Exercise Sciences,Liverpool John Moores University, L3 3AF, UK (MJ.Lake@ljmu.ac.uk).

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Dynamic analysis of a beam with additional auxiliary mass spatial by the spectral element method

Erwin Ulises Lopez Palechor, Marcela Rodrigues Machado, Marcus Vinicius Girão de Morais, Luciano Mendes Bezerra

Abstract: The aim of this paper is to propose a new spectral element with additional mass. Methodologies for structural health monitoring are used to include additional auxiliary mass in the structure in order to change of natural frequencies. Therefore, the additional auxiliary mass can enhance the effects of discontinuities in the structure dynamics response, which could improve the identification and location of the discontinuities. The proposed approach deals with the wave propagation in structures regarding the spectral analysis method. The change in the natural frequencies due the mass is examined by comparing the differences between the dynamic responses of the beam with and without additional auxiliary mass. Similar analyse was also performed with the Galerkin assumed modes technique in order to validate the new spectral element. The proposed technique is validated with a numerical simulation and then compared to experimental data.

[1] Erwin Ulises Lopez Palechor, M.Sc. (Ph.D. student): University of Brasília, Civil Engineering Department, Campus Universitário Darcy Ribeiro, Asa Norte, 70.910-900 Brasília, DF, BRAZIL (erwinlopezpalechor@hotmail.com).

[2] Marcela Rodrigues Machado, Assistant Professor: University of Brasília, Mechanical Engineering Department, Campus Universitário Darcy Ribeiro, Asa Norte, 70.910-900 Brasília, DF, BRAZIL (marcelam@unb.br), the author presented this contribution at the conference.

[3] Marcus Vinicius Girão de Morais, Assistant Professor: University of Brasília, Mechanical Engineering Department, Campus Universitário Darcy Ribeiro, Asa Norte, 70.910-900 Brasília, DF, BRAZIL (mvmorais@unb.br).

[4] Luciano Mendes Bezerra, Associate Professor: University of Brasília, Civil Engineering Department, Campus Universitário Darcy Ribeiro, Asa Norte, 70.910-900 Brasília, DF, BRAZIL (lmbz@unb.br).

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Vector Coding – an application to gait stability and reaction to gait perturbation

Michał Ludwicki, Bartłomiej Zagrodny, Wiktoria Wojnicz, Jerzy Mrozowski, Jan Awrejcewicz

Abstract: The aim of this work is to present an analysis of human normal gait and reaction to gait perturbation with use of Vector Coding method. Understanding of human movement and reaction to perturbation plays a very important role in process of humanoid robot or autonomous exoskeleton balance and also can help to recreate body natural reaction. Vector coding gives a possibility of intersegmental coordination quantification and helps to see the difference between normal and pathological gait. In this case a comparison of normal gait and gait with imbalance (caused by a short duration force impulse) and return to stable/normal gait is analysed. Difference of intersegmental coordination and reaction to temporal perturbation are also considered.

[1)] Michał Ludwicki, Assistant Professor: Lodz University of Technology, Stefanowskiego 1/15, 90-924, bud.A22, K-16, POLSKA (michal.ludwicki@p.lodz.pl), the author presented this contribution at the conference.

[2)] Bartłomiej Zagrodny, Ph.D.: Łódź University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (bartlomiej.zagrodny@p.lodz.pl).

[3)] Wiktoria Wojnicz, Ph.D.: Gdańsk University of Technology, ul. G. Narutowicza 11/12, 80-233 Gdańsk, POLAND (wiktoria.wojnicz@pg.gda.pl).

[4)] Jerzy Mrozowski, Associate Professor: Lodz University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (jerzy.mrozowski@p.lodz.pl).

[5)] Jan Awrejcewicz, Professor: Lodz University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (jan.awrejcewicz@p.lodz.pl).

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Optimal control for robot manipulators with three degrees of freedom

Jose Adenilson Gonçalves Luz Junior, Angelo Marcelo Tusset, Frederic Conrad Janzen, Rodrigo Tumolin Rocha, Jose Manoel Balthazar, Airton Nabarrete

Abstract: This work presents the modeling and simulation of a manipulator robot with three degrees of freedom and considering its structures with rigid behavior. The concepts of kinematics for the mathematical deduction and the Lagrangian mechanics were used to obtain the dynamic models of the manipulator and the DC actuators with permanent magnet. Due to nonlinearity and dynamics characteristics, both the states observer and the control used were based on State Dependet Ricatti Equation (SDRE). The simulations made for constant performance parameters demonstrated the effectiveness of the optimal control applied to the manipulator and to the chosen DC actuator models. The applications of trajectories to the manipulator enrich the applicability of the project and the results obtained with the techniques chosen show his efficiency. Keywords: Robotics; SDRE Control; Nonlinear States Observer; Nonlinear dynamics.

[1)] Jose Adenilson Gonçalves Luz Junior, B.A. (M.Sc. student): UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (jose.adg@hotmail.com).

[2)] Angelo Marcelo Tusset, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (tusset@utfpr.edu.br).

[3)] Frederic Conrad Janzen, Assistant Professor: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (fcjanzen@utfpr.edu.br).

[4)] Rodrigo Tumolin Rocha, Ph.D.: UTFPR, Federal University of Technology – Paraná (UTFPR), Ponta Grossa, PR, BRAZIL (digao.rocha@gmail.com).

[5)] Jose Manoel Balthazar, Professor: ITA, Aeronautics Technological Institute (ITA), São José dos Campos, SP, BRAZIL (jmbaltha@gmail.com), the author presented this contribution at the conference.

[6)] Airton Nabarrete, Assistant Professor: Aeronautics Technological Institute, Marechal Eduardo Gomes Square, 50 - Vila das Acacias, São José dos Campos - SP,, BRAZIL (nabarret@ita.br).

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Spectral approach for dynamic analysis of a composite structure under random excitation

Marcela Machado, Leila Khalij, Adriano Fabro

Abstract: The application of the composite material in aeronautical and aerospace industries has been increasing the last several decades. Compared to metallic material composites present better strength to weight and stiffness to weight ratio. Therefore, the high level of uncertainty in composite materials is mainly associated with the manufacturing processes. The uncertainty in the composite material parameters is reflected in the variability of stiffness and strength descriptors affecting the overall performance, mainly at the dynamic structure response. Randomness can be present in geometry, properties, and external source likewise random excitation. This paper treats the dynamic analysis of a composite plate under random excitation. The plate is modelled by Spectral Finite Element method regarding wave propagation technique. A numerical example is used to study the influence of random source on the dynamic composite structure behaviour.

[1)] Marcela Machado, Ph.D.: University of Brasilia, 70910-900, BRAZIL (marcelam@unb.br), the author presented this contribution at the conference.

[2)] Leila Khalij, Assistant Professor: Institut National des Sciences Appliquées de Rouen, Rouen, FRANCE (leila.khalij@insa-rouen.fr).

[3)] Adriano Fabro, Associate Professor: University of Brasilia, Brasilia, BRAZIL (fabro@unb.br).

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Optimal design of multibody systems using the adjoint method

Paweł Maciąg, Paweł Malczyk, Janusz Frączek

Abstract: Optimal design of multibody systems (MBS) is of primary importance to engineers and researchers working in various fields, e.g.: in robotics or in machine design. The goal of this paper is development and implementation of systematic methods for finding design sensitivities of multibody system dynamics with respect to design parameters in the process of optimization of such systems. The optimal design process may be formulated as finding a set of unknown parameters such that the objective function is minimized under the assumption that design variables may be subjected to a variety of differential and/or algebraic constraints. The solutions of such complex optimal problems are inevitably connected with evaluation of a gradient of the objective function. Herein, a multibody system is described by redundant set of absolute coordinates. The equations of motion for MBS are formulated as a system of differential – algebraic equations (DAEs) that has to be discretized and solved numerically forward in time. The design sensitivity analysis is addressed by using the adjoint method that requires determination and numerical solution of adjoint equations backwards in time. Optimal design of sample planar multibody systems are presented in the paper. The properties of the adjoint method are also investigated in terms of efficiency, accuracy, and problem size.

1) Paweł Maciąg, M.Sc. (Ph.D. student): Institute of Aeronautics and Applied Mechanics, Faculty of Power and Aeronautical Engineering, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (pawmac47@gmail.com), the author presented this contribution at the conference.

2) Paweł Malczyk, Ph.D.: Institute of Aeronautics and Applied Mechanics, Faculty of Power and Aeronautical Engineering, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (pmalczyk@meil.pw.edu.pl).

3) Janusz Frączek, Professor: Institute of Aeronautics and Applied Mechanics, Faculty of Power and Aeronautical Engineering, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (jfraczek@meil.pw.edu.pl).

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Numerical analysis of three-layered wall made of concrete-rubber composites subjected to the dynamic load

Maciej Major, Krzysztof Kuliński, Izabela Major

Abstract: In the paper numerical analysis of three-layered wall subjected to the dynamic load is performed. Mentioned wall comprise of following layers counting from the interior space: concrete block with embedded cross rubber pads, space filled with air/rubber dampers and concrete blocks with I-shape rubber pads, respectively. Concrete blocks transfers mainly compressive loads in the wall, whereas rubber inserts embedded in the production process provide an additional protection against the transversal dynamic load. For the rubber hyperelastic incompressible material the Zahorski material model is assumed, which is still not well-known but definitely well describes the real material properties in the range of large elastic deformations. Two different types of dynamic load applied to the external wall surface are investigated – pressure and concentrated force. As a result of applied loading to the wall, mechanical wave propagation can be observed as the stress distribution plot. In order to determine the percentage damping factor of mechanical wave propagation, wall made of solid concrete blocks with simple air layer between them is also studied. Numerical analysis is performed with the use of ADINA software based on finite element method, for which special author's material library extension was implemented concerning the Zahorski material model.

[1)] Maciej Major, Associate Professor: Politechnika Częstochowska, ul. Dąbrowskiego 69, 42-201 Częstochowa, POLSKA (mmajor@bud.pcz.czest.pl).

[2)] Krzysztof Kuliński, M.Sc. (Ph.D. student): Politechnika Częstochowska, ul. Dąbrowskiego 69, 42-201 Częstochowa, POLSKA (kkulinski@bud.pcz.czest.pl), the author presented this contribution at the conference.

[3)] Izabela Major, Associate Professor: Politechnika Częstochowska, ul. Dąbrowskiego 69, 42-201 Częstochowa, POLSKA (imajor@bud.pcz.czest.pl).

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Algorithm for damping control in vehicle suspension equipped with magneto-rheological dampers

Michał Makowski

Abstract: This paper is devoted to developing the control algorithms of semi-active systems of vehicle suspensions. In order to accomplish the goal, a vehicle was equipped with controlled magneto-rheological (MR) dampers. The model of a vehicle with the controlled suspension was developed. It was assumed that controlling the force in the suspension will be based on two criteria: ride comfort and safety. On the basis of the adopted evaluation criteria, the algorithm for controlling the damping force of vehicle vibrations. The mathematical vehicle model and the control algorithm helped develop a simulation programme. The coefficients adopted in the model were determined empirically. The numerical study of the vehicle model with the controlled suspension was conducted in the Matlab/Simulink programme. As a result of the performed work, the control algorithm was developed, taking into account two conflicting criteria of the drive comfort and safety. A vehicle with the controlled suspension can be driven in the conditions of maximal comfort and safety. A compromise solution was suggested, where a weight factor of the influence of individual control criteria is introduced. In this paper, some sample results of the numerical and experimental tests of a vehicle with the MR dampers are presented.

[1)] Michał Makowski, Ph.D.: Warsaw University of Technology, Institute of Vehicles, 02-524 Warsaw, POLAND (michal.makowski@simr.pw.edu.pl), the author presented this contribution at the conference.

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Optimal auxiliary functions method for investigating a permanent magnet synchronous generator

Vasile Marinca, Nicolae Herisanu

Abstract: In the present paper we investigate the transitory working regime of a permanent magnet synchronous machine that works in actual wind power station. For the nonlinear differential equations which describe this type of machines we apply the optimal auxiliary functions method (OAFM) and an explicit analytical solution is obtained. The governing equations are expressed in the non-dimensional form and are solved by means of OAFM. Two stages of the generator's dynamic behaviors are known: the beginning of the transitory regime and the ending of this regime. The first stage of the regime shows the electromagnetic fast transitory regime and the second one generally emphasize the mechanical slow transitory regime, caused by inertia. In each of these stages of the transitory regime, the solutions are built using different functions, for example trigonometric functions in combination with exponential functions for the first stage and polynomial functions in combination with exponential functions in the case of the second stage. On the other hand, these functions depend on several optimal-convergence-control parameters which ensure a fast convergence of the approximate solution to the exact ones. Numerical examples analyzed in this paper lead to the conclusion that the results obtained through the proposed procedure are very accurate and the method is very efficient in practice.

[1] Vasile Marinca, Professor: University Politehnica Timisoara, Bd. Mihai Viteazu, 1, 300222 Timisoara, ROMANIA (v_marinca@yahoo.co.uk).

[2] Nicolae Herisanu, Professor: University Politehnica Timisoara, Bd. Mihai Viteazu, 1, 300222 Timisoara, ROMANIA (n_herisanu@yahoo.co.uk), the author presented this contribution at the conference.

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Nonlocal elasticity theory for solving dynamic problems via peridynamics

Adam Martowicz, Wieslaw J. Staszewski, Massimo Ruzzene, Tadeusz Uhl

Abstract: The paper deals with the developed peridynamic numerical tools used for solving various types of dynamic problems. The peridynamics makes use of nonlocal formulation for computational mechanics and, therefore, offers unique properties in terms of more realistic modeling different types of physical phenomena. The authors briefly highlight the fundamentals of nonlocal elasticity theory to show capabilities of the elaborated numerical approach. The theoretical part of the work is complemented with the results obtained for various case studies taking into account elastic wave propagation and analysis of crack propagation. Practical aspects regarding efficiency, required computer resources and accuracy of the proposed numerical tools are addressed. Finally, an analogy between peridynamics and Finite Difference formulations is derived to show possibility of building equivalent model descriptions when solving dynamic problems.

[1)] Adam Martowicz, Ph.D.: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (adam.martowicz@agh.edu.pl), the author presented this contribution at the conference.

[2)] Wieslaw J. Staszewski, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (staszews@agh.edu.pl).

[3)] Massimo Ruzzene, Professor: Georgia Institute of Technology, School of Aerospace Engineering, School of Mechanical Engineering, 270 Ferst Drive, GA 30332, Atlanta, USA (ruzzene@gatech.edu).

[4)] Tadeusz Uhl, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (tuhl@agh.edu.pl).

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Nonlocal numerical methods for solving second-order partial differential equations

Adam Martowicz, Wieslaw J. Staszewski, Massimo Ruzzene, Tadeusz Uhl

Abstract: The work presents efficient numerical schemes dedicated for solving dynamic problems governed by second-order partial differential equations. The proposed approach makes use of a nonlocal formulation of the Finite Difference method. Higher order components incorporated into the discretization schemes are found, using the Fourier series based decomposition, to assure desired reduction of numerical dispersion. Hence, the elaborated approach is primarily proposed to carry out both vibration and wave propagation based analyses. Stability conditions and mitigation rate of numerical dispersion for the proposed discretization schemes are verified. The authors discuss the influence of the order of components used in nonlocal formulations on performance of the proposed methods. Additionally, as confirmed with exemplary numerical results, the proposed nonlocal numerical schemes allow for more sparse spatial model discretization, keeping similar properties regarding numerical dispersion, compared to the most commonly used finite difference formulations. Effectively, less populated domain of spatially distributed model's degrees of freedom may be taken into account. This ability may be critical in terms of available computer resources (both processing speed and memory) when dealing with either complicated geometry, topology or long-term temporal analyses.

[1] Adam Martowicz, Ph.D.: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (adam.martowicz@agh.edu.pl), the author presented this contribution at the conference.

[2] Wieslaw J. Staszewski, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (staszews@agh.edu.pl).

[3] Massimo Ruzzene, Professor: Georgia Institute of Technology, School of Aerospace Engineering, School of Mechanical Engineering, 270 Ferst Drive, GA 30332, Atlanta, USA (ruzzene@gatech.edu).

[4] Tadeusz Uhl, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, al. A. Mickiewicza 30, 30-059 Krakow, POLAND (tuhl@agh.edu.pl).

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On solutions of biharmonic problems

Hovik Matevossian, Mikhail Nikabadze, Armine Ulukhanian

Abstract: For solving biharmonic problems with application to radar imaging, we need to solve boundary value problems for the Poisson equation using the scattering model. In addition, no information about boundary values is available. In order to select suitable solutions, we solve the Poisson equation under the side condition that some criterion function, usually a Sobolev norm, should be minimized. Under appropriate smoothness assumptions these problems may be reformulated as boundary value problems for the biharmonic equation.

[1)] Hovik Matevossian, Ph.D.: Federal Research Center "Computer Science and Control", Dorodnitsyn Computing Centre of the Russian Academy of Sciences & Moscow Aviation Institute - National Research University "MAI", 119333 Moscow, Vavilov str., 40, RUSSIA (hmatevossian@graduate.org), the author presented this contribution at the conference.

[2)] Mikhail Nikabadze, Professor: Lomonosov Moscow State University, Leninskie Gory, 1, MOSCOW (nikabadze@mail.ru).

[3)] Armine Ulukhanian, Ph.D.: Bauman Moscow State Technical University, Leninskie Gory, 1, MOSCOW (armine_msu@mail.ru).

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Localization and reconstruction of dynamic forces acting on plane structures using displacement transmissibility

Miguel Matos, Yoann Lage, Miguel Neves, Nuno Maia

Abstract: The vibration displacement amplitudes at different locations can be related using the Multiple Degree-of-Freedom displacement transmissibility concept, which depends on the position of the applied loads. This relationship between responses at some points is used in this work to develop a methodology in frequency domain that is numerically efficient for the localization and reconstruction of dynamic forces acting upon 2D plane structures, as well as for the identification of local modifications. The methodology is based on a finite element model that is able to characterize the dynamic response along all the structure. The methodology is discussed and tested in examples to illustrate its potential.

[1] Miguel Matos, M.Sc. (Ph.D. student): DEM, Instituto Superior Técnico, U. Lisboa, Department of Mechanical Engineering, Av. Rovisco Pais, 1049-001 Lisboa, PORTUGAL (miguelsmatos@hotmail.com).

[2] Yoann Lage, Ph.D.: Condition and Structural Monitoring, TWI Ltd., Granta Park, Great Abington, Cambridge, CB21 6AL, UK (yoann.lage@twi.co.uk).

[3] Miguel Neves, Assistant Professor: IDMEC-IST, Instituto Superior Técnico, Univ. Lisboa, Department of Mechanical Engineering, Av. Rovisco Pais, 1049-001 Lisboa, PORTUGAL (miguel.matos.neves@tecnico.ulisboa.pt).

[4] Nuno Maia, Associate Professor: IDMEC-IST, Instituto Superior Técnico, Univ. Lisboa, Department of Mechanical Engineering, Av. Rovisco Pais, 1049-001 Lisboa, PORTUGAL (nuno.manuel.maia@tecnico.ulisboa.pt), the author presented this contribution at the conference.

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Flap-wise vibrations of cracked beams rotating around a hub

Kemal Mazanoglu

Abstract: This study is on flap-wise vibration analyses of centrifugally stiffened cracked beams using the Rayleigh–Ritz method. Energy expressions are stated for flap-wise vibrations of the cracked Euler–Bernoulli beam rotating around a hub. Distributed flexibility model is employed to take energy effects of an edge crack into consideration. Energy formulations including crack and rotation effects are discretised to apply Rayleigh–Ritz solution method which uses admissible polynomial mode shape function. Analyses are conducted by changing location and depth of crack, rotating speed, and radius of hub. Effects of these parameters on results are clearly reflected and discussed together with advantages and shortcomings of present solution.

[1)] Kemal Mazanoglu, Assistant Professor: Usak University, Usak University, Faculty of Engineering, Department of Mechanical Engineering, 64200, Usak, TÜRKIYE (kemal.mazanoglu@usak.edu.tr), the author presented this contribution at the conference.

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Free vibration analyses of simply supported cracked beams using perturbation and Ritz methods

Kemal Mazanoglu, Elif Cagda Kandemir Mazanoglu

Abstract: This paper presents a method combining the perturbation and Ritz methods to do flexural vibration analyses of cracked simply supported beams. Local flexibility change due to the open crack is defined by the aid of fracture mechanics theory. This flexibility change is taken as the function of non-linear parameter of perturbation method applied on spatial coordinate. Thus, non-linear modeshape function of cracked beam is introduced in order to use in the Ritz's method that is applied for finding natural frequencies. Obtained results are validated by the results given in literature. Advantages and shortcomings of presented method are clearly stated.

[1] Kemal Mazanoglu, Assistant Professor: Usak University, Usak University, Faculty of Engineering, Department of Mechanical Engineering, 64200, Usak, TÜRKIYE (kemal.mazanoglu@usak.edu.tr), the author presented this contribution at the conference.

[2] Elif Cagda Kandemir Mazanoglu, Assistant Professor: Usak University, Usak University, Faculty of Engineering, Department of Mechanical Engineering, 64200, Usak, TÜRKIYE (elif.kandemir@usak.edu.tr).

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Thermal buckling of triangular plates

Olga Mazur, Atul Bhaskar

Abstract: Buckling and dynamics of plates of simple geometries have been widely investigated in the past. For complex geometrical shapes, mathematical formulation is complicated and an analytical treatment frequently infeasible. One has to resort to the use of numerical methods, which are often time-consuming and computationally expensive. Here we propose a scaling to estimate the critical temperature in the thermal buckling problems of isotropic triangular plates within a uniform temperature field. Ritz-method in conjunction with R-function theory is used for calculations that are performed for plates of fixed area but changing shape. The plate is assumed to be simply supported, clamped, or to satisfy mixed boundary conditions. The influence of shape on buckling is studied to explore optimal design of triangular plates with the buckling temperature as the objective function. Critical buckling temperature for triangular plates of varying shape is obtained. Results show that the most unstable plate, with respect to thermal loading, is one with equal sides. Clamping of the boundary increases critical buckling temperature, making plate less susceptible to temperature rise.

[1] Olga Mazur, Ph.D.: National Technical University “KhPI”, Department of Applied Mathematics, Kharkiv, 61002, UKRAINE (mazuroly@gmail.com), the author presented this contribution at the conference.

[2] Atul Bhaskar, Professor: Boldrewood Innovation Campus, University of Southampton, SO16 7QF, UK (A.Bhaskar@soton.ac.uk).

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Computational deterministic simulation of the nonlinear dynamic propagation of diffuse cracks in reinforced concrete bridges through the action of car and truck vehicular models by damage mechanics

Diego Gabriel Metz, Roberto Dalledone Machado, Thiago de Oliveira Abeche, Ana Paula Imai, João Elias Abdalla Filho, Fernando Luiz Martinechen Beghetto, Luiz Antonio Farani de Souza

Abstract: Worldwide, normative codes, such as ACI and EUROCODE, use standard vehicles for bridge's design, with safety coefficients and parameters, to guarantee their structural health. However, it is important to consider the nonlinear dynamic evolution of diffuse cracks propagation due to the action of different vehicles, in a deterministic form. In a vehicle with more degrees of freedom, the dynamic effect of the mass can significantly alter the damaging responses of the concrete on reinforced concrete's bridges. In this sense, this work seeks to evaluate the effects that vehicle models with 4 and 5 degrees of freedom, representing a car and truck respectively, cause in their dynamic interaction with a reinforced concrete bridge whose cracking and plasticity dynamic evolution alter the responses over time. For the nonlinear dynamics analysis of all systems is utilized the ABXDNL 2.7 program. To consider additional vehicles with more degrees of freedom are developed computational routines in C++ programming language for the program. In the bridge model are used Euler-Bernoulli beam elements, with Hermite cubic interpolation functions. It is adopted a constitutive nonlinear dynamic damage model based on the regarded Mazars' damage model, which also considers the effects of the inversion of mechanical solicitations due to vibrations.

[1] Diego Gabriel Metz, B.A. (M.Sc. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (diegogabrielmetz@gmail.com), the author presented this contribution at the conference.

[2] Roberto Dalledone Machado, Professor: Numerical Methods in Engineering Graduate Program (PPGMNE) and Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (rdm@ufpr.br).

[3] Thiago de Oliveira Abeche, M.Sc. (Ph.D. student): Numerical Methods in Engineering Graduate Program (PPGMNE) of the Federal University of Paraná (UFPR), Concentration Area in Computational Mechanics, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (t.abeche@gmail.com).

[4] Ana Paula Imai, B.A. (M.Sc. student): Civil Construction Engineering Graduate Program (PPGECC) of the Federal University of Paraná (UFPR), Concentration Area in Materials and Structures, Brazil, Avenida Cel. Francisco Heráclito dos Santos, 210, Centro de Estudos de Engenharia Civil Professor Inaldo Ayres Vieira (CESEC), Caixa Postal 19.011, CEP 81531-980, Jardim das Américas, Curitiba — PR, BRAZIL (ana_imai@hotmail.com).

[5] João Elias Abdalla Filho, Professor: Mechanical Engineering Graduate Program (PPGEM) of the Pontifical Catholic University of Paraná (PUCPR), Federal Tech. University of Paraná (UTFPR), Brazil & University of Colorado (CU-Boulder), USA, Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba — PR, Brazil and 428 UCB, 80309-0428, Boulder, CO, United States of America, BRAZIL AND USA (joao.filho@pucpr.br).

[6] Fernando Luiz Martinechen Beghetto, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (flbeghetto@utfpr.br).

[7] Luiz Antonio Farani de Souza, Professor: Federal Technological University of Paraná (UTFPR), Brazil, Rua Deputado Heitor Alencar Furtado, 4900, CEP 81280-340, Curitiba — PR, BRAZIL (lasouza@utfpr.br).

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Analysis of the influence of parameters of elastomeric layer in shock-absorbing holder of helical spring on its dynamic and static properties

Krzysztof Michalczyk, Wojciech Sikora

Abstract: Metal helical springs are widely used in general machines building due to excellent strength and elastic properties, but at the same time they exhibit negligible damping properties which is usually an undesirable feature, especially in suspension systems. One of the methods of increasing damping in support systems based on application of helical springs is the use of a spring holder integrated with the spring by means of elastomeric layer, characterized by high damping properties. The results of numerical analyses of the influence of geometrical and material parameters of elastomeric layer on dynamic and static properties of the spring and holder system are presented in the paper. It is shown that proper selection of these parameters can provide significant vibration energy dissipation whilst maintaining relatively low static stiffness.

1) Krzysztof Michalczyk, Ph.D.: AGH University of Science and Technology, 30 Mickiewicza Avenue, 30-059 Krakow, POLAND (kmichal@agh.edu.pl), the author presented this contribution at the conference.

2) Wojciech Sikora, M.Sc. (Ph.D. student): AGH University of Science and Technology, 30 Mickiewicza Avenue, 30-059 Krakow, POLAND (wosikora@agh.edu.pl).

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Tympanoplasty of the middle ear with a retraction pocket: recommendations based on the modal finite element analysis

Gennadi Mikhasev, Sergei Bosiakov, Kirill Yurkevich, Alina Dutina, Lyudmila Petrova, Marina Maisyuk

Abstract: The aim of this study is to formulate recommendations for surgery of retraction pocket of the tympanic membrane and improving of hearing. Finite-element analysis of the eigenfrequencies of the oscillatory systems for normal middle ear, middle ear with pathology of tympanic membrane and middle ear with cartilage graft are carried out. The finite-element model of the middle ear consists of a tympanic membrane, a malleus, an anvil and a stapes. Pathological changes of the tympanic membrane elastic properties are described by a change of the modulus of elasticity. The geometric dimensions of the cartilage graft of the tympanic membrane are assessed to generate the acoustic conditions corresponding to the hearing functions of the normal tympanic membrane. The obtained results can be employed to estimate the thickness of the cartilage graft for restoring of the middle ear functions by means of reconstruction of the tympanic membrane with a retraction pocket.

[1] Gennadi Mikhasev, Professor: Belarusian State University, 220030, BELARUS (mikhasev@bsu.by).

[2] Sergei Bosiakov, Associate Professor: Belarusian State University, 220030, BELARUS (bosiakov@bsu.by).

[3] Kirill Yurkevich, Assistant Professor: Belarusian State University, 220030, BELARUS (kirill.bsu@gmail.com).

[4] Alina Dutina, M.Sc. (Ph.D. student): Belarusian State University, 220030, BELARUS (alinammf@gmail.com), the author presented this contribution at the conference.

[5] Lyudmila Petrova, Professor: Republican Center for Research and Practice in Otolaryngology, 200004, BELARUS (bsm21@mail.ru).

[6] Marina Maisyuk, M.Sc. (Ph.D. student): Republican Center for Research and Practice in Otolaryngology, 220004, BELARUS (merylmmm@mail.ru).

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Computer model of ground under vehicle wheels

Tomasz Mirosław

Abstract: In this paper author presents new approach to modeling ground behavior under pressure of a vehicle's wheel. The ground under the wheel is deformed by compression and displacement in vertical and horizontal direction. Some layer direct under tire is abraded, torn and transported by the wheel. The pressure of the tire causes deformation which grows with increasing of rolling resistance. The model of ground behavior, especially for multi-axle off road vehicle, is very important for traction calculation. This model is nonlinear. The running process of ground transformation depends on forces, acceleration and time and frequencies repeating stresses. In the presented model the ground is divided into cubes/cells which are deformed and transform their density and features. Deformed cubic effects its neighbors and cause their deformation and forces inside them. The pressed cube in first stage is displaced, if it's movement is blocked cube is deformed and if it is still pressed it is transformed to another form of its substance changing its physical properties and features. The presented model can also be applied to crushing stones and calculating swimming resistance in the water.

[1)] Tomasz Mirosław, Ph.D.: Warsaw University of Technology Facultyof Automotive and Construction Machinery Institute of Construction Machinery Engineering, 02-524 Warsaw Narbutta str 84, POLAND (tmiroslaw@simr.pw.edu.pl), the author presented this contribution at the conference.

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Model of 4-wheel electric drive vehicle with ESP and ABS system

Tomasz Mirosław

Abstract: The problem of e-mobility basing on electric drive vehicle is very popular currently. There are several advantages of electric motors over internal combustion engines (ICE) .This positive features are not only the lack of poisonous exhausts or noise but the torque control over full range as well. Such a feature helps us to use electric motor as the brake. In 4 wheels electric drive vehicle we can apply the full electric traction control system. It is obvious for 4 motors system, but it is possible also for 2 motors used separately for front and rear axle propelling with differential gear. In this paper the concept and model 4-wheel 2 motors electric drive vehicle is presented. The dynamic 3D model is described with new concept of wheel-surface cooperation which generates longitudinal and lateral forces for tires. The cooperation model is divided into 3 stages: tire deformation, slip, and attrition of tire, depending on the force generated between road surface and tire. Those force are conducted though suspension system to the rigid body of vehicle. The vectors of forces act on mass center and are effecting on acceleration or create torques which case vehicle rotation. The approach to wheel modeling is easier to be understood and applied for vehicle modelling than most common “magic formulas”. As the result the model of vehicle with electric ABS and ESP is presented.

[1)] Tomasz Mirosław, Ph.D.: Warsaw University of Technology Facultyof Automotive and Construction Machinery Institute of Construction Machinery Engineering, 02-524 Warsaw Narbutta str 84, POLAND (tmiroslaw@simr.pw.edu.pl), the author presented this contribution at the conference.

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Dynamics of a portable module handling system

Robert Mitoraj, Marek Szczotka

Abstract: The paper describes a model of a light module handling system (LMHS) developed for IMR (Inspection, Maintenance and Repair) services typically performed for the seabed-located oil and gas production facilities. The equipment allows for the vessel integration to be performed on a short notice. In order to describe dynamic performance and loads during the operation, the system is characterized by means of a multi-body model consisting both rigid and flexible links. Using the joint coordinates and homogeneous transformations the dynamics can be described by a set of differential equations of the second order and some constraint equations. The system forms several tree-like structures of bodies. The interaction between them takes place on guiding elements and lifting ropes. An important features of the handling system are flexible guide beams and prongs. The flexibility provided by those elements helps to limit some impact loads during the module docking phase. This functionality is modelled by the rigid finite elements. Lifted objects (subsea modules) are described by a set of special elements defining the hydrodynamic interaction. The work will also show some simulation results reflecting a typical operation.

[1)] Robert Mitoraj, M.Sc.: AXTech AS, Fannestrandsvegen 85, 6402 Molde, NORWAY (rmi@axtech.no).

[2)] Marek Szczotka, Associate Professor: University of Bielsko-Biala, Willowa 2, 43 300 Bielsko-Biala, POLAND (msz@axtech.no), the author presented this contribution at the conference.

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Analysis of vibration effects on edgechipping occurrence during rotary ultrasonic drilling

Milan Naď, Lenka Kolíková, Ladislav Rolník, Rastislav Ďuriš

Abstract: Rotary ultrasonic drilling (RUD) is considered as a hybrid process combining grinding process using diamond tool that simultaneously performs axial vibrations with frequency at the ultrasound level. The application of this method hole drilling is mainly in machining of high-strength or brittle materials - alloys, composites and ceramics in industrial and medical applications. During a hole drilling, the hole bottom thickness is changing and consequently as a plate structure is subjected to transition through the resonance conditions. This resonant state can be considered as one of the important effects that leads to occure the "edgechipping" phenomenon. Although intensive research in this application area is still ongoing, the impact of ultrasonic vibrations as well as the influence of the shape of the contact surface of the drilling tool on this phenomenon is still insufficiently analyzed. The effects different contact surfaces of drilling tools on the stress-strain states and prediction of "edgechipping" phenomenon occuring during RUD are analyzed in this paper.

[1] Milan Naď, Associate Professor: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (milan.nad@stuba.sk), the author presented this contribution at the conference.

[2] Lenka Kolíková, Ph.D.: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (lenka.cicmancova@stuba.sk).

[3] Ladislav Rolník, Ph.D.: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (ladislav.rolnik@stuba.sk).

[4] Rastislav Ďuriš, Ph.D.: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (rastislav.duris@stuba.sk).

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Influence of pre-stressed zones in beam structures to the modification their modal properties

Milan Naď, Ladislav Rolník, Lenka Kolíková

Abstract: The reduction of harmful effects of vibrations or prevention of their occurrence is one of the important objectives in the design of machine equipment and structures. One of the opportunities how to achieve the desired dynamic behavior for a given structure is set up or modify its modal properties. Beam structures as one of the fundamental structural element of different machines and structures are considered and modifications of their modal properties are analysed. In this paper the aplication pre-stressed zones and study of their effect on modal properties (natural frequency, mode shapes) in the beam structures are presented. The effect of position and magnitude of pre-stressed zone and also applied pre-stress value on modal properties of beam structures is investigated.

[1] Milan Naď, Associate Professor: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (milan.nad@stuba.sk), the author presented this contribution at the conference.

[2] Ladislav Rolník, Ph.D.: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (ladislav.rolnik@stuba.sk).

[3] Lenka Kolíková, Ph.D.: Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Jana Bottu 25, 917 24 Trnava, SLOVAKIA (lenka.cicmancova@stuba.sk).

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Identification of the model of Stick balancing using the cepstral analysis

Dalma J. Nagy, László Bencsik, Tamás Insperger

Abstract: Stick balancing on the fingertip is one of the simplest human balancing tasks, still it represents the key features of more complex balancing tasks, namely, an unstable equilibrium should be stabilized in the presence of a reaction time delay. In order to understand the mechanism of human balancing, first we have to identify the control concept employed by the human brain during stick balancing. There are several possible concepts in the literature to model this neural control mechanism. Here, we assume a delayed proportional-derivative-acceleration (PDA) feedback. This concept assumes that, besides the inclination and the angular velocity, humans are able to estimate the angular acceleration of the stick from the pressure distribution perceived by mechanoreceptors at the fingertip. Because of the acceleration feedback, the mathematical model is a neutral delayed differential equation (NDDE). For systems governed by NDDEs, cepstral analysis can be used to identify the time delay, and to gain information about the neutral behaviour of the model. In a proposed experimental study, sticks with different weights have to be balanced. In case of sticks with larger masses the pressure at the fingertip during balancing is larger and it is supposed that the acceleration gains are also of higher value. In this work we verify this phenomenon using cepstral analysis of signals obtained by time-domain simulations.

[1] Dalma J. Nagy, B.A. (M.Sc. student): Budapest University of Technology and Economics, H-1111, Budapest Megyetem rkp 5, HUNGARY (nagy.dalma22@gmail.com).

[2] László Bencsik, Ph.D.: MTA-BME Human Balancing Research Group, H-1111, Budapest Megyetem rkp 5, HUNGARY (l.bencsik@hotmail.com), the author presented this contribution at the conference.

[3] Tamás Insperger, Professor: MTA-BME Human Balancing Research Group, H-1111, Budapest Megyetem rkp 5, HUNGARY (insperger@mm.bme.hu).

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Rough terrain mobile robot path planning method based on mobile robot dynamics model and energy minimization

Adam Niewola, Leszek Podsędkowski

Abstract: The energy efficient path finding is one of the most important issues in mobile robots path planning, i.a. for exploration robots, rescue robots or military autonomous vehicles. Most of the path planning algorithms produce a discrete path considering only the kinematics model. Such kind of path is usually difficult to follow and causes relatively big tracking error, in particular in the terms of rough terrain operations. In this paper, we present an extension of the graph searching based mobile robot path planning method which can be applied in order to provide the final path close to the optimal path in the terms of continuous configuration space. The path optimization is based on energy minimization and includes mobile robot dynamics model. Therefore, the final path can be easier to track with smaller tracking error than with the use of kinematics model. It is a critical issue for mobile robot energy resources management.

[1] Adam Niewola, M.Sc. (Ph.D. student): Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLSKA (adam.niewola@gmail.com).

[2] Leszek Podsędkowski, Professor: Lodz University of Technology, Stefanowskiego 1/15 Lodz, POLSKA (lpodsedk@p.lodz.pl), the author presented this contribution at the conference.

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On decomposition of the initial boundary value problems in mechanics

Mikhail Nikabadze

Abstract: The canonical formulation of the second initial boundary value problem of the classical (micropolar) theory of elasticity for any anisotropic material is given. In particular, the canonical formulations of initial boundary value problems are considered in the case of isotropic, transversely isotropic and orthotropic materials. Expressions for tensors-operators of classical (micropolar) equations in displacements (in displacements and rotations) are found. For these tensors-operators the tensors-operators of cofactors are found, on the basis of which the equations are split. It should be noted here that the equations are always split, and the boundary conditions only for bodies with a piecewise plane boundary. From three dimensional canonical equations the corresponding canonical equations for the theory of prismatic bodies are obtained. For prismatic bodies the canonical equations were obtained also in moments with respect to any system of orthogonal polynomials. For each moment of the unknown vector function the equation of elliptic type of high order is obtained, the characteristic roots of which are easily found. Using the Vekua method, we can obtain their analytical solution. Similar questions are considered for the micropolar theory of prismatic thin bodies with two small dimensions. Acknowledgements: this research were supported by the Shota Rustaveli National Science Foundaiton (project no. DI-2016-41) and the Russian Foundation for Basic Research (project no. 15-01-00848-a).

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[1] Mikhail Nikabadze, Professor: Lomonosov Moscow State University, Moscow, RUSSIA (nikabadze@mail.ru), the author presented this contribution at the conference.

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Formulation of initial boundary value problems in the theory of multilayer thermoelastic thin bodies in moments

Mikhail Nikabadze, Tamar Moseshvili, Armine Ulukhanian, Ketevan Tskhakaia, Nodar Mardaleishvili

Abstract: Proceeding from three-dimensional formulations of initial boundary value problems of the three-dimensional linear micropolar theory of thermoelasticity similar formulations of initial boundary value problems for the theory of multilayer thermoelastic thin bodies are obtained, as well as for rigid in the transverse direction thin bodies under a new parameterization of the domain of a thin body. The initial boundary value problems for thin bodies were also obtained in the moments with respect to systems of orthogonal polynomials. We consider some particular cases of formulations of initial boundary value problems. Acknowledgements: this research were supported by the Shota Rustaveli National Science Foundaiton (project no. DI-2016-41) and the Russian Foundation for Basic Research (project no. 15-01-00848-a).

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[1] Mikhail Nikabadze, Professor: Lomonosov Moscow State University, GSP-1, Leninskie Gory, Moscow, 119991, RUSSIAN FEDERATION (nikabadze@mail.ru).

[2] Tamar Moseshvili, Associate Professor: Akaki Tsereteli State University, 59, Tamar Mephe str., Kutaisi, 4600, GEORGIA (tamarmoseshvili@yahoo.com), the author presented this contribution at the conference.

[3] Armine Ulukhanian, Associate Professor: Bauman Moscow State Technical University, ul. Baumanskaia 2-ya, 5/1, Moscow, 105005, RUSSIAN FEDERATION (armine_msu@mail.ru).

[4] Ketevan Tskhakaia, Associate Professor: Akaki Tsereteli State University, 59, Tamar Mephe str., Kutaisi, 4600, GEORGIA (ketevan.tskhakaia@gmail.com).

[5] Nodar Mardaleishvili, Ph.D.: Akaki Tsereteli State University, 59, Tamar Mephe str., Kutaisi, 4600, GEORGIA (nodarmard@mail.ru).

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Formulation of the Initial Boundery Velue Problems in the Theory of Multilayer Thermoelastic Thin Bodies in Moments. II

Mikhail Nikabadze, Tamar Moseshvili, Ketevan Tskhakaia, Nodar Mardaleishvili, Armine Ulukhanyan

Abstract: Various representations of the equations of motion, the heat influx, the constitutive relations of physical and heat content are given for the new body domain parametrization. The definition of the kth order moment of a certain quantity with respect to an orthonormal polynomial systems is given. The expressions of moments of first- and second-order partial derivatives of a certain tensor field are obtained and this is also done for some important expressions required for constructing different variants of the thin body theory.

[1] Mikhail Nikabadze, Professor: Lomonosov Moscow State University, Leninskye Gory, RUSSIA (nikabadze@mail.ru).

[2] Tamar Moseshvili, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe str., GEORGIA (tamarmoseshvili@yahoo.com).

[3] Ketevan Tskhakaia, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe str., GEORGIA (spectri@gmail.com).

[4] Nodar Mardaleishvili, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe str., GEORGIA (nodarmard3@mail.ru).

[5] Armine Ulukhanyan, Ph.D.: Bauman Moscow State Technical University, 2-ya Baumanskaya str., RUSSIA (armine_msu@mail.ru), the author presented this contribution at the conference.

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Formulation of the Initial Boundery Velue Problems in the Theory of Multilayer Thermoelastic Thin Bodies in Moments. III

Mikhail Nikabadze, Tamar Moseshvili, Armine Ulukhanian, Ketevan Tskhakaia, Nodar Mardaleishvili

Abstract: Various variants of equations of motion in moments with respect to orthogonal polynomial systems are obtained. The interlayer conditions are written down under various connections of adjacent layers of a multilayer body. Formulation of the initial boundary velue problems in the theory of multilayer thermoelastic thin bodies in moments are given. Note that the analytic method with the use of the Legendre polynomial system in constructing the one-layer thin body theory and multilayer thin body theory can be successfully used in constructing any thin body theory. Despite this, the classic theories constructed by this method are far to be complete, and the more so, the micropolar theories and theories of other reology are.

[1)] Mikhail Nikabadze, Professor: Lomonosov Moscow State University, Department of Mechanics and Mathematics, Leninskie Gory, 1, Moscow, RUSSIA (nikabadze@mail.ru).

[2)] Tamar Moseshvili, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe street 59, Kutaisi 4600, GEORGIA (tamarmoseshvili@yahoo.com), the author presented this contribution at the conference.

[3)] Armine Ulukhanian, Ph.D.: Bauman Moscow State Technical University, Baumanskaya 2-ya, str., 5, Moscow 105005, RUSSIA (armine_msu@mail.ru).

[4)] Ketevan Tskhakaia, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe street 59, Kutaisi 4600, GEORGIA (spectri@gmail.com).

[5)] Nodar Mardaleishvili, Ph.D.: Akaki Tsereteli Kutaisi State University, Tamar Mephe street 59, Kutaisi 4600, GEORGIA (nodarmard3@mail.ru).

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3D crane model to dynamic analysis

Andrzej Nowak, Paweł Nowak, Łukasz Drąg

Abstract: The rigid finite element method (RFEM) and lumped masses for modelling crane dynamics is presented. The model takes into account the presence of large lifting movements of the crane, which is mounted on floating platform or vessel. The flexibility of the boom and A-frame are discretized by means of the RFEM, as well as the rope system, were taken into account. The model allows for simulation of the movements and loads of crane components with classic excitations (like external forces): by winch, by boom angle changing and/or by a base swing mechanism. The computer implementation of the model has confirmed its high numerical efficiency. This allows the model to be used in solving drive optimization of different cases by solving a dynamic optimization task. The essential element of optimization is the need to integrate the equations of motion of the system at every step of simulation.

[1)] Andrzej Nowak, Associate Professor: University of Bielsko-Biala, Faculty of Management and Transport, Department of Computer Modelling, ul. Willowa 2, 43-309 Bielsko-Biała, POLAND (a.nowak@ath.bielsko.pl), the author presented this contribution at the conference.

[2)] Paweł Nowak, M.Sc.: University of Bielsko-Biala, Faculty of Management and Transport, Department of Computer Modelling, ul. Willowa 2, 43-309 Bielsko-Biała, POLAND (pnowak@ath.bielsko.pl), the author presented this contribution at the conference.

[3)] Łukasz Drąg, Ph.D.: University of Bielsko-Biala, Faculty of Management and Transport, Department of Computer Modelling, ul. Willowa 2, 43-309 Bielsko-Biała, POLAND (ldrag@ath.bielsko.pl).

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Modelling of vibration and large deflections of lattice-boom structures of cranes by means of rigid finite element method

Andrzej Nowak, Paweł Nowak, Marek Metelski

Abstract: The rigid finite element method (RFEM) is the original Polish method of modelling slender systems. Structures with stable or changing configuration are modelled by means of this method. The RFEM is most often used to discretise flexible units of mechanisms and machines, ropes and risers, and dynamics of machine tools, as well as plates and shells. The method can also successfully be used to analyze large lattice-boom structures for deformations. The aim of this paper is to present a 3D model of a lattice-boom structure in which the RFEM is used to discretise the beam elements. The possibility of large deflections of the boom (range of several meters) was considered. The results of the own calculations (deflections, stresses, reaction forces), according to models of varying degrees of complexity, were compared with the results obtained in the professional FEM package Abaqus/CAE.

1) Andrzej Nowak, Associate Professor: University of Bielsko-Biala, Faculty of Management and Transport, Department of Computer Modelling, Willowa 2, 43-309 Bielsko-Biala, POLAND (a.nowak@ath.bielsko.pl), the author presented this contribution at the conference.

2) Paweł Nowak, M.Sc. (Ph.D. student): University of Bielsko-Biala, Faculty of Management and Transport, Department of Computer Modelling, Willowa 2, 43-309 Bielsko-Biala, POLAND (pnowak@ath.bielsko.pl), the author presented this contribution at the conference.

3) Marek Metelski, M.Sc.: PROTEA Sp. z o.o., Galaktyczna 30a, 80-299 Gdańsk, POLAND (marek.metelski@protea.pl).

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Application of Hilbert transform in detection flat places on tram wheels

Tomasz Nowakowski, Paweł Komorski, Grzegorz Marek Szymański, Franciszek Tomaszewski

Abstract: The development of urban rail transport in Poland in recent years has been associated to the access of city dwellers to the modern rolling stock. These rolling stock has to meet the increasingly stringent requirements of it's owners regarding the reliable execution of the transport process, as well as residents' demands for vibroacoustic comfort observed both in the passenger space and track surroundings. All of these activities are related to the reduction of adverse vibrations which may: reduce the durability of the individual components and structural junctions of the tram and generate excessive noise. In this case it is important to maintain the quality of the cooperation of vehicles and track, which revolves around the wheel-rail contact area. One of the main causes for increased vehicle-dependent dynamic impacts at the wheel-rail contact area are irregularities on the rolling surface of the wheels, including flat places. The paper presents the problems of the phenomena which are generated during passing of a tram with flat places on the wheels. Experimental research on the phenomena carried out under real operating conditions is also presented. The purpose of the study was to verify the applicability of Hilbert's transform method in the frequency domain on signals from rails for the purpose of identifying flat places in the vehicle. Finally, a universal algorithm for identifying these irregularities for light rail vehicles has been developed.

[1] Tomasz Nowakowski, M.Sc. (Ph.D. student): Poznan Univeristy of Technology, Department of Rail Vehicle, Marii Sklodowskiej Curie 5, 60-965, POLAND (tomasz.nowakowski@put.poznan.pl), the author presented this contribution at the conference.

[2] Paweł Komorski, M.Sc. (Ph.D. student): Poznan Univeristy of Technology, Department of Rail Vehicle, Marii Sklodowskiej Curie 5, 60-965, POLAND (pawel.komorski@put.poznan.pl).

[3] Grzegorz Marek Szymański, Assistant Professor: Poznan Univeristy of Technology, Department of Rail Vehicle, Marii Sklodowskiej Curie 5, 60-965, POLAND (grzegorz.m.szymanski@put.poznan.pl).

[4] Franciszek Tomaszewski, Professor: Poznan Univeristy of Technology, Department of Rail Vehicle, Marii Sklodowskiej Curie 5, 60-965, POLAND (franciszek.tomaszewski@put.poznan.pl).

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Mathematical models of two parametric pendulums with modulated length

Paweł Olejnik, Jan Awrejcewicz, Michal Fečkan

Abstract: Dynamics of a parametric pendulum excited by a wave-modulated discrete function of its length is investigated both analytically and with the use of computer simulations. An existence results of almost periodic sequences of ordinary differential equations with linear boundary value conditions are observed. Behavior of an exemplary oscillator subjected to both an almost-periodic step elongation and forcing, analogously tends to almost-periodic motions. Finally, conditions for that synchronization as well as numerical trajectories on phase planes and Poincaré sections are presented.

1) Paweł Olejnik, Associate Professor: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (pawel.olejnik@p.lodz.pl).

2) Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

3) Michal Fečkan, Professor: Department of Mathematical Analysis and Numerical Mathematics, Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Mlynská Dolina, 842 48 Bratislava, SLOVAKIA (michal.feckan@gmail.com).

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Study of the dynamics of two societies with economic exchange

Gerard Olivar Tost, Jorge Armando Amador Moncada, Héctor Andrés Granada Díaz

Abstract: The results obtained so far in the literature show the dynamic interaction between population and renewable resources in an isolated community. These results suggest that the success or failure of a society depends on the management of these resources; That is, the long-term sustainable levels of both population and resources depend on the values of the system parameters. The objective of this work is to introduce an economic interaction between two societies and to study the impact it has on development paths. The proposed model implies that both regions can exchange a certain amount of their respective natural resources under the assumption that different regions have different economic activities; That is, they can exploit various natural resources and have different agricultural activities. This exchange allows meeting the energy requirements of the population in each of the regions without overexploiting the resources themselves. This dynamic can be thought of as an export-import process. In this paper, rectangular control areas defined by population and resource thresholds were used. However other forms and other different conditions could be utilized to obtain the desired behavior. Since the system is very sensitive to the initial conditions and parameter values, a more general dynamic analysis is performed using branch diagrams and Filippov's theory.

[1] Gerard Olivar Tost, Professor: Universidad Nacional de Colombia - Manizales, 170003, COLOMBIA (golivart@unal.edu.co), the author presented this contribution at the conference.

[2] Jorge Armando Amador Moncada, M.Sc. (Ph.D. student): Universidad Nacional de Colombia - Manizales, Campus La Nubia, Manizales, COLOMBIA (jaamadorm@unal.edu.co).

[3] Héctor Andrés Granada Díaz, Associate Professor: University of Tolima, Ibagué, COLOMBIA (hagranadad@ut.edu.co).

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A piecewise-smooth control of dengue

Gerard Olivar Tost, Luis Eduardo López Montenegro, Aníbal Muñoz Loaiza

Abstract: The following research focuses on mathematical modeling of the transmission and control of Dengue fever by means of systems of nonlinear ordinary differential equations. Initially, a mathematical model is formulated to represent the transmission of the disease to the human population considering breeding grounds where mosquito proliferates, the phases of evolution of the mosquito, and the human population. The model comprises a nonlinear system of nine differential equations where each equation represents the variation of a single subpopulation. Based on the original model, a system of twelve differential equations is formulated representing the dynamic transmission and constant control of the disease. In this model, a biological control is applied using the Wolbachia bacteria, which inhibits the transmission of the virus from an infected mosquito to humans. Finally, a new model with biological control is developed from the original two-dimensional model. We consider a constant control and derive a piecewise smooth dynamical system, in which a non-smooth local bifurcation of codimension 1 that determines the collision of equilibrium points on the discontinuity boundary. This bifurcation occurs when the parameter R0, which represents the Basic Reproduction Number of Dengue fever, is varied.

[1] Gerard Olivar Tost, Professor: Universidad Nacional de Colombia - Manizales, Campus La Nubia, Manizales, COLOMBIA (golivart@unal.edu.co), the author presented this contribution at the conference.

[2] Luis Eduardo López Montenegro, M.Sc. (Ph.D. student): Universidad Nacional de Colombia - Manizales, Campus La Nubia, COLOMBIA (lelopezm@unal.edu.co).

[3] Aníbal Muñoz Loaiza, Associate Professor: Universidad del Quindío, Armenia, COLOMBIA (anibalml@hotmail.com).

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On the Stability and Ultimate Boundedness of Solutions for certain Third Order Non-Autonomous Delay Differential Equations

Akinwale Olutimo

Abstract: Sufficient conditions are established to ensure the uniform asymptotic stability and uniform ultimate boundedness o solutions of certain third order nonlinear non-autonomous delay differential equations. By using Lyapunov's second or direct method, we obtain new results on the subject which improve the well known results in the literature with particular cases of the equation considered for the ultimate boundedness and asymptotic behavior of solutions using complete Lyapunov functions. Our aim is to further extend and improve on the results to more general equation considered for which the forcing and nonlinear terms depend on certain variables and deviating arguments.

[1)] Akinwale Olutimo, Ph.D.: Lagos State University, Nigeria, Department of Mathematics, Lagos State University, Badagary Expresway, Ojo, Lagos. Nigeria., NIGERIA (aolutimo@yahoo.com), the author presented this contribution at the conference.

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Dynamic load - carrying capacity of ribbed plates

Sławomir Onopiuk, Adam Stolarski

Abstract: The paper contains the analysis of influence of the discrete stiffening on dynamic load-carrying capacity of inelastic rectangular stiffened plates. The computational analysis of vibration such plates, induced by pressure impulse, was presented in the paper. The method of the structural dynamic analysis was developed using the principles of the finite element method. Using proper kinematics hypotheses for the plate and for the ribs three-dimensional deformation problem of the stiffened plate was reduced to two-dimensional. The computational model of the stiffened plate results from a division into two-dimensional rectangular plate elements and into standard bar elements with 6 degrees of freedom in FEM nodes. The cross-section of the stiffened plate was divided into layers along their thickness. The elastic/visco-perfectly plastic model of the material, modified by the delayed yield effect, was used for the description of the material properties. The modification of Perzyna's elastic-viscoplasticity constitutive equations is founded on their integrating with initial condition as the dynamic yield limit, which is determinate on the base of the Campbell`s dynamic yield criterion. The numerical results for the simply supported and fully clamped, stiffened rectangular plates made of mild steel are given. The results, which indicate the influence of the stiffening ribs on the displacements and the character of dynamic deformation processes of the plates, were studied and discussed in comparison with results for homogeneous plates.

[1] Sławomir Onopiuk, Ph.D.: Military University od Technology, Department of Civil Engineering and Geodesy, 2 Kaliskiego Street, 00-908 Warsaw-49, POLAND (slawomir.onopiuk@wat.edu.pl), the author presented this contribution at the conference.

[2] Adam Stolarski, Professor: Military University of Technology, Department of Civil Engineering and Geodesy, 2 Kaliskiego Street, 00-908 Warszaw - 49, POLAND (adam.stolarski@wat.edu.pl).

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Analysis of vibrations of an oscillator using statistical series

Agnieszka Ozga

Abstract: Solving of a problem for systems subjected to random series of pulses is aimed at determining an approximate distribution of the amplitudes of stochastic pulses forcing vibrations of an oscillator with damping. The difficulties that arose in connection with interpretation of experimental data forced us to search for a mathematical model, where algorithms were applied based on precise solutions. Under appropriate assumptions regarding random variables: the time of action of a pulse and their amplitude values, the deviation of the oscillator from its balanced position is a process which, in the limit as time tends to infinity, is stationary and ergodic. At the first stage of the simulation study discussed in this paper, classification of the elements of the structure of statistical series is necessary. The work was inspired by attempts at constructing a measuring device that would control granularity of the medium in a dust pipeline. The device had to signal appearance of big or small particles in excessive quantity in the transported dust.

[1)] Agnieszka Ozga, Ph.D.: AGH University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, POLAND (aozga@agh.edu.pl), the author presented this contribution at the conference.

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On the use of a Tuned Mass Damper (TMD) to control the seismic response of a cantilevered highway sign support

Fabio Paiva, Rui Barros

Abstract: This work contributes to a better understanding of the seismic response of cantilevered sign support structures used in highways. For such, the present paper presents a comparative study of the seismic response of a cantilever sign support when subjected to earthquakes with and without a tuned mass damper (TMD). The paper starts with a brief summary of different methodologies to assess seismic input on structures. Some guidelines on the considered procedure for the selection of appropriate suites of accelerograms complying with Eurocode 8 prescription for Portugal (Faro) are presented. To mitigate earthquakes dynamic effects, the sign support structure can be equipped with a TMD with proven efficiency and ease of application and modelling, for the out-of-plane vibration control of the sign support in terms of displacements and accelerations reductions when the structure is subjected to series of real accelerograms compatible with the earthquake scenario of Eurocode 8-1.

[1] Fabio Paiva, M.Sc. (Ph.D. student): FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division, Rua Roberto Frias, PORTO 4200-465, PORTUGAL (fmp@fe.up.pt).

[2] Rui Barros, Professor: FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division (VAT number for accounting purposes: 501 413 197), Rua Roberto Frias, PORTO 4200-465, PORTUGAL (rcb@fe.up.pt), the author presented this contribution at the conference.

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Model of kinetic energy recuperation system for city bus

Tomasz Pałczyński, Jakub Łagodzińdki

Abstract: Energy consumption is a significant issue for public transport providers, because of the relatively high vehicle mass and the huge amounts of energy lost overcoming inertia forces. In city buses, the kinetic braking energy is usually transformed into waste heat and cannot be recovered. In this paper, we propose a system to enable the recovery of braking energy in city buses using a Kinetic Energy Recuperation System (KERS). The main assumptions of the system were elaborated in a model of city bus dynamics developed by the authors, based on the real driving cycles of buses in Lodz. The following components were modelled in the Matlab/Simulink model: the flywheel supported in an active magnetic bearing, two reverse electric motors, high ratio gears, the control system. The main objective of the control system was to balance the braking and drive system with optimal usage of the flywheel system. The charging and discharging phases of the KERS and the energy stored were analyzed. The fuel consumption savings were calculated by a comparison with normal city bus driving cycles without KERS. The presented model could be a very useful tool for research into city bus dynamics with KERS systems, providing a wide range of operational parameters for city bus powertrains.

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[1] Tomasz Pałczyński, Ph.D.: Lodz Univesity of Technology, Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (tomasz.palczynski@p.lodz.pl), the author presented this contribution at the conference.

[2] Jakub Łagodzińdki, Ph.D.: Lodz Univesity of Technology, Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (jakub.lagodzinski@p.lodz.pl).

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CFD predict dynamic properties (stiffness and dumping) of long labyrinth seals in axial balance drum for high frequency pump

Adam Papierski, Andrzej Błaszczyk, Mariusz Susik

Abstract: Rotordynamic instability due to fluid flow in seals is a well-known phenomenon that can occur in pumps, steam turbines and compressors. While analysis methods using bulk-flow equations are computationally efficient and can predict dynamic properties fairly well for short seals, they often lack accuracy in cases of seals with complex geometry or with large aspect ratios (L/D above 1.0). This paper presents the linearized rotordynamic coefficients for a liquid seal with complex geometry subjected to incompressible turbulent flow. The fluid-induced forces acting on the rotor are calculated by means of a three-dimensional computational fluid dynamics (3D-CFD) analysis, and are then expressed in terms of equivalent linearized stiffness, damping, and fluid inertia coefficients. The results of rotor dynamic analysis using the coefficients derived from CFD approach

[1] Adam Papierski, Associate Professor: Lodz University of Technology Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (adam.papierski@p.lodz.pl), the author presented this contribution at the conference.

[2] Andrzej Błaszczyk, Professor: Lodz University of Technology Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (andrzej.blaszczyk@p.lodz.pl).

[3] Mariusz Susik, Ph.D.: Lodz University of Technology Institute of Turbomachinery, 90 - 924 Łódź, 219/223 Wólczańska Street, POLAND (mariusz.susik@p.lodz.pl).

paper id: BIF132

Chaotic dynamics of a two-layer beam set, described by mathematical models of the first and second approximation

Irina V. Papkova, Olga A. Saltykova, Jan Awrejcewicz, Vadim A. Krysko

Abstract: Chaotic dynamics of a two beams set with a small clearance between them is investigated. Such a clearance is adopted for problems where geometric nonlinearity can be ignored. In the studied case each of the beams may exhibit vibrations with an amplitude of no more than 0.25 of the beam height. The transverse uniformly distributed harmonic load acts on the outer beam (beam 1). The contact interaction is accounted through the Kantor model. Two cases are considered: (i) beam 1 is described by the first approximation model, and beam 2 is governed by the second approximation model; (ii) beam 1 is described by a second approximation model, whereas beam 2 by a first approximation model. The problem is solved as a system with an infinite number of degrees of freedom. The finite difference method and Runge-Kutta type methods are used. The analysis of the obtained results is carried out by the methods of nonlinear dynamics and the qualitative theory of differential equations. The problems were solved both in geometrically linear and nonlinear formulations. The solution takes into account the constructive nonlinearity. To obtain reliable results, we calculated the values of the largest Lyapunov exponent using three different algorithms, and hence our results can be treated as true ones.
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[1] Irina V. Papkova, Associate Professor: Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (ikravzova@mail.ru).

[2] Olga A. Saltykova, Associate Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION, and Cybernetic Institute, National Research Tomsk Polytechnic University, 634050 Tomsk, Lenin Avenue, 30, RUSSIAN FEDERATION (olga_a_saltykova@mail.ru).

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl), the author presented this contribution at the conference.

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru).

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Enhancing the stability of the boost converter through saltation matrix

Arnold Perez, Guillermo Muñoz, Fabiola Angulo

Abstract: It is well known that using current mode control, the boost power converter requires a compensation ramp when the voltage gain is greater than twice the input voltage. However, as the slope of the compensation ramp increases overcompensation occurs, and the system response is slower when changes are applied, mainly if the converter feeds light loads. In this work, a new method to tune the parameters of the compensator in a peak-current mode-controlled converter is derived using information of the saltation matrix, particularly its induced norm. At the beginning, the tuning parameters obtained from a classical method are considered, including the slope of the compensation ramp, and after, analyzing the norm of the saltation matrix we obtain a new set of parameters which provides a very wide range to guarantee stability of the period-1 orbit. The method is validated by mean of numerical and analytical solutions.

[1] Arnold Perez, B.A. (M.Sc. student): Universidad Nacional de Colombia Sede Manizales, Carrera 27 No. 64 60, Manizales, COLOMBIA (aperezco@unal.edu.co).

[2] Guillermo Muñoz, M.Sc. (Ph.D. student): Universidad Nacional de Colombia Sede Manizales, Carrera 27 No. 64 60, Manizales, COLOMBIA (jgmunozc@unal.edu.co).

[3] Fabiola Angulo, Professor: Universidad Nacional de Colombia Sede Manizales, Carrera 27 No. 64 60, Manizales, COLOMBIA (fangulog@unal.edu.co), the author presented this contribution at the conference.

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Nullspace method for the uniqueness analysis of reaction and driving forces in rigid multibody systems with redundant nonholonomic constraints

Marcin Pękal, Janusz Frączek, Marek Wojtyra

Abstract: Redundantly constrained mechanisms are commonly used. Such systems, modelled as rigid multibody systems (MBS), have – in general – non-unique reactions. This may lead to unrealistic (arbitrary) simulation results, e.g. when friction is considered. However, some of the reactions may be uniquely determined. Uniqueness of reactions may be examined by using Jacobian-based method or kinetostatics-based method. Moreover, numerical methods utilizing direct sum or nullspace approach may be used to determine which reactions/drives are unique. Analogous problem of indeterminacy is also present in overactuated MBS. In this paper, the Jacobian-based nullspace method for the uniqueness analysis of reactions and driving forces for nonholonomic MBS is developed and discussed. The method may be used for planar or spatial systems described by absolute or natural coordinates. The approach may be used only for MBS with linear (Pfaffian) nonholonomic constraints. In order to illustrate the proposed approach, exemplary planar nonholonomic system with three actuation cases, i.e. non-actuated, fully actuated and overactuated MBS is considered.

[1] Marcin Pękal, M.Sc. (Ph.D. student): Institute of Aeronautics and Applied Mechanics, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (mpekal@meil.pw.edu.pl), the author presented this contribution at the conference.

[2] Janusz Frączek, Professor: Institute of Aeronautics and Applied Mechanics, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (jfraczek@meil.pw.edu.pl).

[3] Marek Wojtyra, Associate Professor: Institute of Aeronautics and Applied Mechanics, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (mwojtyra@meil.pw.edu.pl).

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Influence of plain journal bearing parameters on the rotor nonlinear behaviour

Pavel Polach, Luboš Smolík, Jan Rendl, Michal Hajžman

Abstract: Dynamics of rotors supported by journal bearings is a well-known and interesting branch of nonlinear computational mechanics. There is a fluid film utilized in order to generate appropriate bearing forces to support a rotor. Rotating structures can be described by lumped parameter models or by continuous models discretized using the finite element method. The model of bearing forces is related to the solution of the Reynolds equation, which is a partial differential equation for the unknown pressure field. This paper deals with the investigation of rotor nonlinear behaviour with respect to the design parameters of plain journal bearings. The Reynolds equation is solved numerically employing a verified in-house solver based on finite differences. The pressure distribution serves for the calculation of nonlinear bearing forces acting on a rotor. Bearing forces together with the model of a rotating structure form equations of motion of the whole system as a set of ordinary differential equations. The nonlinear rotor behaviour is solved by direct numerical integration of equations of motion which is a suitable way for the evaluation of possible instabilities with respect to the bearing parameters. Obtained numerical results are compared with dynamical behaviour calculated using a commercial simulation software.

1) Pavel Polach, Ph.D.: Research and Testing Institute Plzen, Tylova 1581/46, 301 00 Plzen, CZECH REPUBLIC (polach@vzuplzen.cz), the author presented this contribution at the conference.

2) Luboš Smolík, M.Sc. (Ph.D. student): New Technologies for the Information Society, European Centre of Excellence, University of West Bohemia, Univerzitní 8, 306 14 Plzen, CZECH REPUBLIC (carlist@ntis.zcu.cz).

3) Jan Rendl, M.Sc. (Ph.D. student): New Technologies for the Information Society, European Centre of Excellence, University of West Bohemia, Univerzitní 8, 306 14 Plzen, CZECH REPUBLIC (rendlj@students.zcu.cz).

4) Michal Hajžman, Ph.D.: New Technologies for the Information Society, European Centre of Excellence, University of West Bohemia, Univerzitní 8, 306 14 Plzen, CZECH REPUBLIC (mhajzman@kme.zcu.cz).

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Modeling and experimental investigation of dynamics of two pendulums elastically coupled and driven by magnetic field

Krystian Polczyński, Grzegorz Wasilewski, Jan Awrejcewicz, Adam Wijata

Abstract: In this work both experimental and simulation results of a study of two physical pendulums coupled through an elastic torsional element are presented. Permanent magnets are attached to the pendulums ends and the system motion is forced by a variable magnetic field with a help of the exciting coils. The electric current signal possesses rectangular shape, and the experimental investigations have been carried out for different frequencies and amplitudes of the current signal (excitation). The derived mathematical model has been validated experimentally taking into account its experimentally confirmed parameters. The magnetic fields interactions have been reduced to the moment of a force based on the experimentally obtained data. A few of the dynamically different cases are studied including the elastically coupled/un-coupled pendulums and the system excitation carried out either by one or two pendulums. Regular and chaotic dynamics of this mechatronic system have been detected, illustrated and discussed.

[1)] Krystian Polczyński, B.A. (M.Sc. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics,, Stefanowskiego 1/15, 90-924, Lodz, POLAND (krystia3n@gmail.com), the author presented this contribution at the conference.

[2)] Grzegorz Wasilewski, Ph.D.: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Łąkowa 19/21, POLSKA (grzegorz.wasilewski@p.lodz.pl).

[3)] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[4)] Adam Wijata, M.Sc. (Ph.D. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (adam.wijata@p.lodz.pl).

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paper id: ENG240

Impact Models of WC-Co composite

Eligiusz Postek, Tomasz Sadowski

Abstract: The main goal of the paper is the presentation of the application of peridynamics for evaluation of the WC-Co samples under impact load. The method is versatile in the case brittle materials. WC/Co ceramic metal-matrix composites are characterised by very high mechanical properties that allow for application of the composites mostly in production of different types of cutting tools. Combining a phase of brittle hard wolfram carbide (WC) grains with a metallic interface of cobalt (Co) that exhibits plastic properties geometrically complex microstructure with significantly different mechanical properties of the phases is created. The presence of the elastic-plastic interface material that is Co binder, the different kind of defects are initiated. The defects are mostly due to the material porosity. During material loading pores start to coalesce and finally one can observe creation of microcracks system distributed along interfaces. The system of microcracks is crucial for the load carrying capacity of the material.

[1] Eligiusz Postek, Ph.D.: Institute of Fundamental Technological Research Polish Academy of Sciences, Department of Information and Computational Science, Pawinskiego 5B, 02-106 Warsaw, POLAND (epostek@ippt.gov.pl).

[2] Tomasz Sadowski, Professor: Lublin University of Technology, Department of Solid Mechanics, Nadbystrzycka 40, 20-618 Lublin, POLAND (t.sadowski@pollub.pl), the author presented this contribution at the conference.

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paper id: MAT88

An analysis of dynamics of truck with trailer

Adam Przemyk, Szymon Tengler, Andrzej Harlecki

Abstract: Results of an analysis of dynamics of truck with a trailer are presented in the paper. A mathematical model of a truck with trailer, constituting a multibody system was developed by using formalism of Lagrange's equations, based on the joint coordinates and matrices of homogeneous transformations taken from robotics. In the adopted procedure it has been assumed that the modeled system can move over the road with unevenness of a specific shape. Within the computer simulations performed behavior of the modeled system was studied in the road traffic conditions while performing typical road maneuvers, and changing design parameters and load of the trailer. The developed mathematical model can be treated as a virtual prototype of the system in question. According to the authors the proposed method can have practical significance and it can be used in designing the trucks with trailer. Lots of significant design proposals can be formulated on basis of the results of the performed simulations, and they can become the basis for making real trail prototypes.

[1)] Adam Przemyk, M.Sc. (Ph.D. student): University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (a.przemyk@gmail.com), the author presented this contribution at the conference.

[2)] Szymon Tengler, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (stengler@ath.bielsko.pl).

[3)] Andrzej Harlecki, Professor: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (aharlecki@ath.bielsko.pl).

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paper id: VIB15

Flutter running waves in turbine blades cascade

Ladislav Pust, Ludek Pesek, Miroslav Byrtus

Abstract: The existence of flutter running waves has been often observed at experimental investigation of turbine blades cascade. The presented paper is an attempt to explain origin and behaviour of running flutter waves in the rotating blade cascade excited by steam flow from the stationary bladed disk. One of the reasons for existence of running waves are the running periodic forces from steam wakes due to different numbers of blades of stationary and rotating wheels. On a computational model of turbine disk with 10 blades there are shown properties – velocities, directions and modes – of these forced running waves. Interaction of this kind of forced excitation with aero-elastic self-excitation – flutter – causes origin of flutter running waves. These flutter waves will be analysed in the paper for several kinds and combinations of aero-elastic self-excitations.

1) Ladislav Pust, Associate Professor: Institute of Thermomechanics AS CR, v.v.i., Dolejskova 5, Prague 8, CZECH REPUBLIC (pust@it.cas.cz), the author presented this contribution at the conference.

2) Ludek Pesek, Ph.D.: Institute of Thermomechanics AS CR, v.v.i., Dolejskova 5, Prague 8, CZECH REPUBLIC (pesek@it.cas.cz).

3) Miroslav Byrtus, Ph.D.: ZCU Plzen, Univerzitní 2732/8, 301 00 Plzeň 3, CZECH REPUBLIC (mbyrtus@rice.zcu.cz).

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paper id: OPT234

Optimal control of hybrid systems with sliding modes

Radosław Pytlak, Damian Suski, Tomasz Tarnawski

Abstract: This paper concerns the numerical procedure for solving hybrid optimal control problems in the case the sliding modes are present. The presented procedure posseses the features, which distinguish it from existing procedures. The first feature is modeling and simulating the sliding mode by differential-algebraic equations (DAEs) which helps to automatically track the sliding motion surface. The second feature is the calculation of gradients of the cost and constraints functions with the help of adjoint equations. The adjoint equations presented in the paper take into account sliding motion as well as jump conditions at transition instants. The third feature is the integration of the presented procedure into the Interactive Dynamic Optimization Server (IDOS), which is an environment for solving different optimal control problems. IDOS user interface relies on Dynamic Optimization Modeling Language (DOML), which is an extension of Modelica language. The fourth feature is that the proposed algorithm is globally convergent under standard regularity assumptions. It seems to be the first such method for optimal control problems which can handle sliding modes of hybrid systems. The procedure have been tested and the results for two exemplary optimal control problems are presented. One of them concerns optimal control of a mechanical system with dry friction.

[1] Radosław Pytlak, Professor: Warsaw University of Technology, Faculty of Mathematics and Information Science, 00-662 Warsaw, ul. Koszykowa 75, POLAND (r.pytlak@mini.pw.edu.pl), the author presented this contribution at the conference.

[2] Damian Suski, M.Sc. (Ph.D. student): Warsaw University of Technology, Department of Mechatronics, 02-525 Warsaw, ul. Sw. Andrzeja Boboli 8, POLAND (d.suski@mchtr.pw.edu.pl).

[3] Tomasz Tarnawski, Ph.D.: Kozminski University, Department of Quantitative Methods and Information Technology, 03-301 Warsaw, POLAND (ttarnawski@kozminski.edu.pl).

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paper id: LIF160

Microtubule dynamics in coupled fields

Andrzej Radowicz, Agnieszka Radowicz- Chil

Abstract: Microtubules (MTs) are long hollow cylindrical macromolecules about 25 nm in diameter served as a major component of cytoskeleton in eukaryotic cells. The single MT structure is formed of tubulin heterodimers and is highly charged polar polyelectrolyte. Dimers in MT possess dipole moments capable of amplifying electromagnetic signals. MT performs also a crucial role in producing mechanical capacity in order to maintain cellular motion, cellular division, gene expression, motility, etc. The cylindrical MT may vibrate or be the medium for propagation of electro-magneto-elastic signals [Y. Sirenko 1996, M. del Rocio Cantero at al. 2016]. In such case MT is an good example of electro-magneto-mechanical system being far from thermodynamic equilibrium, as we met in biological systems [J. Pokorny 2013]. Up till now, considerable progress has been made during last decades in understanding the relation between MT material properties and their ability to carry out several functions in cell [O. Kucera at al. 2017]. This work is an essay to describe the distribution of electro-magneto-elastic coupled fields excited by the general line source in anisotropic strip with piezoelectric, piezomagnetic and electromagnetic couplings. As an example of such strip part of MT wall is taken, consisting of polarized dimers. The problem is solved for the strip with free surfaces, immersed in isotropic medium. The analysis is accomplished in an implicit form, expressed in terms of eigenvectors and eigenvalues.

[1] Andrzej Radowicz, Professor: Kielce University of Technology, Kielce , Al. 1000-lecia PP, POLAND (radowicz@tu.kielce.pl), the author presented this contribution at the conference.

[2] Agnieszka Radowicz- Chil, Ph.D.: Holycross Cancer Center, Artwinskiego 3 Kielce, POLAND (agarad@poczta.fm).

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paper id: CON354

Parameter optimization for minimizing vibrations in milling process

João Ribeiro, Manuel Braz César, Ana Pereira, Rui Barros

Abstract: Controlling or minimizing vibrations in milling machines represents one of the biggest challenges industry face nowadays to achieve the required work-piece surface quality. Advanced CNC machines are often used to produce high precision machined work-pieces with superior surface finish. However, chatter or harmful self-excited vibrations can occur during cutting processes which can limit the performance of the machine itself and the quality of the machined product. This paper presents some optimization methods to minimize vibrations using milling parameters such as cutting and feed speed, axial and radial penetration. An experimental research is also carried out to evaluate the vibration of the tool lead of a CNC machine during the cutting process of a metallic alloy work-piece. Finally, the optimal solution to improve the performance of the milling operation is discussed and assessed.

1) João Ribeiro, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (jribeiro@ipb.pt).

2) Manuel Braz César, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (brazcesar@ipb.pt), the author presented this contribution at the conference.

3) Ana Pereira, Assistant Professor: Polytechnic Institute of Bragança, Campus de Santa Apolónia - 5300-253 Bragança, PORTUGAL (apereira@ipb.pt).

4) Rui Barros, Associate Professor: Faculty of Engineering of the University of Porto, R. Dr. Roberto Frias, 4200-465 Porto, PORTUGAL (rcb@fe.up.pt).

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Recognition of periodical solutions of dynamic systems with special Hamiltonian structure using the adaptive bacterial foraging optimization algorithm

Constantin Ruchkin

Abstract: In this paper we consider the problem of detection periodic solutions of dynamical systems with a special Hamiltonian structure. The detection of periodic solutions of dynamical systems is carried out by means of an analysis of the Poincaré sections of phase space on the plane for the presence of closed trajectories of a special type on these sections. In most regular cases, the trajectories under investigation represent special geometric shapes like circles, an ellipse, etc. We have classified these shapes. We use a recently developed swarm intelligence technique, known as the Bacterial Foraging Optimization Algorithm (BFOA) for detecting circles and etc. from digital images. An adaptive version of BFOA is then applied to search the entire edge-map for circular shape. Each bacterium here models a trial circle and a fuzzy objective function has been derived over the domain of such trial circles. The better a test circle approximates the actual edge-circle, the lesser becomes the value of this function. Minimization of the objective function with BFOA ultimately leads to the fast and robust extraction of circular shapes from the given image. In the work the conditions of applicability of this approach for different geometric forms are also considered. The parameters under which the method will give the most optimal result are calculated. A comparison Bacterial Foraging Optimization Algorithm with the Hough method is made.

[1)] Constantin Ruchkin, Associate Professor: Donetsk National Technical University, Donetsk, st. Artem, 58, UKRAINE (c_ruchkin@mail.ru), the author presented this contribution at the conference.

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paper id: BIF274

Nonlinear aspects of the human middle ear

Rafal Rusinek, Krzysztof Kecik

Abstract: A biomechanical system of the human middle ear consists of the tympanic membrane, three ossicles connected each other and with temporal bone by means of ligaments and tendons. The intact middle ear is weakly nonlinear by nature. That causes an interesting dynamical behaviour. However, sometimes the middle ear can have dysfunctions which should be treated with the help of prostheses. In this contribution we propose the middle ear prosthesis made of the shape memory alloy. This kind of the prosthesis improves its implementation during surgical operation but can lead to strongly nonlinear behaviour for the sake of pseudoelastic effect. Therefore, an analytical and a numerical study is presented to find all types of possible solutions, regular and irregular ones. ACKNOWLEDGEMENT The work is financially supported under the project of National Science Centre (Poland) no. 2014/13/B/ST8/04047.

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1) Rafal Rusinek, Associate Professor: Lublin University of Technology, Nadbystrzycka 38D lublin, POLAND (r.rusinek@pollub.pl), the author presented this contribution at the conference.

2) Krzysztof Kecik, Assistant Professor: Lublin University of Technology, Nadbystrzycka 38D lublin, POLAND (k.kecik@pollub.pl).

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paper id: BIF83

Theoretical and experimental investigation of nonlinear dynamical features in a MEMS device electrically actuated

Laura Ruzziconi, Nizar Jaber, Lakshmoji Kosuru, Mohammed L. Bellaredj, Stefano Lenci, Mohammad Younis

Abstract: We consider a clamped-clamped microbeam electrically actuated. Experimental tests are performed. The microbeam is perfectly straight. The first three experimental natural frequencies are detected and several backward and forward frequency sweeps are acquired. Nonresonant and the resonant branches coexist. They undergo bending toward higher frequencies values, which is a feature not particularly common in MEMS. Experimental behavior charts are obtained where the curves of experimental appearance and/or disappearance of the attractors are reported. After extracting the unknown parameters, a single mode Galerkin reduced-order model is derived. To enhance the computational efficiency, the contribution of the electric force term is computed in advance and stored in a table. Extensive numerical simulations are performed, both from a local and global perspective. The model is observed to catch all the main nonlinear features of the device response and provide a satisfactory agreement with the experimental data. The overall scenario is explored when both the frequency and the electrodynamic voltage are varied.

1) Laura Ruzziconi, Assistant Professor: eCampus University, Faculty of Engineering, 22060 Novedrate, ITALY (laura.ruzziconi@gmail.com), the author presented this contribution at the conference.

2) Nizar Jaber, Ph.D.: King Abdullah University of Science and Technology (KAUST), Physical Sciences and Engineering Division, Thuwal 23955-6900, SAUDI ARABIA (nizar.jaber@kaust.edu.sa).

3) Lakshmoji Kosuru, Ph.D.: King Abdullah University of Science and Technology (KAUST), Physical Sciences and Engineering Division, Thuwal 23955-6900, SAUDI ARABIA (lakshmoji.kosuru@kaust.edu.sa).

4) Mohammed L. Bellaredj, Ph.D.: King Abdullah University of Science and Technology (KAUST), Physical Sciences and Engineering Division, Thuwal 23955-6900, SAUDI ARABIA (bellaredj1_fayal@yahoo.fr).

5) Stefano Lenci, Professor: Polytechnic University of Marche, Department of Civil and Building Engineering, and Architecture, via Brecce Bianche, 60131 Ancona, ITALY (lenci@univpm.it).

6) Mohammad Younis, Associate Professor: King Abdullah University of Science and Technology (KAUST), Physical Sciences and Engineering Division, Thuwal 23955-6900, SAUDI ARABIA (Mohammad.Younis@kaust.edu.sa).

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paper id: VIB206

Dynamics and effectiveness of Villari effect in magnetostrictive composite beam in the presence of magnetic field

Andrzej Rysak

Abstract: The aim of the study is to investigate the dynamic magnetization of the magnetostrictive beam with the neutral axis shifted, subjected to nonlinear perturbations and to the external magnetic field. We present the results of experimental tests of the hybrid composite beam system, formed by the coupling of the magnetostrictive and aluminum cantilever. The investigated system is attached to the handle which is kinematically excited by shaker. Hybrid configuration of the system was created by adding a piezoelectric patch and an electromagnetic coil to the mechanical part. Both these elements were placed near the handle holding the beam. In the experiment, the voltages generated by the coil and piezo element were measured in parallel with the excitation velocity. To characterize the system properties, we analyse the time series, frequency characteristics, FFT spectra and magnetization hysteresis. By comparing the results obtained under different conditions of the system operation, we can assess the influence of the non-linear disturbances and the external magnetic field on the dynamics of the Villari phenomenon.

[1)] Andrzej Rysak, Ph.D.: Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, POLAND (a.rysak@pollub.pl), the author presented this contribution at the conference.

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Study of the high-amplitude solutions in the system of magnetic sliding oscillator with many degrees of freedom

Andrzej Rysak, Konrad Chwełatiuk

Abstract: Magnetic interactions are strongly non-linear, especially for small distances between magnets. Their implementation to the oscillator gives it the ability to display complex non-linear and chaotic behaviours. These phenomena under certain conditions can lead to widening of the vibration bandwidth of the system which in the case of energy harvesting systems increases their efficiency, especially under varying excitation conditions. In this paper we compare the numerical and experimental study of different systems of longitudinal magnetic oscillators with one and many degrees of freedom. Tested oscillator configurations differ in magnet parameters and system rigidity. In systems modelling we look for conditions in which the high-amplitude solutions occur over a wide frequency range. Predictions of models are next verified in experimental investigations.

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[1] Andrzej Rysak, Ph.D.: Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, POLAND (a.rysak@pollub.pl), the author presented this contribution at the conference.

[2] Konrad Chwełatiuk, M.Sc.: Lublin University of Technology, Nadbystrzycka 36, 20-618 Lublin, POLAND (chwela16@gmail.com).

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Signal prediction in bilateral teleoperation with force-feedback

Mateusz Saków, Krzysztof Marchelek, Arkadiusz Parus, Mirosław Pajor, Karol Miądlicki

Abstract: Today's world is full of devices being controlled by a joystick, a keyboard or other remote control. From early 60's of the previous century, research is being carried out to obtain remote device operation. Remote devices like bilateral teleoperation systems with force-feedback, undoubtedly are the future development of the robotics. Unfortunately, teleoperators are strongly affected by the time delay which has a crucial impact on the stability and force-feedback channel transparency. The research addresses the transport delay problem in a sensor-less control scheme based on a inverse model used for environmental force estimation. The dynamic inverse model used in the control unit was extended with special transmittances to overcome the transport delay problem. The transmittance which is a model-free prediction block, is characterized by a strongly linear and positive phase diagram in a useful frequency spectrum which allows the system to predict the manipulator's motion with close to constant time shift. The gain of the prediction block is close to the a unity when system is operating, also in a useful frequency spectrum. The proposed nonlinear inverse dynamic model structure which nonlinearity includes the modified friction model based on the Stribeck friction interpretation was validated on a 1-DOF hydraulic manipulator test stand. The experiment and simulations confirmed the effectiveness of the predictive nonlinear inverse model by reducing the time and phase shift error between measured and simulated control signals.

[1] Mateusz Saków, M.Sc. (Ph.D. student): West Pomeranian University of Technology, Szczecin, Faculty of Mechanical Engineering and Mechatronics/Institute of Mechanical Technology, al. Piastów 19, 70-310 Szczecin, POLAND (mateusz.sakow@zut.edu.pl), the author presented this work at the conference.

[2] Krzysztof Marchelek, Professor: West Pomeranian University of Technology, Szczecin, Faculty of Mechanical Engineering and Mechatronics/Institute of Mechanical Technology, al. Piastów 19, 70-310 Szczecin, POLAND (krzysztof.marchelek@ps.pl).

[3] Arkadiusz Parus, Ph.D.: West Pomeranian University of Technology, Szczecin, Faculty of Mechanical Engineering and Mechatronics/Institute of Mechanical Technology, al. Piastów 19, 70-310 Szczecin, POLAND (arkadiusz.parus@zut.edu.pl).

[4] Mirosław Pajor, Professor: West Pomeranian University of Technology, Szczecin, Faculty of Mechanical Engineering and Mechatronics/Institute of Mechanical Technology, al. Piastów 19, 70-310 Szczecin, POLAND (miroslaw.pajor@zut.edu.pl).

[5] Karol Miądlicki, M.Sc. (Ph.D. student): West Pomeranian University of Technology, Szczecin, Faculty of Mechanical Engineering and Mechatronics/Institute of Mechanical Technology, al. Piastów 19, 70-310 Szczecin, POLAND (karol.miadlicki@zut.edu.pl).

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Carier frequency amplitud modulation phenomenon as model of creeping motion

Jan Samsonowicz, Stanisław Radkowski

Abstract: The paper presents a review of modeling and realization of creeping motion using the phenomenon of modulation of the harmonic function. As an example, the possibility of constructing a model realizing such a formulated task is described. This is the case of the motion of a plane figure defined by two tangents (internally) circles with radii R0 <R1 and centers of coordinates (x0 (t), y0 where d0 = distance (x0 (t), y0), (x1 (t), y0)) = | x1 (t) - x0 (t) | <R1 which means that the smaller circle ("drive" of the device) rotates within a larger movement with opposite orientations. We assume that both circles are connected in such a way that the rotation of one forces the rotation of the other at an angular velocity proportional to the ratio R1 / R0. Such a system can be viewed using both the waveform description as a comparison with the "creep" of the system and motion that can be observed in the external system and the generated coordinate system changes associated with the subsystem (one of the wheels). In reversing the problem, it can be said that a description of the mechanics of a bike, a tank crawler or a live earthworm can be effectively described in terms of fourierian terms. Our goal will be to look at the suitability of such descriptions with the mechanisms that occur in reality

[1] Jan Samsonowicz, Ph.D.: WARSAW UNIVERSITY OF TECHNOLOGY, ul Narbutta 84,02-524 Warszawa, POLAND (J.Samsonowicz@mini.pw.edu.pl).

[2] Stanisław Radkowski, Professor: WARSAW UNIVERSITY OF TECHNOLOGY, ul Narbutta 84,02-524 Warszawa, POLAND (ras@simr.pw.edu.pl), the author presented this contribution at the conference.

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paper id: LIF49

Theoretical investigations on the behavior of artificial sensors for surface texture detection

Moritz Scharff, Maximilian Darnieder, Joachim Steigenberger, Jorge H. Alencastre, Carsten Behn

Abstract: Animal vibrissae are used as natural inspiration for artificial tactile sensors, e.g., the mystacial vibrissae enable rodents to perform several tasks in using these tactile hairs: object shape determination and surface texture discrimination. Referring to the literature, the Kinetic Signature Hypothesis states that the surface texture detection is a highly dynamic process. It is assumed that the animals gather information about the surface texture out of a spatial, temporal pattern of kinetic events. This process has to be analyzed in detail to develop an artificial tactile sensor with similar functionalities. Hence, we set up a mechanical model for theoretical investigations of the process. This model is analyzed in two different directions using numerical simulations: at first a quasi-static and then a fully dynamic description.

1) Moritz Scharff, M.Sc. (Ph.D. student): Technische Universtität Ilmenau, Dept. of Mechanical Engineering, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (moritz.scharff@tu-ilmenau.de).

2) Maximilian Darnieder, M.Sc. (Ph.D. student): Technische Universität Ilmenau, Dept. of Mechanical Engineering, Gustav-Kirchhoff-Platz 2, 98693 Ilmenau, GERMANY (maximilian.darnieder@tu-ilmenau.de).

3) Joachim Steigenberger, Professor: Technische Universität Ilmenau, Institute of Mathematics, Weimarer Straße 25, 98693 Ilmenau, GERMANY (jstei@gmx.de).

4) Jorge H. Alencastre, Professor: Pontificial Catholic University of Peru, Av. Universitaria N°1801, San Miguel, Lima, PERU (jalenca@pucp.edu.pe).

5) Carsten Behn, Associate Professor: Technische Universität Ilmenau, Dept. of Mechanical Engineering, Technical Mechanics Group, Max-Planck-Ring 12, 98693 Ilmenau, GERMANY (carsten.behn@tu-ilmenau.de), the author presented this work at the conference.

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paper id: VIB46

Dynamical investigation of a vibration driven locomotion system based on a multistable tensegrity structure

Philipp Schorr, Susanne Sumi, Valter Böhm, Klaus Zimmermann

Abstract: This paper discusses selected realization possibilities of vibration driven mobile robots based on compliant prestressed structures with multiple states of self-equilibrium. Therefore, a multistable tensegrity structure is considered exemplarily. The structure has two equilibrium configurations with different prestress states and corresponding dynamical properties. In the considered specific application, this discrete adjustable behavior of those structures is advantageous. The vibration modes of the structure and consequently the uniaxial locomotion of the system can be adapted according to the given environmental conditions. In order to study the dynamical behavior of the considered system, the nonlinear equations of motion are derived. Selected variants of periodic actuation are compared with the help of transient dynamical analyses, to show possible different vibration modes and the according locomotion. The movement efficiency of the system is evaluated depending on actuation and environmental parameters.

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[1] Philipp Schorr, M.Sc. (Ph.D. student): Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Philipp.Schorr@tu-ilmenau.de), the author presented this work at the conference.

[2] Susanne Sumi, M.Sc. (Ph.D. student): Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Susanne.Sumi@tu-ilmenau.de).

[3] Valter Böhm, Associate Professor: Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Valter.Boehm@tu-ilmenau.de).

[4] Klaus Zimmermann, Professor: Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Klaus.Zimmermann@tu-ilmenau.de).

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paper id: STA68

Elastically mounted double pendulum in flow

Yury Selyutskiy, Andrei Holub, Marat Dosaev, Rinaldo Garziera

Abstract: An elastically mounted double-link aerodynamic pendulum is considered. It is assumed that the flow acts only upon the second link of the system. Conditions of asymptotic stability of the trivial equilibrium (when both links are stretched along the flow) are obtained. Limit cycles are studied that arise in the system for a certain range of values of parameters. Experiments with such pendulum are performed in the wind tunnel of the Institute of Mechanics of Lomonosov MSU, where parameters of periodic motions are registered for different wind speeds, and different locations of the wing with respect to the second link. It is shown that experimental data is in qualitative agreement with results of numerical simulation.

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1) Yury Selyutskiy, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, 119192, Michurinsky prosp. 1, Moscow, RUSSIA (seliutski@imec.msu.ru), the author presented this contribution at the conference.

2) Andrei Holub, M.Sc. (Ph.D. student): Lomonosov Moscow State University, Institute of Mechanics, 119192, Michurinsky prosp. 1, Moscow, RUSSIA (holub.imech@gmail.com).

3) Marat Dosaev, Associate Professor: Lomonosov Moscow State University, Institute of Mechanics, 119192, Michurinsky prosp. 1, Moscow, RUSSIA (dosayev@imec.msu.ru).

4) Rinaldo Garziera, Professor: University of Parma, via Università, 12 - I 43121 Parma, ITALY (rinaldo.garziera@unipr.it).

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Riccati transformation and oscillation of superlinear second order functional differential equations

Abhay Kumar Sethi, Arun Kumar Tripathy

Abstract: In this work, we establish the sufficient conditions for oscillation and asymptotic behavior of all solutions of the unforced second order linear neutral differential equations with variable delays and variable coefficients for two possible cases, and for different ranges of unknown neutral coefficient by using Riccati technique . The paper includes ten theorems for various ranges of neutral coefficient depending on the possible cases. Also, two examples are included to showing feasibility and effectiveness of our main results.

[1)] Abhay Kumar Sethi, M.Sc. (Ph.D. student): Sambalpur University, Dept of Mathematics Sambalpur University, Jyoti Vihar, Burla-78019, INDIA (sethiabhaykumar100@gmail.com), the author presented this contribution at the conference.

[2)] Arun Kumar Tripathy, Associate Professor: Sambalpur University, Jyoti vihar Burla 768019, INDIA (arun_tripathy70@rediffmail.com).

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Method of direct separation of motions applied to a non-ideal electromechanical pendulum system

Shahram Shahlaei-Far, Jose Manoel Balthazar

Abstract: This paper uses the approach of Vibrational Mechanics (VM) performing the Method of Direct Separation of Motions (MDSM) for the analysis of a non-ideal rotor mechanism with a limited power source. We employ a modification of the method to study the governing equations of a non-ideally excited electromechanical pendulum system consisting of three masses (block, rotating, pendulum) and a DC motor. The mechanism has three degrees of freedom and we derive the main equations of the slow component of motion from the initial governing equations to allow for a derivation of analytical solutions in the stability domain and the analysis of nonlinear phenomena. The paper focuses on a purely analytical approach.

1) Shahram Shahlaei-Far, Ph.D.: Instituto Tecnologico de Aeronautica (ITA), Praca Marechal-do-Ar Eduardo Gomes 50, 12228-900, Vila das Acacias, Sao Jose dos Campos, SP, BRAZIL (shazzz_85@yahoo.de), the author presented this contribution at the conference.

2) Jose Manoel Balthazar, Professor: Instituto Tecnologico de Aeronautica (ITA), Praca Marechal-do-Ar Eduardo Gomes 50, 12228-900, Vila das Acacias, Sao Jose dos Campos, SP, BRAZIL (jmbaltha@gmail.com).

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paper id: MAT3

Non-smooth first integrals of dynamical systems with dissipation

Maxim V. Shamolin

Abstract: We study nonconservative systems for which the usual methods of the study, e.g., Hamiltonian systems, are inapplicable. Thus, for such systems, we must ``directly'' integrate the main equation of dynamics. We generalize previously known cases and obtain new cases of the complete integrability in transcendental functions of the equation of dynamics of a rigid body in a nonconservative force field. We obtain a series of complete integrable nonconservative dynamical systems with nontrivial symmetries. Moreover, in almost all cases, all first integrals are expressed through finite combinations of elementary functions; these first integrals are transcendental functions of their variables. In this case, the transcendence is understood in the sense of complex analysis, when the analytic continuation of a function into the complex plane has essentially singular points. This fact is caused by the existence of attracting and repelling limit sets in the system (for example, attracting and repelling focuses). We detect new integrable cases of the motion of a rigid body, including the classical problem of the motion of a spherical pendulum in a flowing medium. This activity is also devoted to general aspects of the integrability of dynamical systems with variable dissipation.

[1] Maxim V. Shamolin, Professor: Institute of Mechanics, Lomonosov Moscow State University, 1 Michurinskii Ave., 119192, Moscow, RUSSIAN FEDERATION (shamolin@rambler.ru), the author presented this work at the conference.

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paper id: ENG241

Hysteretic properties of shell dampers

Ivan Shatskyi, Ihor Popadyuk, Andrii Velychkovych

Abstract: The achievements of the authors in the analytical modeling of hysteretic energy dissipation in the shells with deformable filler at the expense of dry friction are presented. Two construction variants are considered: solid shell and shell with cut. Based on the one-dimensional models of shells and filler the non-conservative quasi-static problems for the dampers under nonmonotonic loading are formulated and solved. The distribution of the stresses and displacements in contact system has been studied for the processes of active loading, unloading and repeated loading. The loop of structural damping (the force-displacement diagramm) is constructed too. The last obtained result describes the effect of maximum energy absorption by a shell damper. Importance of tribology settings of contact system, for which the dissipated energy of the external load reaches the maximum, is revealed.

[1] Ivan Shatskyi, Professor: Ivano-Frankivsk Branch of Pidstryhach-Institute for Applied Problems in Mechanics and Mathematics, NAS of Ukraine / Department of modelling of damping systems, Mykytynetska Str., 3, 76002, Ivano-Frankivsk, UKRAINE (ipshatsky@gmail.com), the author presented this contribution at the conference.

[2] Ihor Popadyuk, Associate Professor: Ivano-Frankivsk Branch of Pidstryhach-Institute for Applied Problems in Mechanics and Mathematics, NAS of Ukraine / Department of modelling of damping systems, Mykytynetska Str., 3, 76002, Ivano-Frankivsk, UKRAINE (igorpopadyuk60@gmail.com).

[3] Andrii Velychkovych, Associate Professor: Ivano-Frankivsk National Technical University of Oil and Gas / Department of structural mechanics, Karpatska Str., 15; 76019, Ivano-Frankivsk, UKRAINE (velja2@mail.ru).

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paper id: BIF87

Deterministic Chaos in Some Pendulum Systems with Delay

Aleksandr Shvets, Alexander Makaseyev

Abstract: Dynamic system "pendulum - source of limited excitation" with taking into account the various factors of delay is considered. Mathematical model of the system is a system of ordinary differential equations with delay [1-3]. Three approaches are suggested that allow to reduce the mathematical model of the system to systems of differential equations, into which various delay factors enter as some parameters. Genesis of deterministic chaos is studied in detail. Maps of dynamic regimes, phase-portraits of attractors of systems, phase-parametric characteristics and Lyapunov's characteristic exponents are constructed and analyzed. The scenarios of transition from steady-state regular regimes to chaotic ones are identified. It is shown, that in some cases the delay is the main reason of origination of chaos in the system "pendulum - source of limited excitation". Literature: 1. Shvets A.Yu., Makaseyev A.M. Chaotic Oscillations of Nonideal Plane Pendulum Systems // Chaotic Modeling and Simulation (CMSIM) Journal, 2012, № 1. – p. 195–204. 2. Shvets A.Yu., Makaseyev A.M. Delay Factors and Chaotization of Non-ideal Pendulum Systems // Chaotic Modeling and Simulation (CMSIM) Journal, 2012, № 4. – p. 633–642. 3. Shvets A.Yu., Makaseyev A.M. Influence of the Delay on the Occurrence of Deterministic Chaos in Some Non-Ideal Pendulum Systems // Research Bulletin of National Technical University of Ukraine “Kyiv Polytechnic Institute”. – 2015, № 4(102). – p. 110–116.

[1] Aleksandr Shvets, Professor: National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, 37, Prosp.Peremohy, Solomyanskyi district, Kyiv, Ukraine, 03056., UKRAINE (alex.shvets@bigmir.net), the author presented this contribution at the conference.

[2] Alexander Makaseyev, Ph.D.: National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, 37, Prospect Peremohy, 03056, Kyiv, Ukraine, UKRAINE (makaseyev@ukr.net).

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paper id: MAT67

The first exit time stochastic theory applied to estimate the life time of a complicated machine. The case of cars

Christos Skiadas, Charilaos Skiadas

Abstract: We develop a first exit time methodology to model the life time process of a complicated machine. We assume that functionality level of a complicated mechanical system follows a stochastic process during time and the end of the functionality of the system comes when the functionality function reaches a zero level. After solving several technical details including the Fokker-Planck equation for the appropriate boundary conditions we estimate the transition probability density function and then the first exit time probability density of the functionality of the system reaching a barrier during time. The formula we arrive is essential for complicated mechanical forms as for several machines. A simpler case has the form called as Inverse Gaussian and was first proposed independently by Schrodinger and Smoluchowsky in the same journal issue (1915) to express the probability density of a simple first exit time process hitting a linear barrier. Applications to the functionality life time of cars are done.

[1] Christos Skiadas, Professor: ManLaB, Technical University of Crete, Chania, Greece, Vyzantiou 6, Nea Penteli, 15236, GREECE (skiadas@cmsim.net), the author presented this contribution at the conference.

[2] Charilaos Skiadas, Associate Professor: Department of Mathematics and Computer Science, Hanover College, Indiana, USA, Hanover College, Indiana, USA (skiadas@hanover.edu).

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New control methods for flutter and thermal buckling elimination

Zhiguang Song, Xiao He, Feng-Ming Li

Abstract: In traditional active flutter and thermal buckling control, piezoelectric materials are used to increase the stiffness of the structure by providing an active stiffness, and usually the active stiffness matrix is symmetric and has different forms with the aerodynamic and thermal stiffness matrices. That is to say that the active stiffness not only cannot wholly offset the influence of the aerodynamic and thermal stiffness, but also will affect the natural frequencies of the structural system. In other words, by traditional active flutter and thermal buckling control methods, the flutter and thermal buckling bounds can just be moved backward but cannot be eliminated. In this investigation, new flutter and thermal buckling control methods which can suppress the flutter and thermal buckling effectively and without affecting the natural frequencies of the structural system are proposed by exerting active control forces and springs on some discrete points of the structure. In the structural modeling, the Kirchhoff plate theory and supersonic piston theory are applied. From the numerical results, it can be noted that the present control method is effective on the flutter and thermal buckling suppression. After being controlled by the present control method, natural frequencies of the structure remains unchanged

[1] Zhiguang Song, Associate Professor: Dynamics and Vibrations Group Numerical Methods in Mechanical Engineering Mechanical Engineering Technische Universität Darmstadt, Dolivostr. 15, Darmstadt, 64293, GERMANY (song@dyn.tu-darmstadt.de), the author presented this contribution at the conference.

[2] Xiao He, Ph.D.: College of Aerospace and Civil Engineering, Harbin Engineering University, No. 45 Nantong Dajie, Harbin, 150001, CHINA (hit_hx@163.com).

[3] Feng-Ming Li, Professor: College of Aerospace and Civil Engineering, Harbin Engineering University, Harbin 150001, CHINA (lifengming@hrbeu.edu.cn).

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Impact of elastic rod on thin elastic isotropic and orthotropic plate

Josef Soukup, Jan Skočilas, Blanka Skočilasova

Abstract: The theory of the solution of the elastic rod impact on the thin plane elastic isotropic and orthotropic plate is presented. The various material and geometrical models of the plate are solved. The plate is supported without any restriction around its perimeter. The plate is loaded continuously or by the solitary force acting on the upper facial surface in the perpendicular direction to the midline surface of the unloaded plate. The plates are solved with and without corrections. The article is review of the present knowledge in the field of study.

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[1] Josef Soukup, Associate Professor: UJEP in Ústí nad Labem, Faculty of Production Technology and Management, Na Okraji 1001/7, Ústí nad Labem, CZECH REPUBLIC (soukupj@fvtm.ujep.cz), the author presented this contribution at the conference.

[2] Jan Skočilas, Ph.D.: CTU in Prague, Faculty of Mechanical Engineering, Department of Process Engineering, Technicka 4, Prague 6, 16607, CZECH REPUBLIC (jan.skocilas@fs.cvut.cz).

[3] Blanka Skočilasova, Ph.D.: UJEP in Ústí nad Labem, Faculty of Production Technology and Management, Na Okraji 1001/7, Ústí nad Labem, CZECH REPUBLIC (skocilasova@fvtm.ujep.cz).

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paper id: MAT115

Convergence of dual infinity series

Josef Soukup, Blanka Skočilasova, Jan Skočilas

Abstract: The solution of the system of the partial differential motion equations describing the movement of plate element by Fourier's series is presented in the article. The investigated function is expressed by product of three or four functions of the particular variables. These functions are demanded relation for the calculation of the displacement components, rotation components and stress components. These functions are defined in the form of the dual infinite series. The sum of these functions is necessary to perform by the numerical summarization element by element. The convergence of these series has to be proved before, namely in the equations of stresses.

[1] Josef Soukup, Associate Professor: Faculty of Production Technology and Management, J. E. Purkyně University in Ústí nad Labem, Pasteurova 1, 400 96 Ústí nad Labem, CZECH REPUBLIC (soukupj@fvtm.ujep.cz), the author presented this contribution at the conference.

[2] Blanka Skočilasova, Ph.D.: Faculty of Production Technology and Management, J. E. Purkyně University in Ústí nad Labem, Na Okraji 1001/7, Ústí nad Labem, CZECH REPUBLIC (skocilasova@fvtm.ujep.cz).

[3] Jan Skočilas, Ph.D.: CTU in Prague, Faculty of Mechanical Engineering, Department of Process Engineering, Technicka 4, Prague 6, 16607, CZECH REPUBLIC (jan.skocilas@fs.cvut.cz).

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paper id: ASY236

Nonlinear effects in dynamics of the micromechanical gyroscope

Roman Starosta, Grażyna Sypniewska-Kamińska, Jan Awrejcewicz

Abstract: Resonant sensors basing on microstructures and belonging to microelectromechanical systems (MEMS) have been developed in recent years. The paper deals with dynamics of micro-gyroscope being a sensor designed for measuring the angular displacement. Such device is used for the attitude control of a moving object. Vibration of the basic measuring element suspended on a set of two pivoted and mutually orthogonal axes is the object of our study. One coordinate of the angular velocity of the support can be measured by the MEMS system. Since, the resonance is the desirable state of work of this sensor, the elastic properties of the support should be appropriately designed. Therefore, it is important to consider also the nonlinear behaviour of the system It is assumed the elastic features of the sensor suspension are weakly nonlinear. The equations of motion of the micromechanical sensor have been derived using the Lagrange formalism. The approximated solutions obtained using MSM allow to investigate the resonant behaviour of the system.

[1)] Roman Starosta, Assistant Professor: Poznan University of Technology, ul. Jana Pawła II, 24, 60-965 Poznań, POLAND (roman.starosta@put.poznan.pl), the author presented this contribution at the conference.

[2)] Grażyna Sypniewska-Kamińska, Ph.D.: Poznan University of Technology, ul. Jana Pawła II, 24, 60-965 Poznań, POLAND (grazyna.sypniewska-kaminska@put.poznan.pl).

[3)] Jan Awrejcewicz, Professor: The Lodz University of Technology, Stefanowskiego 1/15, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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paper id: VIB43

Dynamic analysis of a compliant tensegrity structure for the use in a gripper application

Susanne Sumi, Philipp Schorr, Valter Böhm, Klaus Zimmermann

Abstract: The use of compliant tensegrity structures in robotic applications offers several advantageous properties. In this work the dynamic behaviour of a planar tensegrity structure with multiple static equilibrium configurations is analysed, with respect to its further use in a two-finger-gripper application. In this application, two equilibrium configurations of the structure correspond to the opened and closed states of the gripper. The transition between these equilibrium configurations, caused by a proper selected actuation method, is essentially dependent on the actuation parameters and on the system parameters. To study the behaviour of the dynamic system and possible actuation methods, the nonlinear equations of motion are derived and transient dynamic analyses are performed. The movement behaviour is analysed in relation to the prestress of the structure and actuation parameters.

[1] Susanne Sumi, M.Sc. (Ph.D. student): Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Susanne.Sumi@tu-ilmenau.de), the author presented this work at the conference.

[2] Philipp Schorr, M.Sc. (Ph.D. student): Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Philipp.Schorr@tu-ilmenau.de).

[3] Valter Böhm, Associate Professor: Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Valter.Boehm@tu-ilmenau.de).

[4] Klaus Zimmermann, Professor: Technische Universität Ilmenau, Max-Planck-Ring 12; D-98693 Ilmenau, GERMANY (Klaus.Zimmermann@tu-ilmenau.de).

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Stimulation of nerve endings via medical device

Antonin Svoboda, Josef Soukup

Abstract: In this article is solved problem of stimulating of nerve endings of patients after spin injury via vibro-generator. Was developed mechanism of vibrations which can able change amplitude and fervency and vibration. Here is published solution of construction mechanism, results of experimental measuring and optimization of construction. Next is described use in practice. During the development of the structure, was paid great attention to the safety of the mechanism, the device is powered on the battery. This solution eliminates the deficiencies of similar devices used in the world, powered from the network (110 - 230 V). The success rate of vibrator use, in patients is ranges between 60-80%.

[1)] Antonin Svoboda, M.Sc. (Ph.D. student): Mechanical engineering, 400096, CZECH REPUBLIC (svoban@email.cz), the author presented this contribution at the conference.

[2)] Josef Soukup, Associate Professor: Mechanical engineering, 400096, CZECH REPUBLIC (soukupj@fvtm.ujep.cz).

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Influence of the spring system in vehicle vibrafon

Martin Svoboda, Václav Schmid, Josef Soukup

Abstract: The issue of damping and determining the required properties of shock absorbers and springs in passenger cars is directly related to the efforts of motor vehicle engineers to increase the comfort of the vehicle crew and, above all, road safety. The aim is also to reduce the negative impact of the transmission of vibrations on other parts of the vehicle, thus increasing the wear and reduction of their life. The aim of this work was to assess the spring system system of a passenger car. The types of shock absorbers and springs of the passenger car were also addressed. For the measurements were used the acceleration and thrust sensors were used between the wheel and the road. To measure using test benches. The benefits and reserves of individual systems were compared. For suspension cushioning systems, all cushioning settings were evaluated. The work was done experimentally in laboratory environment as well as in real operation.

[1] Martin Svoboda, Ph.D.: Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (svoboda@fvtm.ujep.cz), the author presented this contribution at the conference.

[2] Václav Schmid, M.Sc. (Ph.D. student): Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (schmid.vaclav@seznam.cz).

[3] Josef Soukup, Associate Professor: Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (soukupj@fvtm.ujep.cz).

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paper id: NUM208

Modal analysis of the vehicle model

Martin Svoboda, Václav Schmid, Josef Soukup

Abstract: The article deals with the experimental and numerical solution of the vertical oscillation of the me-chanical system (vehicle model). It was solved symmetrical and unbalanced load distributions at dif-ferent kinematic excitation (symmetrical and unbalanced). Excitation was performed by jumping of individual wheels (springs). The numerical model of vertical oscillation was verified by experimental measurements on the laboratory model. To refine numerical model was used modal analysis. Based on the comparison of experimental results and FEM, the boundary conditions of the numerical model were specified. Part of the work was also the determination of its own shapes. Compliance results of numerical and experimental solution is higher than 90%. Further refinement would be possible to achieve a more precise determination of the spring characteristic and the mate-rial constants (damping).

[1] Martin Svoboda, Ph.D.: Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (svoboda@fvtm.ujep.cz), the author presented this contribution at the conference.

[2] Václav Schmid, M.Sc. (Ph.D. student): Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (schmid.vaclav@seznam.cz).

[3] Josef Soukup, Associate Professor: Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem, Pasteurova 1, Ústí nad Labem, 400 96, ČESKÁ REPUBLIKA (soukupj@fvtm.ujep.cz).

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Optimization of construction processes using multi-criteria analyses

Elżbieta Szafranko

Abstract: In the construction activities we encounter many complex decision problems. They concern both planning, designing and execution of construction works. These problems require assessment of the different possibilities of the solution by evaluating the criteria describing the evaluated phenomena. Due to the large number of decisive factors it is important to use methods that allow for more criteria to be included in evaluations. The paper will be presented the opportunity to optimize decision-making processes using methods of multi-variant analysis.

[1)] Elżbieta Szafranko, Ph.D.: University of Warmia and Mazury in Olsztyn, the Faculty of Geodesy, Geospatial and Civil Engineering, ul. Heweliusza 4, 20-724 Olsztyn, POLAND (elasz@uwm.edu.pl), the author presented this contribution at the conference.

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Influence of damping on dynamic behavior of reinforced concrete beams

Anna Szcześniak, Adam Stolarski

Abstract: In the paper, we presented an analysis of the damping influence on the behavior of reinforced concrete beams under dynamic load. The solution to this problem can be obtained using an iterative calculation process. The range of inelastic dynamical properties for the structural materials was considered, and the deformation processes of reinforced concrete bar elements was modeled. We used an elastic/visco-perfectly plastic material model modified by the delayed yield effect for the reinforcing steel. For concrete we used the nonstandard deformation model of material including dynamic strength criterion and material softening. The load capacity analysis method for the structural system was developed using the finite difference method. We considered different ranges of damping that were the results of bending on the structural element. We considered the frequencies of the bending vibrations. For the damping factor of the transverse displacements, we applied a viscous resistance for bending vibrations. Numerical experiments for a reinforced concrete beam were run. To verify the correctness of assumptions, the obtained numerical results were compared with experimental results taken from literature.

1) Anna Szcześniak, Ph.D.: Military University of Technology, Faculty of Civil Engineering and Geodesy, 2 Kaliskiego Street, 00-908 Warsaw, POLAND (anna.szczesniak@wat.edu.pl), the author presented this contribution at the conference.

2) Adam Stolarski, Professor: Military University of Technology, Faculty of Civil Engineering and Geodesy, 2 Kaliskiego Street, 00-908 Warsaw, POLAND (adam.stolarski@wat.edu.pl).

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Dynamical Systems - Theory and Applications

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paper id: VIB59

Free vibration of cantilever bars having a shape of solid and hollow curvilinear truncated cone

Olga Szlachetka, Jacek Jaworski, Marek Chalecki

Abstract: To calculate first natural frequency of transversal vibrations of clamped-free bars with variable cross section, an energetic method can be used. Authors of this paper analysed solid and hollow slender posts having the shape of solid of revolution with the generatrix described by an exponential curve. The Rayleigh's method was used with the assumption that the shape of the post axis deflected during vibration is the same as a shape of the axis of a beam deflected by a uniform continuous static load. It was assumed that the material of the bars is elastic and continuously distributed what required numerous integrations of complicated expressions, therefore the calculations were carried out using the MATHEMATICA environment. Apart of the elastic energy of the bar, the authors took into consideration the potential energy connected to changes of location of the gravity center of elementary material slices during the post axis deflection. It was considered both the kinetic energy resulting from the replacement of the material slices perpendicularly to the post axis as well as the energy connected to their rotation. The obtained results are very close to those obtained in FEM

[1] Olga Szlachetka, Ph.D.: Faculty of Civil and Environmental Engineering, Warsaw University of Life Sciences - SGGW, Nowoursynowska 166, 02-787 Warsaw, POLAND (olga_szlachetka@wp.pl).

[2] Jacek Jaworski, Ph.D.: Faculty of Civil and Environmental Engineering, Warsaw University of Life Sciences - SGGW, Nowoursynowska 166, 02-787 Warsaw, POLAND (jacek_jaworski@sggw.pl), the author presented this work at the conference.

[3] Marek Chalecki, Ph.D.: Faculty of Civil and Environmental Engineering, Warsaw University of Life Sciences - SGGW, Nowoursynowska 166, 02-787 Warsaw, POLAND (marek_chalecki@sggw.pl).

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Off-road 4-wheel drive vehicle dynamics and control

Jan Szlagowski, Zbigniew Zebrowski, Tomasz Mirosław, Adam Zawadzki

Abstract: In this paper the dynamic model of 4 wheel drive off-road autonomous vehicle or wheeled mobile robots is presented. This model was developed from tractor dynamic model which was verified in real field. The way of building universal model is proposed, and used for simulation of various electric drive configuration as: 2 axles-1 motor, 2 axles -2 motors and 4 wheels 4 motor. The simulation result is discussed. The various properties of vehicle driven in various way are presented and explained basic on this model rules. The model was built in Matlab/Simulink software. The simulation results are compared with real test of physical model behavior. In the conclusion the comparison of various drive properties and skills are presented, and recommendations are suggested.

[1] Jan Szlagowski, Professor: Warsaw University of Technology Facultyof Automotive and Construction Machinery Institute of Construction Machinery Engineering, 02-524 Warsaw Narbutta str 84, POLAND (jsz@simr.pw.edu.pl).

[2] Zbigniew Zebrowski, Associate Professor: Warsaw University of Technology Facultyof Automotive and Construction Machinery Institute of Construction Machinery Engineering, 02-524 Warsaw Narbutta str 84, POLAND (zzebrowski@simr.pw.edu.pl).

[3] Tomasz Mirosław, Ph.D.: Warsaw University of Technology Facultyof Automotive and Construction Machinery Institute of Construction Machinery Engineering, 02-524 Warsaw Narbutta str 84, POLAND (tmiroslaw@simr.pw.edu.pl), the author presented this contribution at the conference.

[4] Adam Zawadzki, M.Sc. (Ph.D. student): Warsaw University of Technology, Narbutta 84, Warsaw, POLAND (a.zawadzki@simr.pw.edu.pl).

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Synchronisation analysis of a de-tuned three-blades rotor

Zofia Szmit, Jerzy Warmiński, Jarosław Latalski

Abstract: The aim of the paper is to check a synchronization phenomenon of a rotating structure composed of three composite beams and a hub. The beams are made of carbon-epoxy material and consist of eighteen nonsymmetrical layers. Furthermore, it is assumed in the analysis that one of the beam is detuned, because of a difference in the angels of each layer compering to remaining ones. Non-classical effects as a transverse shear, material anisotropy and cross-section warping are taken into account. The partial differential equations of motion are derived by the Hamilton's principle, and the reduction to the ordinary differential equations of motion have been done by Galerkin's method. Finally, the equations have been solved numerically, the resonance curves have been obtained. The synchronization phenomenon for motion of the hub and blades of the rotor have been based on the resonance curves. Two possible variants of the rotor excitation are considered: (a) torque produced by harmonic function or (b) torque given by a chaotic oscillator.

[1] Zofia Szmit, M.Sc. (Ph.D. student): Department of Applied Mechanics, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 38D, 20-618 Lublin, POLAND (z.szmit@pollub.pl), the author presented this contribution at the conference.

[2] Jerzy Warmiński, Professor: Department od Applied Mechanics, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 38D, 20-618 Lublin, POLAND (j.warmiński@pollub.pl).

[3] Jarosław Latalski, Assistant Professor: Department od Applied Mechanics, Faculty of Mechanical Engineering, Lublin University of Technology, Nadbystrzycka 38D, 20-618 Lublin, POLAND (j.latalski@pollub.pl).

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paper id: CON371

Comparison of different control strategies of a self-balancing robot

Przemyslaw Szulim, Adrian Chmielewski

Abstract: The aim of the paper is to present the most important stages of work associated with the construction and control of a two-wheel self balancing robot. The article shows the comparison of several control strategies implemented based on cascaded PID controller, LQR and LQG controller. The aim of the analysis was at first to compare the basic parameters that describe the performance of the control system. Another important aspect of the analysis was to compare the sensitivity of the proposed control strategy on incomplete knowledge about the object. Once again the effect of inaccurate estimated model parameters on the parameters that describe the performance of the control system was presented. Performed analysis were based on simulation studies and verified on a real object.

[1] Przemyslaw Szulim, Ph.D.: Warsaw University of Technology, Faculty of Automotive, Institute of Vehicles, Narbutta 84, Warszawa, 02-524, POLAND (p.szulim@mechatronika.net.pl), the author presented this contribution at the conference.

[2] Adrian Chmielewski, M.Sc. (Ph.D. student): Warsaw University of Technology, Faculty of Automotive, Institute of Vehicles, Narbutta 84, Warszawa, 02-524, POLAND (adrian.chmmielewski@wp.pl).

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paper id: ENG312

The analytical approach for identification of magnetically induced vibrations of working in faulty state BLDC motor

Przemyslaw Szulim, Stanislaw Radkowski

Abstract: In the paper Authors present a model connecting influence of typical mechanical faults, like eccentricity, torque pulsation and demagnetization on vibrations spectrum of brushless DC (BLDC) motor. Accurate process of modeling was presented. A 2D model of motor was taking in consideration. Each of a characteristic section (i.e. rotor shaft, rotor core, permanent magnet, air gap, stator core, and exterior region) was described by partial differential equations. Each equation, together with boundary conditions, creates set of ten partial differential equations describing distribution of magnetic potential and magnetic field. At this stage chosen faults were modeled. Analytical model of unbalanced force and cogging torque as a source of vibrations were calculated. In order to simulate behavior of working model of motor Matlab software was used, where the model of electric commutator and the developed magnetic model were joined together. Results were compared with real vibration signal acquired from the test stand with BLDC motor.

[1)] Przemyslaw Szulim, Ph.D.: Warsaw University of Technology, Faculty of Automotive, Institute of Vehicles, Narbutta 84, Warszawa, 02-524, POLAND (p.szulim@mechatronika.net.pl), the author presented this contribution at the conference.

[2)] Stanislaw Radkowski, Professor: Warsaw University of Technology, Faculty of Automotive, Institute of Vehicles, Narbutta 84, Warszawa, 02-524, POLAND (Stanislaw.Radkowski@simr.pw.edu.pl).

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Advanced adaptive critic design in control of mobile transport robot

Marcin Szuster

Abstract: The article presents a discrete tracking control system with adaptive critic design in dual-heuristic dynamic programming configuration for a mobile transport robot. The control object is a three wheeled mobile robot with design modeled on a fork-lift track with a rear driving wheel mounted in a rotary steering mechanism. The mobile transport robot is equipped with a lift for the transport of loads. The tracking control system consists of a dual-heuristic dynamic programming algorithm, a PD controller and a supervisory therm. The dual-heuristic dynamic programming algorithm is composed of an actor and a critic realized in a form of Random Vector Functional Link Neural Networks. The actor NN generates a control signal and the critic NN evaluates the quality of tracking by approximation of the derivative of the value function with respect to the state of controlled object. Numerical tests were conducted to confirm correct execution of a tracking movement.

[1] Marcin Szuster, Ph.D.: Rzeszow University of Technology, al. Powstancow Warszawy 12, POLAND (mszuster@prz.edu.pl), the author presented this contribution at the conference.

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Dynamical Systems - Theory and Applications

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paper id: CON172

Gr-GDHP algorithm in tracking control of robotic manipulator

Marcin Szuster

Abstract: The article presents a discrete tracking control system with modified neural dynamic programming algorithm in a form of goal representation (Gr-) globalized dual heuristic dynamic programming (GDHP) method. As distinct from traditional GDHP algorithm, in a new Gr- version an additional goal neural network is integrated into the algorithm providing internal reinforcement signal, that speeds up the adaptation process of actor's and critic's neural networks weights. The goal's, actor's and critic's neural networks were realized as Random Vector Functional Link neural networks. The control object is a 3 degrees of freedom robotic manipulator. Numerical tests were conducted to confirm correct execution of a tracking movement.

1) Marcin Szuster, Ph.D.: Rzeszow University of Technology, al. Powstancow Warszawy 12, POLAND (mszuster@prz.edu.pl), the author presented this contribution at the conference.

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paper id: EXP218

Methods for automatic detection of damage to cutting tools in applications of industrial robots

Dariusz Szybicki, Krzysztof Kurc, Piotr Gierlak, Andrzej Burghardt

Abstract: The article presents methods of automatic detection of damage to cutting tools. Automation of tool diagnostics is crucial for robotic mass production. Two diagnostic methods have been proposed one based on the use of a multi-axis force and torque sensor and another based on use of a structured light 3D scanner. Both methods have been implemented in a real robotic station consisting of two ABB industrial robots with ForceControl add-on, a 2-axis positioner, and a 3D scanner mounted on the robotic arm. The first method is based on measuring and analysing the inertia forces occurring in the spinning of a not balanced tool. For measurements of a force there was used a sensor included in a standard ForceControl add-on. A method using a 3D scanner with Atos Professional software was proposed in the case of tool damage that generates too little unbalance. A program for scanning and detecting the damage of the milling cutter and grinding points has been written. Prepared software recognizes damage to cutting tools using one of the following classifiers: "Surface Profile" or "Surface Cylinder". It also communicates with the robot controller providing information of suitability or not of chosen tool. The presented solutions were verified on a robotic machining station.

[1] Dariusz Szybicki, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (dszybicki@prz.edu.pl), the author presented this contribution at the conference.

[2] Krzysztof Kurc, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (kkurc@prz.edu.pl).

[3] Piotr Gierlak, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (pgierlak@prz.edu.pl).

[4] Andrzej Burghardt, Associate Professor: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (andrzejb@prz.edu.pl).

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Modelling and experimental study of roller coaster wheel with vibration reduction passive system

Dariusz Szybicki, Krzysztof Kurc, Piotr Gierlak, Andrzej Burghardt, Radosław Sitek, Marek Goczał

Abstract: This article is about modelling and dynamic testing of a prototype roller coaster wheel with vibration reduction passive system. The developed solution was designed to replace the existing wheels. Roller coasters are used in amusement parks to carry people on the track, which allow to perform complex evolutions.The main components of the device are the track and roller coaster trolley.The trolley wheel is a key element of the system as it connects the track and the trolley and must provide safety standards.The wheel is subjected to the dynamic loads, including mechanical vibration, which results from the nature of the trolley movement.Working conditions affect the strength of the structure, fatigue of the material and accelerated wear of the bearings.In addition, the vibrations cause negative feelings of the passengers of the trolley and produce noise.The passive vibration reduction system is based on a patented solution which use a flexible wheel hub disc and an intermediary damping material. In the simplified mathematical model the radial susceptibility of the wheel has been taken into account in order to select the parameters of the vibration reduction system. Analytical modelling, FEM simulations and dynamic experimental studies have been performed to confirm the correctness of the developed solutions.

[1] Dariusz Szybicki, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (dszybicki@prz.edu.pl), the author presented this contribution at the conference.

[2] Krzysztof Kurc, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (kkurc@prz.edu.pl).

[3] Piotr Gierlak, Ph.D.: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (pgierlak@prz.edu.pl).

[4] Andrzej Burghardt, Associate Professor: Rzeszow University of Technology, al. Powstańców Warszawy 12, 35-959 Rzeszów, POLAND (andrzejb@prz.edu.pl).

[5] Radosław Sitek, B.A. (M.Sc. student): ENERGY 2000 Sp. z o.o. ENERGYLANDIA Sp. k., al. 3 Maja 2, 32-640 Zator, POLAND (radek@energylangia.pl).

[6] Marek Goczał, B.A. (M.Sc. student): ENERGY 2000 Sp. z o.o. ENERGYLANDIA Sp. k., al. 3 Maja 2, 32-640 Zator, POLAND (marek@energy2000.pl).

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Experimental investigation of a human-like rib cage model subjected to an impact load

Olga Szymanowska, Wojciech Kunikowski, Bartłomiej Zagrodny, Jan Awrejcewicz, Paweł Olejnik

Abstract: This work continues some experimental investigations of a human-like rib cage subjected to an impact load. The construction of the experimental rig is based on a Hybrid III thorax calibration test stand. The measured impact velocity reaches 4 m/s and the impact mass 23 kg. The elastic impact subsystem consists of a rigid disc, the initial velocity of which is initiated by a pre-tensioned spring of high stiffness. Time characteristics of force and deflection responses of the investigated model constitute reference properties in identification of the human-like rib cage. Another aim of this work is to obtain biologically compatible parameters, like stiffness and damping of the artificial chest, by fitting a proper material that will to an average degree imitate properties of internal organs of the human chest. All measurements presented in the work were collected with the use of the NI cRIO embedded system. Chest deflection was captured by measuring the angle between the sides of shoulders of an isosceles triangle. The triangle was mounted between the sternum and the vertebral column, and the angle was captured with a potentiometer. In addition, an accelerometer was used to record the acceleration of the impacting mass.

[1] Olga Szymanowska, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (olga.szymanowska@dokt.p.lodz.pl).

[2] Wojciech Kunikowski, M.Sc. (Ph.D. student): Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (wojciech.kunikowski@gmail.com).

[3] Bartłomiej Zagrodny, Assistant Professor: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (bartlomiej.zagrodny@p.lodz.pl).

[4] Jan Awrejcewicz, Professor: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[5] Paweł Olejnik, Associate Professor: Department of Automation, Biomechanics and Mechatronics, Faculty of Mechanical Engineering, Lodz University of Technology, 1/15 Stefanowski Street, 90-924 Lodz, POLAND (pawel.olejnik@p.lodz.pl), the author presented this contribution at the conference.

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paper id: OPT248

Distributed Multi-population Genetic Algorithm to improve driver's comfort

Szymon Tengler, Kornel Warwas

Abstract: A solution of the task how to select the optimal parameters of a sub-assembly of a driver's seat of a special vehicle with a high gravity center will be presented in this paper. In the analyzed vehicle there were twelve sub-assemblies. The vehicle was modeled with use of joint coordinates, and homogenous transformations. Equations of motion were derived from Lagrange equations of the second kind. An aim of optimization is to select appropriate values of damping factors of a driver's seat sub-assembly to provide the best possible driving comfort. The optimization aim is to minimize a functional determining vertical acceleration of a driver's seat. There was made own implementation of an algorithm called Distributed Multi-population Evolutionary Algorithm, basing on genetic algorithms with floating coding of genes in the chromosome of the client-server architecture. The proposed method is based on a possibility of processing lots of populations at the same time with information exchange between the populations. A particular iteration of the procedure consists of standard genetic operators: a natural selection, one point crossing, irregular mutation and a data exchange in the grid. Results of numerical calculations for a vehicle driving at a different velocity through an obstacle in a form of a bump will be presented in the paper.

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[1] Szymon Tengler, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (stengler@ath.bielsko.pl), the author presented this contribution at the conference.

[2] Kornel Warwas, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (kwarwas@ath.bielsko.pl).

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Deterministic chaos and strange attractors in dynamics of Rydberg atomic and molecular systems in an electromagnetic field

Valentin Ternovsky, Anna Kuznetsova, Marina Gurskaya, Anna Buyadzhi

Abstract: We present a new mathematical approach to studying deterministic chaos and strange attractors in dynamics of nonlinear processes in Rydberg atomic and molecular systems in an electromagnetic field. To treat chaotic dynamics of systems it is constructed effective scheme that includes new quantum-dynamic models (based on the finite-difference solution of the Schrödinger equation, optimized operator perturbation theory and realistic model potential for quantum systems.) and advanced analysis methods such as correlation integral, fractal, Lyapunov exponents (LE), Kolmogorov entropy, power spectrum analysis, etc [1,2]. Availability of multiple resonances with super little widths in spectra in external field is treated and provided by interference phenomena and fluctuations. There are computed chaos parameters ; e g. some parameters of GeO molecule dynamics in infrared field 25 GW / cm2 are: correlation D (2.73), embedding D, Kaplan-York D (2.51), LE (the first two are, +, +).
1. A.V.Glushkov et al, in: Adv. in Neural Networks, Fuzzy Systems and Artificial Intelligence, Ser.: Rec Adv. in Computer Eng, Ed. J.Balicki. 21, 143 (2014); in: Dynamical Systems Theory Eds. J. Awrejcewicz et al (Lodz). T1, 461 (2013). 2. A.Glushkov, L.N.Ivanov, J.Phys.B. 26, L379 (1993); A.Glushkov et al, Int.J. Quant. Chem. 99, 936 (2004)

1) Valentin Ternovsky, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (ternovskyvb@gmail.com), the author presented this contribution at the conference.

2) Anna Kuznetsova, Ph.D.: Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (annuwka.k@gmail.com).

3) Marina Gurskaya, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (gurskaya.marina@gmail.com).

4) Anna Buyadzhi, M.Sc. (Ph.D. student): Odessa State University - OSENU, Lvovskaya str. 15, of.408, UKRAINE (buyadzhiaa@gmail.com).

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paper id: MAT65

A new asymptotic-tolerance model of dynamics of thin uniperiodic cylindrical shells

Barbara Tomczyk, Anna Litawska

Abstract: Thin linearly elastic Kirchhoff-Love-type circular cylindrical shells with a periodically micro-heterogeneous structure in circumferential direction (uniperiodic shells) are analysed. At the same time, the shells have constant structure in axial direction. The aim of this note is to formulate and discuss a new averaged asymptotic-tolerance model for the analysis of dynamic problems for the shells under consideration. This model is derived by applying the combined modelling which includes two techniques: the asymptotic modelling procedure and a certain extended version of the known tolerance non-asymptotic modelling technique based on a new notion of weakly slowly-varying function proposed in [Tomczyk B., Woźniak C., Tolerance models in elastodynamics of certain reinforced thin-walled structures. In: Kołakowski Z. & Kowal-Michalska K. (eds.), Statics, Dynamics and Stability of Structures, vol. 2, Lodz University of Technology Press, Lodz, 123-153, 2012]. Contrary to the exact shell equations with highly oscillating, non-continuous and periodic coefficients, governing equations of the averaged combined model have constant coefficients depending also on a cell size. Hence, this model allows us to investigate the effect of the microstructure size on dynamic behaviour of the shells. An important advantage of the model is that it makes it possible to separate the macroscopic description of some special problems from the microscopic description of these problems.

[1] Barbara Tomczyk, Ph.D.: Lodz University of Technology, Department of Structural Mechanics, Al. Politechniki 6, POLAND (barbara.tomczyk@p.lodz.pl).

[2] Anna Litawska, M.Sc. (Ph.D. student): Lodz University of Technology, Department of Structural Mechanics, Politechniki 6, POLAND (a.litawska@gmail.com), the author presented this contribution at the conference.

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Micro-dynamics of thin tolerance-periodic cylindrical shells

Barbara Tomczyk, Paweł Szczerba

Abstract: Thin linearly elastic Kirchhoff-Love-type open circular cylindrical shells having a functionally (transversally) graded macrostructure and a tolerance-periodic microstructure in circumferential direction are objects of consideration. At the same time, the shells have constant structure in axial direction. On the microscopic level, the geometrical, elastic and inertial properties of these shells are determined by highly oscillating, non-continuous and tolerance-periodic functions in circumferential direction. On the other hand, on the macroscopic level, the averaged (effective) properties of the shells are described by functions being smooth and slowly varying along circumferential direction. The aim of this note is to study some problems of micro-dynamics of these shells, e.g. micro-vibrations depending on a cell size. The micro-dynamic problems will be analysed in the framework of the averaged asymptotic-tolerance model proposed in [Tomczyk B., Szczerba P., Combined asymptotic-tolerance modeling of dynamic problems for functionally graded shells. Composite Structures (2017). http://dx.doi.org/10.1016/j.compstruct.2017.02.021]. Contrary to the exact shell equations with highly oscillating, non-continuous and tolerance-periodic coefficients, governing equations of the averaged model mentioned above have continuous and slowly varying coefficients depending also on a cell size. An important advantage of this model is that it makes it possible to investigate micro-dynamics of the tolerance-periodic shells independently of their macro-dynamics.

[1] Barbara Tomczyk, Ph.D.: Department of Structural Mechanics, Lodz University of Technology, 90-924, POLAND (barbara.tomczyk@p.lodz.pl).

[2] Paweł Szczerba, M.Sc. (Ph.D. student): Department of Structural Mechanics, Lodz University of Technology, 90-924, POLAND (szczerba.paw@gmail.com), the author presented this work at the conference.

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paper id: CON57

Automatic parking of a car in a garage – a three-case study

Maciej Trojnacki

Abstract: The paper is concerned with the problem of automatic parking of a car in a garage. Current state of the art in self-driving cars and methods of automatic parking, with particular regard to a garage, were discussed. For simulation studies, the kinematic bicycle model of the vehicle was adopted. In order to solve the problem of automatic parking, the method which includes planning characteristic poses of the vehicle and realization of motion between these poses using pose controller was used. Three strategies of automatic parking in a garage taking into account limitations of a car and its surroundings are considered and simulated. The conclusions resulting from performed simulation research and comparison of analyzed parking strategies are presented.

[1)] Maciej Trojnacki, Associate Professor: Industrial Research Institute for Automation and Measurements PIAP, Al. Jerozolimskie 202, 02-486 Warsaw, POLAND (mtrojnacki@piap.pl), the author presented this work at the conference.

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paper id: CON170

Compensation of an influence of crane's support flexibility on load motion using a PID controller

Andrzej Urbaś, Krzysztof Augustynek, Szymon Tengler

Abstract: The paper presents a mathematical model used for a dynamics analysis and control of operating motions of a crane. The crane, modeled in a form of an open-loop kinematic chain, is mounted on flexible supports. The load moved by the crane is treated as a lumped mass hung on a flexible rope. Dynamics equations were derived from the Lagrange equations of the second kind. In the description of the model joint coordinates and homogeneous transformation matrices were applied. Formulated in such a way the mathematical model was used to analyze an influence of crane's supports flexibility on load motion. The aim of the paper is to determine operating motions of the crane in such a way that the load moves along the assumed trajectory. The influence of the crane's supports flexibility on load motion is compensated by PID controllers.

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[1] Andrzej Urbaś, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (aurbas@ath.bielsko.pl).

[2] Krzysztof Augustynek, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (kaugustynek@ath.bielsko.pl).

[3] Szymon Tengler, Ph.D.: University of Bielsko-Biala, Willowa 2, Bielsko-Biala, POLAND (stengler@ath.bielsko.pl), the author presented this contribution at the conference.

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paper id: CON92

Dynamics and control of a truck-mounted crane with a flexible jib

Andrzej Urbaś, Adam Jabłoński, Jacek Kłosiński, Krzysztof Augustynek

Abstract: Oscillations affected a crane carrying loads significantly influence performance and wear of its components. Especially, oscillations which remain after each working motion of the crane are undesirable. A mathematical model for dynamics analysis of a truck-mounted crane is presented in the paper. The proposed model is applied to a control problem of a crane. The dynamics equations of motion are derived based on the Lagrange approach using the formalism of joint coordinates, homogeneous transformation matrices. The flexibility of a jib and friction in joints are taken into account in the dynamics model. The rigid finite element method is applied to modeling the flexible links of the crane. Friction in the joints is modeled by means of the LuGre friction model. Numerical results obtained from the solution of the control problem of selected working motions of the crane are presented in the paper. The working motions assure the minimization of the tangent component of the load oscillations. In the proposed control model this component is compared with the assumed set point value. The obtained control error is used to compensate driving torques.

[1] Andrzej Urbaś, Ph.D.: University of Bielsko-Biała, 43-309 Bielsko-Biała, ul. Willowa 2, POLAND (aurbas@ath.bielsko.pl).

[2] Adam Jabłoński, M.Sc. (Ph.D. student): University of Bielsko-Biała, 43-309 Bielsko-Biała, ul. Willowa 2, POLAND (ajablonski@ath.bielsko.pl), the author presented this contribution at the conference.

[3] Jacek Kłosiński, Associate Professor: University of Bielsko-Biała, 43-309 Bielsko-Biała, ul. Willowa 2, POLAND (jklosinski@ath.bielsko.pl).

[4] Krzysztof Augustynek, Ph.D.: University of Bielsko-Biała, 43-309 Bielsko-Biała, ul. Willowa 2, POLAND (kugustynek@ath.bielsko.pl).

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A fractional perspective to the modelling of Lisbon's Public Transportation Network

Duarte Valério, José Tenreiro Machado, António Lopes, António Santos

Abstract: In this paper, the public transportation network (PTN) of the city of Lisbon is analysed from 1901 to 2015, employing different mathematical tools. In a first stage, the fractal dimension and the fractional entropy are used to quantify the evolution of the PTN in space and time. These measures prove to be appropriate to quantify the growth of the PTN, as the description is compatible with known historical events. In a second stage, the distance between consecutive stops is analysed, revealing a power-law behaviour, as expected from the fractal geometry of the network.

[1] Duarte Valério, Ph.D.: IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, PORTUGAL (duarte.valerio@tecnico.ulisboa.pt).

[2] José Tenreiro Machado, Professor: Institute of Engineering, Polytechnic of Porto, Dept. of Electrical Engineering, R. Dr. António Bernardino de Almeida, 431, 4249 - 015 Porto, PORTUGAL (jtm@isep.ipp.pt), the author presented this contribution at the conference.

[3] António Lopes, Assistant Professor: Faculty of Engineering, University of Porto, Rua D. Roberto Frias, 4200 - 465 Porto, PORTUGAL (aml@fe.up.pt).

[4] António Santos, M.Sc.: IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, PORTUGAL (antonio.f.santos@tecnico.ulisboa.pt).

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Passage through resonance in conservative and dissipative systems

Ferdinand Verhulst

Abstract: This paper compares passage through resonance in the case of a conservative system and in the case of a dissipative system. The structure of the resonance zone is essential, in the dissipative case solutions can be trapped in resonance, in the conservative case we have always passage but often this is delayed by the internal structure of the resonance zone. The theory of detuned resonance and the Poincare recurrence theorem are tools to describe the internal structure of the resonance zone. In the conservative case we will demonstrate this for three degrees-of-freedom. For our dissipative system we have chosen a toy problem and a gyroscopic system that displays many phenomena.

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1) Ferdinand Verhulst, Ph.D.: University of Utrecht, PO Box 80.010, 3508TA Utrecht, NETHERLANDS (f.verhulst@uu.nl), the author presented this contribution at the conference.

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Tubular latticed telecommunication towers under wind load and vortex shedding effects

Dario Vieira, Rui Barros

Abstract: The main goal of this work is to evaluate the response of the diagonals members of steel lattice towers with circular profiles cross-sections, under the wind load determined according to the current regulation EN1991-1-4. For this study, it has been developed a program in VBA using Excel for the evaluation of the response due to vortex shedding induced vibrations and possible failure due to fatigue. A formulation is proposed is for the mitigation or supressing of the amplitudes of vibration, using the Ansys Fluent software for testing. The results obtained of applying small fins in the center section of certain diagonals of the telecommunication tower, with potential to failure due to vortex shedding in the perpendicular direction of wind load, are expected to minimize the damage due to fatigue and increase the expected life time of the structure.

[1] Dario Vieira, M.Sc. (Ph.D. student): FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division, Rua Roberto Frias, PORTO 4200-465, PORTUGAL (darintagos@gmail.com).

[2] Rui Barros, Professor: FEUP - Faculdade Engenharia Universidade do Porto , Dept Civil Engineering, Structural Division (VAT number for accounting purposes: 501 413 197), Rua Roberto Frias, PORTO 4200-465, PORTUGAL (rcb@fe.up.pt), the author presented this contribution at the conference.

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Biomechatronic solution for human fingers replacement

Kostiantyn Vonsevych, Mikhail Bezuglyi, Jerzy Mrozowski, Jan Awrejcewicz

Abstract: Human hand is a complex natural mechanism that allows providing a significant amount of daily life interactions. An important role in its construction plays a presence of fingers, which provides the most precise and delicate tasks. As consequence, in the case of them loss, even partial replacement of some function needs the application of multiple biomechatronic systems. The most modern solution that can be implemented as natural analogue is a bionic prosthesis. It usually consists of few individual modules such as electronic feedback and controlling units, mechanical parts etc. Construction of such prosthesis should have a biomimetic size, view and as more as possible amount of DoF. When the controlling unit, which is actually the "artificial brain" of the system, should be portable and have an appropriate level of accuracy. In general, successful implementation of these modules needs a cumbersome or multi-channel hardware that makes a final device expensive or large and non-mobility. The one-channel sEMG controlling unit based on ANN method of signal classification could be a possible partial solution for described problem. ANN with well-organised structure and correctly selected TDF parameters of measured EMG signal can allow producing a unit with classification rate more than 95% even with 6 types of provided movements. Joint use of such "artificial brain" in prostheses with microcontrollers based hardware can make it an enough portable for artificial fingers and now studies in the research provided by authors.

[1] Kostiantyn Vonsevych, M.Sc. (Ph.D. student): Igor Sikorsky Kyiv Polytechnic Institute, 56 Prosp Peremohy str., 03-056 Kyiv, UKRAINE (wonsewych@gmail.com), the author presented this contribution at the conference.

[2] Mikhail Bezuglyi, Associate Professor: Igor Sikorsky Kyiv Polytechnic Institute, 56 Prosp Peremohy str., 03-056 Kyiv, UKRAINE (mikhail_bezuglyy@ukr.net).

[3] Jerzy Mrozowski, Professor: Lodz University of Technology, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jerzy.mrozowski@p.lodz.pl).

[4] Jan Awrejcewicz, Professor: Lodz University of Technology, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

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Identification of muscle forces of lower limbs based on the registration of motion using the BTS system

Tomasz Walczak, Grażyna Sypniewska-Kamińska, Henryk Kamiński, Rafał Chełkowski, Adam Michałowski

Abstract: This paper describes a biomechanical model of the human body with the aim of identification of muscles forces of the lower limb during different activities. Introduced multibody model of human body is relatively simple. The body segments are treated as rigid bodies interconnected via ideal joints, only the forces of the main muscles of lower limbs are taken into account. At other joints of the body are identified only the torques produced by whole groups of muscles related to the given joint. The equations of motion are obtained using the Lagrange formalism. Such description allows to determining the forces and the torques generated by human muscles for any considered motion, where known are the geometrical and mass properties of the body segments, and their velocities and acceleretions. All of necessarily data concerning the chosen different kind of human activity like jump, gait etc are collected by the system BTS dedicated to analysis of motion. Proposed mechanical model together with its mathematical description and optimization method which is applied in the identification because of the additional forces whose number is greater than the number of equations could be useful to more accurate research of human muscles work properties, and overloading of joints during many human physical activities.

[1] Tomasz Walczak, Ph.D.: Institute of Applied Mechanics, Poznań University of Technology, Jana Pawła II 24, 60965, POLAND (tomasz.walczak@put.poznan.pl), the author presented this contribution at the conference.

[2] Grażyna Sypniewska-Kamińska, Ph.D.: Institute of Applied Mechanics, Poznań University of Technology, Jana Pawła II 24, 60965, POLAND (grazyna.sypniewska-kaminska@put.poznan.pl).

[3] Henryk Kamiński, Ph.D.: Institute of Applied Mechanics, Poznań University of Technology, Jana Pawła II 24, 60965, POLAND (henryk.kaminski@put.poznan.pl).

[4] Rafał Chełkowski, B.A. (M.Sc. student): Institute of Applied Mechanics, Poznań University of Technology, Jana Pawła II 24, 60965, POLAND (rafal.chelkowski@student.put.poznan.pl).

[5] Adam Michałowski, B.A. (M.Sc. student): Institute of Applied Mechanics, Poznań University of Technology, Jana Pawła II 24, 60965, POLAND (adam.michalowski@student.put.poznan.pl).

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The concept of autonomous damper in vehicle suspension

Jan Warczek, Rafał Burdzik, Łukasz Konieczny

Abstract: The vibration of a vehicle treated as an object can be varied in two basic ways. Parametric or structural modifications can be made. Applying parametric modifications is not always possible. Examples are the suspension of motor vehicles. Changing the elasticity factor is limited by the allowable deflection arrow for different loads. Structural modifications are used for vibration isolation or vibration elimination. Vibro-isolation tasks are somewhat contradictory and practically impossible to achieve in passive systems. The alternative is to use in the suspension system elements with adjustable characteristics. On the vibrations object of the specified mass acts on the control signal. The control signal has a force dimension. This force is produced by a vibration isolator for which vibration parameters are input signals. The control force is the weighted sum of the forces of elasticity and damping. These components of the control force are proportional to relative displacement and relative velocity, respectively. In the developed concept of autonomous vibration damper, a control algorithm is applied which deactivating damper if the damping force influences the increase acceleration of the object's vibration.

[1] Jan Warczek, Ph.D.: Silesian University of Technology, Faculty of Transport,, Krasinskiego Street 8, 40-019 Katowice,, POLAND (jan.warczek@polsl.pl).

[2] Rafał Burdzik, Associate Professor: Silesian University of Technology, Faculty of Transport,, Krasinskiego Street 8, 40-019 Katowice,, POLAND (rafal.burdzik@polsl.pl), the author presented this contribution at the conference.

[3] Łukasz Konieczny, Assistant Professor: Silesian University of Technology, Faculty of Transport,, Krasinskiego Street 8, 40-019 Katowice,, POLAND (lukasz.konieczny@polsl.pl).

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Validation of the numerical model of Impuls I electric multiple unit driver's cab

Paweł Wątroba, Mariusz Pawlak, Damian Gąsiorek

Abstract: This article presents the validation of numerical model of the electric multiple unit (EMU) driver's cab. The subject of the study was the cage of the driver of the Impuls I rail vehicle of Newag S.A. The numerical model was developed in the LS-Dyna environment based on the documentation received from the manufacturer. The driver's cab was modelled as shell elements, the additional parts required for crash test were modelled as solid elements. Experimental research was carried out on the order of Newag S.A. on the experimental track of the Railway Institute in Węglewo near Zmigrod according to PN-EN 15227. The collision was recorded by 3 cameras used for fast changing phenomena. Additionally, acceleration sensors were placed at specific locations of the construction. The article presents some results from experimental research and their comparison with the results of numerical simulation.

[1)] Paweł Wątroba, M.Sc. (Ph.D. student): Silesian University of Technology, Faculty of Mechanical Engineering, ul. konarskiego 18A, 44-100 Gliwice, POLAND (pawel.watroba@polsl.pl).

[2)] Mariusz Pawlak, Ph.D.: Silesian University of Technology, Faculty of Mechanical Engineering, ul. Konarskiego 18A, 44-100 Gliwice, POLAND (mariusz.pawlak@polsl.pl), the author presented this contribution at the conference.

[3)] Damian Gąsiorek, Associate Professor: Silesian University of Technology, Faculty of Mechanical Engineering, ul. Konarskiego 18A, 44-100 Gliwice, POLAND (damian.gasiorek@polsl.pl).

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Numerical crash analysis of the cable barrier

Krzysztof Wilde, Dawid Bruski, Stanisław Burzyński, Jacek Chróścielewski, Wojciech Witkowski

Abstract: Safety barriers are used to increase road safety. Their basic task is to prevent the errant vehicle from getting off the road in places which are dangerous. Cable barriers, in comparison to other types of safety barriers, are more beneficial constructions for vehicle passengers. Barriers, which are used on European roads, must fulfill the requirements of EN 1317 standards by passing appropriate crash tests. Because of their high cost, numerical simulations are increasingly used to evaluate the properties of safety barriers, especially in the early stages of the barrier design or in the modifications of existing ones. Simulations allow for a detailed insight into the impact mechanism and their cost are much lower compared to real crash tests. Since the crash phenomenon is a dynamic process and the duration of vehicle-barrier contact is short, numerical simulations are performed using explicit dynamics algorithm in LS-DYNA commercial FEM system. In this study the numerical simulation of cable barrier crash test using 900-kg vehicle (TB11 test) and 13000-kg bus (TB51) were carried out. The results of TB51 test were compared with the results obtained from real crash test. Additionally, the influence of friction coefficient value on results was analyzed. This work is supported by the National Centre for Research and Development (NCBiR) and General Director for National Roads and Motorways (GDDKiA) under the research project "Road Safety Equipment".

[1] Krzysztof Wilde, Professor: Gdańsk University of Technology, Gabriela Narutowicza 11/12, 80-233 Gdańsk, POLAND (krzysztof.wilde@wilis.pg.gda.pl).

[2] Dawid Bruski, M.Sc. (Ph.D. student): Politechnika Gdańska, Gabriela Narutowicza 11/12, 80-233 Gdańsk, POLAND (dawbrusk@pg.gda.pl), the author presented this contribution at the conference.

[3] Stanisław Burzyński, Assistant Professor: Gdańsk University of Technology, Gabriela Narutowicza 11/12, 80-233 Gdańsk, POLAND (stanislaw.burzynski@wilis.pg.gda.pl).

[4] Jacek Chróścielewski, Professor: Gdańsk University of Technology, Gabriela Narutowicza 11/12, 80-233 Gdańsk, POLAND (jacek.chroscielewski@wilis.pg.gda.pl).

[5] Wojciech Witkowski, Associate Professor: Gdańsk University of Technology, Gabriela Narutowicza 11/12, 80-233 Gdańsk, POLAND (wojciech.witkowski@wilis.pg.gda.pl).

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Experimental and numerical investigations of one-degree-of-freedom impacting oscillator

Krzysztof Witkowski, Grzegorz Kudra, Grzegorz Wasilewski, Fryderyk Wiądzkowicz, Jan Awrejcewicz

Abstract: The work concerns preliminary studies of dynamics of experimental setup consisting of a cart mounted on a guide, connected with springs to the support and equipped with a rigid limiter of motion. The cart is excited by an unbalanced disk driven with a step motor. Mathematical model of the system is developed with particular attention paid to modelling of the impacts as well as resistance of linear ball bearing. The collisions are modelled as soft impacts with Hertzian contact stiffness. Model parameters are identified and good agreement between numerical simulations and experimental results is obtained. System dynamics is then analysed using different numerical tools: Poincaré maps, bifurcation diagrams and Lyapunov exponents.

[1] Krzysztof Witkowski, M.Sc. (Ph.D. student): Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (krzys_wit@wp.pl), the author presented this contribution at the conference.

[2] Grzegorz Kudra, Assistant Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (grzegorz.kudra@p.lodz.pl).

[3] Grzegorz Wasilewski, Ph.D.: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (grzegorz.wasilewski@p.lodz.pl).

[4] Fryderyk Wiądzkowicz, B.A.: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (f.wiadzkowicz@gmail.com).

[5] Jan Awrejcewicz, Professor: Lodz University of Technology, Department of Automation, Biomechanics and Mechatronics, Stefanowski 1/15, 90-924 Łódź, POLAND (jan.awrejcewicz@p.lodz.pl).

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Dynamics of a double physical pendulum with magnetic interaction

Mateusz Wojna, Grzegorz Wasilewski, Jan Awrejcewicz, Adam Wijata

Abstract: The paper is devoted to numerical and experimental investigations of a system consisting of the double physical pendulum with magnetic interaction caused by a pair of permanent magnets repelling each other. The poles of the magnets are oriented so that a repulsive force occurs between them. To the experimental rig of double physical pendulum system with the first body periodically forced a constructed magnetic interaction forces measurement system is added. The work consists of modelling, simulation and experimental measurements to validate the analytical predictions and the numerical simulation of the earlier introduced mathematical model. The parameters of the model are estimated matching the output signals from model and experiment. The analyzed system shows several types of non-linear effects. Few chaotic zones are detected numerically and confirmed experimentally.

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[1] Mateusz Wojna, B.A. (M.Sc. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (mateuszwojna94@gmail.com), the author presented this contribution at the conference.

[2] Grzegorz Wasilewski, Ph.D.: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (grzegorz.wasilewski@p.lodz.pl).

[3] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[4] Adam Wijata, M.Sc. (Ph.D. student): Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, Stefanowskiego 1/15, 90-924, Lodz, POLAND (adam.wijata@p.lodz.pl).

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Gravity waves in a reservoir with uneven bottom: asymptotic approach

Ryszard Wojnar, Włodzimierz Bielski

Abstract: We are considering long gravity waves of incompressible fluid in a channel (1-D problem) and a tank with uneven bottoms (2-D problem). We point that it is possible to apply asymptotic homogenization to determine the effective depth of the reservoir and the velocity of the wave. We write a corresponding gravity wave equations for the channel and the tank with periodic micro-heterogeneous bottom (and eventually walls), and perform homogenisation. Our small parameter ϵ is the ratio of lengths l to L. The length l is typical length scale of the wall waviness, and the length L is the length of gravity wave. Finally, we replace the variable depth of the fluid by a certain mean one. We obtain homogenised equations of long gravity waves, find the effective depth of reservoir and the effective velocity of waves. Next, we extend the applications of Keller - Dykhne's formula, [1], to description of the long gravity waves. The method is applied to obtain the effective depth in the case of uneven bottom with chess-board structure. In fluid dynamics, gravity waves are waves generated in a fluid medium or at the interface between two media when the force of gravity or buoyancy tries to restore equilibrium,[2]. Here, we discuss the propagation of gravity waves in a canal with uneven bottom, and relates to the problem of flows in beds of rivers with obstacles at the bottom (such as stones or plants). [1] A. M. Dykhne, Zh. Eksp. Teor. Fiz. 59, 110 (1970). [2] L. D. Landau and E. M. Lifshitz, Fluid mechanics, Pergamon Press, Oxford - New York 1987.

1) Ryszard Wojnar, Ph.D.: Institute of Fundamental Technological Research PAS, Pawińskiego 5B, 02-106 Warszawa, POLAND (rwojnar@ippt.pan.pl), the author presented this contribution at the conference.

2) Włodzimierz Bielski, Professor: Institute of Geophysics Polish Academy of Sciences, ul. Księcia Janusza 64, 01-452 Warsaw, POLAND (wbielski@igf.edu.pl).

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Approach for determination of functioning of lower limb muscles

Wiktoria Wojnicz, Bartłomiej Zagrodny, Michał Ludwicki, Małgorzata Syczewska, Jerzy Mrozowski, Jan Awrejcewicz

Abstract: The purpose of the study is elaboration of approach for determination of functioning of chosen muscles that are essential for gait performance (Tibialis Anterior, Rectus Femoris, Gastrocnemius Medialis, Biceps Femoris). The scope of the study involves the analysis of the symmetric planar motion performing in the sagittal plane of the body by applying planar multibody model and electromyography signals (EMG) registered over normal gait performance. The analysis is performed by applying two types of multibody model: six degree of freedom system and seven degree of freedom system. Inverse dynamics task was used to calculated joint moments influenced ankle joints, knee joints and hip joints. Applied model also described single support phase and double support phase by assuming the model of interaction between the ground and the contact foot. It was assumed that activity state of each considered muscle is determined by average activation time and its sequence in time.

[1] Wiktoria Wojnicz, Ph.D.: Gdańsk University of Technology, ul. G. Narutowicza 11/12, 80-233 Gdańsk, POLAND (wiktoria.wojnicz@pg.gda.pl), the author presented this contribution at the conference.

[2] Bartłomiej Zagrodny, Ph.D.: Łódź University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (bartlomiej.zagrodny@p.lodz.pl).

[3] Michał Ludwicki, Ph.D.: Łódź University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (michal.ludwicki@p.lodz.pl).

[4] Małgorzata Syczewska, Professor: Instytut „Pomnik - Centrum Zdrowia Dziecka”, Al. Dzieci Polskich 20, 04-730 Warszawa, POLAND (M.Syczewska@ipczd.pl).

[5] Jerzy Mrozowski, Associate Professor: Łódź University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (jerzy.mrozowski@p.lodz.pl).

[6] Jan Awrejcewicz, Professor: Łódź University of Technology, ul. Stefanowskiego 1/15 , 90-924 Łódź, POLAND (jan.awrejcewicz@p.lodz.pl).

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Implementation of the adaptive control algorithm for the KUKA LWR 4+ robot

Łukasz Woliński

Abstract: Model-based control methods are very attractive in the field of robotics as their tracking performance can exceed the classical controllers (such as the independent joint PID controllers). Using the dynamic model of the manipulator, however, requires detailed knowledge about the manipulator's dynamic parameters such as link masses and inertias or joint friction properties. These parameters are not always easily identifiable and, to some degree, might vary between robots of one kind (e.g. slight differences in masses/inertias) or during the robot operation (e.g. friction changes related to the temperature). Thus, the identified model might not always be suitable for the desired control tasks. A possible method to overcome the aforementioned problems is to use the adaptive control scheme. In that approach, the parameters of the model are constantly updating their values in real-time to assure good tracking performance. This paper deals with the implementation of such an adaptive controller for the KUKA LWR 4+ robot. Using the KUKA's communication protocols, a C++ implementation of the outer-loop adaptive controller (which feeds the KUKA controller with the desired joint torques) was created and its quality evaluated.

[1] Łukasz Woliński, M.Sc. (Ph.D. student): Institute of Aeronautics and Applied Mechanics, Warsaw University of Technology, Nowowiejska 24, 00-665 Warsaw, POLAND (lwolinski@meil.pw.edu.pl), the author presented this contribution at the conference.

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Modeling and control of motion systems for an electro-hydraulic Tripod manipulator

Piotr Woś, Ryszard Dindorf

Abstract: The paper presents the results of theoretical considerations, experimental studies and control of electro-hydraulic servo control of manipulator. The structure of the device together with an analysis of its kinematic structure is described. The structure of dynamic manipulator model is derived from each axis dynamic model. The issue that has been discussed, focused on providing robust of electro-hydraulic servo controller to change the dynamic properties. The results of simulation and experimental tests data are presented and analyzed.

[1] Piotr Woś, Professor: Kielce University of Technology, al. Tysiaclecia Panstwa Polskiego 7, POLSKA (wos@tu.kielce.pl), the author presented this contribution at the conference.

[2] Ryszard Dindorf, Professor: Kielce University of Technology, al. Tysiaclecia Panstwa Polskiego 7, POLSKA (dindorf@tu.kielce.pl).

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paper id: NUM221

Energy based composite damping modelling

Mario Wuehrl, Matthias Klaerner, Lothar Kroll

Abstract: Both, composite materials with either anisotropic layers, like fibre-reinforced polymers, or isotropic layers like metal or simple polymer layers offer a high potential in lightweight design applications. However, the thin structures react delicately to vibrations due to their high stiffness to mass ratio. In general, the damping of these composite materials is estimated using volumetric based averaging. However, thin structures show primary out of plane loads, for which the main strain energy is stored in the outer layers. As the damping of a material is a dissipation of strain energy under cyclic load, we assume that the outer layers contribute more to the complete composite damping making a volumetric mean value insufficient. In detail, the strain energy is varying not only by thickness but locally distributed among the whole part. The presented approach uses the FEA-based strain energy distribution to estimate the overall damping of the composite. This leads to an energetic averaged damping for each specific deformation state. The new model can be applied for modal damping of different mode shapes or amplitude dependent damping for nonlinear materials. As an example, the damping of a hybrid composite with steel face sheets and a very thin shear sensitive plastic core is estimated for different stress states. Furthermore, the applicability of this modelling approach is discussed for composites with anisotropic layers.

[1)] Mario Wuehrl, M.Sc.: Technische Universität Chemnitz - Institut für Strukturleichtbau, D-09107 Chemnitz, GERMANY (mario.wuehrl@mb.tu-chemnitz.de), the author presented this contribution at the conference.

[2)] Matthias Klaerner, M.Sc. (Ph.D. student): Technische Universität Chemnitz - Institut für Strukturleichtbau, D-09107 Chemnitz, GERMANY (matthias.klaerner@mb.tu-chemnitz.de).

[3)] Lothar Kroll, Professor: Technische Universität Chemnitz - Institut für Strukturleichtbau, D-09107 Chemnitz, GERMANY (lothar.kroll@mb.tu-chemnitz.de).

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Understanding of origination, development and the sunset of the Ottoman Empire using wavelets and Lyapunov exponents

Tatyana Y. Yaroshenko, Jan Awrejcewicz, Igor Pelve, Vadim A. Krysko

Abstract: The methods of nonlinear dynamics are widely used for the study of time series of various types. In his paper we study historical time series using wavelets and the spectrum of Lyapunov exponents. Namely, for the study of historical time series we employ continuous (Meyer) and discrete (Haar) wavelets. The sign of the spectrum of Lyapunov exponents, allows to study the chaotic or stable state of historical processes. Wolf, Rosenstein and Kantz methods as well as the neural networks are applied while detecting the largest Lyapunov exponents. We show that it is possible to identify the causes and tendencies of the development and crisis states of different historical processes. As a practical application of this methodology a development and the collapse of the Ottoman Empire is investigated. The process of its development since the establishment of Osman Gazi in 1299 and before its collapse in 1922 on the basis of time series changes with regard to the territory of the state and the population is studied numerically. Acknowledgements: This work has been supported by the Grant RSF № 16-11-10138

[1] Tatyana Y. Yaroshenko, Associate Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tyyaroshenko@gmail.com).

[2] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[3] Igor Pelve, Professor: Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (rectorat@sstu.ru).

[4] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru), the author presented this contribution at the conference.

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Application of non-linear dynamics to Poland's evolution

Tatyana Y. Yaroshenko, Jan Awrejcewicz, Igor I. Shulga, Maxim V. Zhigalov, Vadim A. Krysko

Abstract: Poland played an important role in the European arena throughout its existence. In the course of time, the Polish state evolved and changed from creation since X century. Its territory was expanded in time, for example, by the creation of one of the powerful European states of the era of Polish–Lithuanian Commonwealth in 1569. as a result of the unification of the Kingdom of Poland and the Grand Duchy of Lithuania. To that time, the economy, science and culture were on the rise. There was also a period of economic and political decline, which led to the triple division from 1772 to 1795 among Russia, Prussia and Austria. Poland has practically ceased to exist as a sovereign state. After the First World War, Poland was revived and dynamically developed until now. Thus, the development of a state is a dynamic process, for which the methods of non-linear dynamics can be applied. This work introduces the concept of the internal energy of the state, the internal energy of the state is being investigated by wavelet functionality also Haar, Meyer and Mhat. The stable or crisis of Poland is being investigated on the basis of changes in the energy component.

[1] Tatyana Y. Yaroshenko, Associate Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tyyaroshenko@gmail.com).

[2] Jan Awrejcewicz, Professor: Lodz University of Technology, Faculty of Mechanical Engineering, Department of Automation, Biomechanics and Mechatronics, 1/15 Stefanowski Str., 90-924 Lodz, POLAND (awrejcew@p.lodz.pl).

[3] Igor I. Shulga, Professor: Department History of the Fatherland and Culture, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (IgorShulga@yandex.ru).

[4] Maxim V. Zhigalov, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (max.zhigalov@gmail.com).

[5] Vadim A. Krysko, Professor: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (tak@san.ru), the author presented this contribution at the conference.

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Start of vibrating machines with unbalanced drive considering its elasticity

Nikolai Yaroshevich, Ivan Zabrodets, Tatiana Yaroshevich

Abstract: Start dynamic of the vibration machine with inertia vibration exciters considering the elastic connection of asynchronous electric motor rotors and unbalanced vibration exciter is investigated. It is shown that availability of elastic connection brings essential features to dynamic of vibration machine's drive that must be considered during the planning. Formulas for assessment the starting deformation amplitudes and moments that occurs in vibration machine's drive coupling are got in an analytical form. It is demonstrated that oscillation amplitudes of elastic coupling at the start moment mostly depend on the remoteness of its own frequency from the current frequency in motor electricity network. Equation of coupling's torsional oscillations close to stationary rotation mode of unbalanced vibration exciter is got. It is revealed the existing connection between oscillation of bearing vibration system and coupling's drive elasticity. It is found that during the start of vibration machines in case of Sommerfeld effect, except resonant increase of braking vibration moment and "stopping" of engine's speed, resonant oscillation of elastic-damping elements (that connect motor and exciter rotors, that increase dynamic loads and energy losses in the system) excite.

[1] Nikolai Yaroshevich, Professor: Lutsk National Technical University, 43026, Lutsk, Sobornosti av. 42/60, UKRAINE (yaroshevichmp@gmail.com), the author presented this work at the conference.

[2] Ivan Zabrodets, M.Sc. (Ph.D. student): Lutsk National Technical University, 43026, Lutsk, Lvivska str. 75, UKRAINE (m_yaroshevich@mail.ru).

[3] Tatiana Yaroshevich, Associate Professor: Lutsk National Technical University, 43026, Lutsk, Sobornosti av. 42/60, UKRAINE (m_yaroshevich@mail.ru).

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paper id: EXP112

Experimental verification of contact phenomena modeling in alive structures on the example of the implant-bone

Marcin Zaczyk, Danuta Jasińska-Choromańska

Abstract: The work presents modeling of contact phenomena in living structures. The selected methods of numerical modeling (FEM) describing of phenomena at the boundary of two materials joining are presented. The work focused on the phenomena of living structures and their interactions. On the example of the implant system, different techniques of modeling contact phenomena were compared with the results from the experiment. This study have showed the main features of the selected modeling techniques for example the difficulties degree of the model, the time consuming calculation and the degree of confidence in the results obtained. The obtained results have shown that the most advantageous method is that which allows the interaction of the numerical values to be introduced without the excessive generation of finite elements (grids) at the material boundary.

[1)] Marcin Zaczyk, Ph.D.: Warsaw University of Technology, 8 Boboli Str., 02-525 Warsaw, POLAND (m.zaczyk@mchtr.pw.edu.pl), the author presented this contribution at the conference.

[2)] Danuta Jasińska-Choromańska, Associate Professor: Warsaw University of Technology, 8 Boboli Str., 02-525 Warsaw, POLAND (danuta@mchtr.pw.edu.pl).

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paper id: MTR71

A theoretical and experimental investigation of parametrically excited nonlinear two-degree-of-freedom electromechanical systems

Bahareh Zaghari, Cameron Levett, Emiliano Rustighi

Abstract: This work presents a nonlinear parametrically excited cantilever beam with electromagnets. A parametrically excited two-degree-of-freedom (2-DOF) system with linear time-varying stiffness, nonlinear cubic stiffness, nonlinear cubic parametric stiffness, and nonlinear damping is considered. In previous studies, the stability and bifurcation of nonlinear parametrically excited 2-DOF systems were investigated through analytical, semi-analytical and numerical methods. In this contribution, the response amplitude and phase of the system at parametric resonance, parametric combination resonance and anti-resonance are demonstrated experimentally, and novel results are discussed. Experimental amplitude-frequency plots, phase portraits and Poincare maps are presented to show the stable solutions. Solutions for the system response are presented for specific values of parametric excitation frequency and the energy transfer between modes of vibrations is observed. The proposed nonlinear parametrically excited 2-DOF system can be used to design Micro-Electro-Mechanical Systems (MEMS) parametric amplifiers, electrical filters and non-contact magnetic vibration isolators. The experimental results are validated with analytical and numerical models, demonstrating an improvement in the efficiency of these electrical systems.

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[1] Bahareh Zaghari, Ph.D.: Faculty of Physical Sciences and Engineering, University of Southampton, SO171BJ, UNITED KINGDOM (b.zaghari@soton.ac.uk), the author presented this contribution at the conference.

[2] Cameron Levett, B.A.: Institute of Sound and Vibration Research (ISVR), University of Southampton, SO171BJ, UNITED KINGDOM (cl14g15@soton.ac.uk).

[3] Emiliano Rustighi, Associate Professor: Institute of Sound and Vibration Research (ISVR), University of Southampton, SO171BJ, UNITED KINGDOM (er@isvr.soton.ac.uk).

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paper id: MTR369

Bionic movement algorithms implemented in mechatronic robots

Bartłomiej Zagrodny, Cezary Miśkiewicz, Krystian Polczyński, Jan Awrejcewicz

Abstract: This paper concerns the problem of bionic movement algorithms of two types of limbless species: serpentes and geometridae. Bionic aspects seem to play important role in the processes of designing and development of new mechatronic systems and in modeling of their movement patterns. Evolution of the biological systems and resulting benefits cannot be neglected as the nature has created a lot of very complicated but specialized and effective systems. This gives an opportunity to observe, examine and then mimic them by some mechatronical systems. In this work we are presenting a way of implementation undulatory and inch-worm like movement locomotion algorithms in two different robots.

[1)] Bartłomiej Zagrodny, Ph.D.: Łódź University of Technology, Stefanowskiego 1/15 Łódź, POLAND (bartlomiej.zagrodny@p.lodz.pl), the author presented this contribution at the conference.

[2)] Cezary Miśkiewicz, B.A. (M.Sc. student): Łódź University of Technology, Stefanowskiego 1/15 Łódź, POLAND (cezary.miskiewicz@edu.p.lodz.pl).

[3)] Krystian Polczyński, B.A. (M.Sc. student): Łódź University of Technology, Stefanowskiego 1/15 Łódź, POLAND (krystian.polczynski@edu.p.lodz.pl).

[4)] Jan Awrejcewicz, Professor: Łódź University of Technology, Stefanowskiego 1/15 Łódź, POLAND (jan.awrejcewicz@p.lodz.pl).

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paper id: MAT81

Vibrations of a multi-span continuous beam subjected to a moving stochastic load

Filip Zakęś, Paweł Śniady

Abstract: The dynamic behavior of multi-span uniform continuous beam excited by moving stochastic load is studied. In this paper we consider two models of moving load, namely: load described by space-time stochastic process and random series of concentrated forces moving with constant velocity. We assume that forces have random amplitudes and their appearance on the beam is described by point stochastic process (Poisson process). Solution of the problem in terms of expected values, variances and cumulants of the higher order (for the second case of load) was obtained by introducing dynamic influence function. In determination of the dynamic influence function Volterra integral equations was applied (Zakęś, Śniady 2016). Solution is illustrated with two numerical examples of 2- and 3-span beam.

[1] Filip Zakęś, M.Sc.: Wrocław University of Environmental and Life Sciences, C. K. Norwida 25 50-375 Wrocław, POLAND (filip.zakes@up.wroc.pl), the author presented this contribution at the conference.

[2] Paweł Śniady, Professor: Wrocław University of Environmental and Life Sciences, C. K. Norwida 25 50-375 Wrocław, POLAND (pawel.sniady@up.wroc.pl).

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The contact interaction of a nano-plate supported by nano-beams in the temperature field

Alena A. Zakharova, Jan Awrejcewicz, Tatyana V. Yakovleva, Vadim S. Kruzhilin, Anton V. Krysko

Abstract: In this work a mathematical model of nonlinear dynamics and contact interaction of a nano-plate, supported by a local set of nano-beams under conditions of external dynamic and temperature influences is proposed. It includes the kinematic model of approximation for the plate and for the beams . The contact interaction between nano-plate and nano-beams is governed by the Winkler model. This mathematical model describes the work of composite elements of micromechanical systems. Algorithms for calculating the contact interaction of plate-beam nano-structures have been developed. The temperature fields for the plate (three-dimensional) and the beams (two-dimensional) are determined separately from the heat equation by the method of finite differences of the second and fourth order of accuracy. Next, the obtained set of non-linear PDEs is reduced to Cauchy problems using the Faedo-Galerkin approach in higher approximations and methods of finite differences of the 2nd and 4th order of accuracy. The Cauchy problems are solved by various methods of the Runge-Kutta types. Several methods for analyzing the sign of the largest Lyapunov exponent are used to determine the type of vibrations of a plate-beam nano-structures: the methods of Wolf, Kantz, and Rosenstein. This ensures the reliability of the solutions obtained and reveals the “truth” of chaos if the vibrations are chaotic. Examples of computations are presented. Acknowledgement This work has been supported the Ministry of Education and Science of the Russian Federation by the Grant № 2.1642.2017

[1] Alena A. Zakharova, Professor: Cybernetic Institute, National Research Tomsk Polytechnic University, Lenin Avenue 30, 634050 Tomsk, RUSSIAN FEDERATION (zaa@tpu.ru).

[2] Jan Awrejcewicz, Professor: Lodz University of Technology, 1/15 Stefanowskego Str., 90-924 Lodz, POLAND (jan.awrejcewicz@p.lodz.pl).

[3] Tatyana V. Yakovleva, Ph.D.: Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, and Cybernetic Institute, National Research Tomsk Polytechnic University, 634050 Tomsk, Lenin Avenue, 30, RUSSIAN FEDERATION (Yan-tan1987@mail.ru).

[4] Vadim S. Kruzhilin, B.A. (M.Sc. student): Department of Mathematics and Modeling, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (mrkruzhilin@mail.ru).

[5] Anton V. Krysko, Professor: Cybernetic Institute, National Research Tomsk Polytechnic University, 634050 Tomsk, Lenin Avenue, 30 , and Department of Applied Mathematics and Systems Analysis, Saratov State Technical University, Politehnicheskaya 77, 410054 Saratov, RUSSIAN FEDERATION (anton.krysko@gmail.com), the author presented this contribution at the conference.

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paper id: NUM66

The mathematical modelling of nonlinear vibration of rotors influenced by magnetic and electric effects

Jaroslav Zapoměl, Petr Ferfecki, Jan Kozánek

Abstract: The main parts of magnetorheological squeeze film dampers placed in the rotor supports are two concentric rings. The gap between them is filled by magnetorheological oil. Its squeezing due to the rotor vibration produces the damping force. The magnetic flux generated in the coils embedded in the damper housing passes through the magnetorheological oil and as its flow resistance depends on magnetic induction the change of the applied current can be used to control the damping force. The variation of the width of the damper gap changes the magnetic flux which consequently changes magnitude of the applied current due to induction of the electromotoric voltage. As a result, the rotor vibration attenuation depends on a complex interaction between mutually coupled mechanical, hydraulic, magnetic and electric transient phenomena. In the mathematical model the magnetorheological oil is represented by a bilinear material, the yielding shear stress of which depends on magnetic induction. The damper body is assumed to be consisted of a set of meridian segments and each segment as a divided core of an electromagnet with the gap filled by magnetorheological oil. The pressure distribution in the lubricating film is governed by the Reynolds equation that has been adaped to bilinear material. The dependence of the yielding shear stress on magnetic induction is approximated by a power function. The computer simulations contributed to learning more on the complex relation between the electromagnetic phenomena occuring in magnetorheological dampers and the vibration attenuation of rotors.

[1] Jaroslav Zapoměl, Professor: Institute of Thermomechanics, Dolejškova 5, CZECH REPUBLIC (jaroslav.zapomel@vsb.cz), the author presented this contribution at the conference.

[2] Petr Ferfecki, Ph.D.: VŠB - Technical University of Ostrava, 17. listopadu 15, Ostrava, CZECH REPUBLIC (petr.ferfecki@vsb.cz).

[3] Jan Kozánek, Ph.D.: Institute of Thermomechanics, Dolejškova 5, CZECH REPUBLIC (kozanek@it.cas.cz).

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paper id: OPT30

Optimal thrust programming along the brachistochronic trajectory with drag

Alena Zarodnyuk, Oleg Cherkasov

Abstract: The problem of maximization of the horizontal coordinate of mass-point moving in the vertical plane driven by gravity, viscous drag, and thrust is considered. The slope angle and the thrust are considered as a control variables. The problem is related to the modified brachistochrone problem. Principle maximum procedure allows to reduce the optimal control problem to the boundary value problem for a system of two nonlinear differential equations. The qualitative analysis of the trajectories of this system is performed, and the robust properties of the optimal solutions are determined. Optimal controls depending on the state variables are designed. Characteristic features of the designed controls allows to construct quasi-optimal solutions for the more complex systems, where phase plane method is not applicable.

1) Alena Zarodnyuk, M.Sc. (Ph.D. student): Lomonosov Moscow State University, 119991, RUSSIA (alenaz_90@inbox.ru), the author presented this contribution at the conference.

2) Oleg Cherkasov, Ph.D.: Lomonosov Moscow State University, 119991, RUSSIA (oyuche@yandex.ru), the author presented this contribution at the conference.

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paper id: OPT299

The use of waste heat from flue gas in the process of combined generation of heat and electricity

Robert Zarzycki

Abstract: The study discusses the system of condensation steam power unit fuelled by biomass with high water content. This power unit was heated through installation of the steam outlet from the turbine and heat exchanger. Due to the high flue gas waste from the furnace, which results from high waste content in the flue gas, an additional heat condenser was designed to allow for heat recovery from the flue gas through condensation of part of water contained in this gas. In this case it is possible to initially heat water in the heat condenser in the heating system and than to supply it to the heat exchanger. Due to the variable demand for heat depending on the weather conditions, the study proposed the design of a heat buffer that allows for storage of hot water and supplying this water to the network. The absorption heat pump system (APC) was designed before the inlet to the heat condenser in order to improve the efficiency of its use through reduction in the temperature of the network water. The water with the temperature of 95oC obtained through operation of the APC can be supplied to the heat buffer or, after mixing with the stream of water leaving the heat condenser, to the heat power network. The use of this solution limits substantially the time of operation of the main heat exchanger, thus reducing the demand for the steam and increases electrical power of the power unit and improves its efficiency through heat recovery from the flue gas. The results of calculations revealed significant benefits resulting from the design and operation of the proposed power heat system.

[1)] Robert Zarzycki, Ph.D.: Czestochowa University of Technology, Department of Energy Engineering, Brzeznicka 60a, POLSKA (zarzycki@is.pcz.czest.pl), the author presented this contribution at the conference.

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paper id: OPT298

Pulverized coal gasification with steam and flue gas

Robert Zarzycki, Rafał Kobyłecki, Zbigniew Bis

Abstract: The study presents the concept and numerical calculations of the coal dust gasification in the dispersion reactor with power of 10 MW. The gasification process in the reactor can be performed in the atmosphere of O2, CO2 and H2O. The combustible gases obtained during gasification are composed mainly of CO and H2 and can be used to feed pulverized coal-fired boilers. Integration of the reactor for coal dust gasification with the pulverized coal-fired boiler allows for the improved flexibility, especially in the range of low loads if stabilization of coal dust combustion in pulverized-fuel burners or support for their work with ignition burners fed with gas or light fuel oil are necessary. Several numerical calculations of the coal dust gasification process were conducted in the atmospheres with different chemical composition (O2, CO2 and H2O). Their goal was to determine optimal process conditions for gasification due to the aerodynamics and process kinetics. Numerical calculations allowed for determination of the set of parameters that allow for optimal reactor operation due to the control of the temperature inside the reactor and the composition of the obtained combustible gases. The concept of the dispersion reactor presented in this study and the results of numerical calculations can be helpful for development of the devices with greater powers which in the nearest future should be integrated in the systems of pulverized coal-fired boilers in order to reduce their minimum load without using the ignition burners.

[1] Robert Zarzycki, Ph.D.: Czestochowa University of Technology, Department of Energy Engineering, Brzeznicka 60a, POLSKA (zarzycki@is.pcz.czest.pl).

[2] Rafał Kobyłecki, Professor: Czestochowa University of Technology, Department of Energy Engineering, Brzeznicka 60a, POLSKA (rafalk@is.pcz.czest.pl), the author presented this contribution at the conference.

[3] Zbigniew Bis, Professor: Czestochowa University of Technology, Department of Energy Engineering, Brzeznicka 60a, POLSKA (zbis@is.pcz.czest.pl).

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paper id: LIF278

Non-linear modeling of human body dynamic

Adam Zawadzki, Tomasz Miroslaw

Abstract: In this paper the concept and a method of modeling static and dynamic load of human body parts like: bones and muscles during movement is presented. Currently the problem of human body modelling is very important for many domains of our "better life" programs like: an automotive -to find the best solution for human protection during accidents, sport – to find the most efficient and least fatigue ways of movements, , health protection or lengthen the active life of elder people. The human body is not rigid multi-body system, but elastic and flexible. Moreover it is variable over time. It consists of semi-stiff bones, elastic muscles and tendons. Other parts like stomach or liver are hanging on elastic wires and move in relatively each to other during whole acceleration etc. All those elements can be broken or fatigue under some load. So the model of human body is not linear and shouldn't be modelled by linear equation sets. Presented model of human body bases on combination of three types elements. One type is "bones" which are joined in joints and conduct loads to the support surface; the elastic tendons keeping the joints and propelling bones rotation in joints, and muscle which generate forces for stabilization system or for propelling bones. In this paper the simplified model of human body build in Mathab/Simuling software is presented. Some results of simulation load of knee during squat or landing after jump and they are compared with real tests results.

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[1] Adam Zawadzki, M.Sc. (Ph.D. student): Warsaw University of Technology Institute of constrution Machinary Engineering, 02-524 Warsaw Narbutta str 84, POLAND (a.zawadzki@simr.pw.edu.pl), the author presented this contribution at the conference.

[2] Tomasz Miroslaw, Ph.D.: Warsaw University of Technology Institute of constrution Machinary Engineering, 02-524 Warsaw Narbutta str 84, POLSKA (tmiroslaw@simr.pw.edu.pl).

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paper id: CON259

Contact force control for a high speed pantograph using co-simulations

Paweł Zdziebko, Adam Martowicz, Tadeusz Uhl

Abstract: Active control for operational conditions, which is performed for high speed pantographs is one of the promising solutions for improving the current collection quality in high speed railways. The present work deals with an exemplary configuration of a controller proposed to reduce the contact force deviation in the modeled slider-to-catenary interface. Adapted settings of the controller were proposed for different train speeds. The performance of the controller is analyzed with the use of a co-simulation tool to determine the pantograph-catenary interaction, presented recently by the authors in other works. It was achieved by computing statistical parameters of the contact force. The simulation algorithm considers the Finite Element nonlinear model of a catenary and Multibody pantograph model. Various control scenarios were successfully analyzed including disturbance from locomotive vibrations and aerodynamic forces fluctuations. Considering realistic scenarios for a rail vehicle ride, a significant parameter describing time-delays in the control loop was also investigated. The proposed control strategy revealed satisfactory reduction of the standard deviation for the contact force.

[1] Paweł Zdziebko, M.Sc. (Ph.D. student): AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (zdziebko@agh.edu.pl), the author presented this contribution at the conference.

[2] Adam Martowicz, Ph.D.: AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (adam.martowicz@agh.edu.pl).

[3] Tadeusz Uhl, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (tuhl@agh.edu.pl).

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paper id: VIB251

Influence of the mechanical properties of pantograph's structural parts on its interaction with a catenary

Paweł Zdziebko, Adam Martowicz, Tadeusz Uhl

Abstract: The paper addresses dynamic interaction in the pantograph – catenary system present in a rail vehicle. The contact force, which is measured between pantograph and catenary, may significantly fluctuate during ride due to nonlinear properties of the entire system. This may cause unexpected drops of the current flow efficiency and further power decreases. Following the relevant significance of the addressed issue, the authors performed an analysis of the influence of suspension properties of the critical pantograph's passive components on the improvement of electric current collection on a train. The analysis was performed based on a co-simulation model for the pantograph-catenary interaction elaborated by the authors. The Finite Element catenary model assumes nonlinear droppers, large displacements and contact with the pantograph's slider. To overcome limits of widely used lumped parameters model of the pantograph, the relatively more realistic Multibody model was considered. Reported in other works, the use of Multibody models, in which all properties of pantograph keep physical sense, provide wide range of design improvements for better current collection. By using the adapted model, the ability of implementation additional dampers in a pantograph structure for improvement of contact quality was investigated. Utilized pantograph model takes into account friction forces, suspension springs and aerodynamic effects. Presented results proof the ability to effectively improve current collection merely by adjusting pantograph's passive components.

[1] Paweł Zdziebko, M.Sc. (Ph.D. student): AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (zdziebko@agh.edu.pl), the author presented this contribution at the conference.

[2] Adam Martowicz, Ph.D.: AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (adam.martowicz@agh.edu.pl).

[3] Tadeusz Uhl, Professor: AGH University of Science and Technology, Department of Robotics and Mechatronics, Al. A. Mickiewicza 30, 30-059 Krakow, POLAND (tuhl@agh.edu.pl).

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Control optimization for a three-segmented hopping leg model of human locomotion

Ambrus Zelei, Bernd Krauskopf, Tamás Insperger

Abstract: The research of human and robotic legged locomotion applies dynamic models with a wide range of complexity and aims to answer many different questions. In our research we focus on the effect of kinematic parameters and foot placement techniques on the ground-foot impact intensity. Our method is to use the multibody dynamic model of a segmented leg. We obtain a quantitative measure for the foot collision intensity by analytic calculations. The pre-impact velocity conditions are obtained by a hopping three-segmented planar leg model that imitates pedal locomotion. The single legged model contains the foot, the shank, the thigh and a reaction wheel attached in the hip. Stable periodic motion, i.e. hopping was achieved by means of control torques in the ankle, the knee and the hip joint. Different control strategies are specified for the grounded and flight phase. The parameters of the linear feedback controller are tuned to optimise different cost functions, such as running speed, energy efficiency and impact intensity. We also investigate how the stability of periodic motion depends on the control gains.

1) Ambrus Zelei, Ph.D.: Department of Applied Mechanics, Budapest University of Technology and Economics and MTA-BME Research Group on Dynamics of Machines and Vehicles, Muegyetem rkp 3., BUDAPEST, H-1111, HUNGARY (zelei@mm.bme.hu), the author presented this contribution at the conference.

2) Bernd Krauskopf, Professor: Department of Mathematics, the University of Auckland, Private Bag 92019, Auckland 1142, NEW ZEALAND (b.krauskopf@auckland.ac.nz).

3) Tamás Insperger, Associate Professor: Department of Applied Mechanics, Budapest University of Technology and Economics and MTA-BME Lendület Human Balancing Research Group, Muegyetem rkp 3., BUDAPEST, H-1111, HUNGARY (insperger@mm.bme.hu).

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Four-bar mechanism substitution for balance board experiments: a parametric study

Ambrus Zelei, Csenge A. Molnár, Tamás Insperger

Abstract: Our ongoing research aims at the study of balancing on a rolling balance board with respect to dynamic properties such as stability and stabilizability. The goal is to identify the parameter regions where human subjects are able to keep themselves stable in the upright position for at least 60 sec. The radius of the balance board and the height of the foot platform are adjusted for each individual test, which is a time demanding process. The goal of this paper is to give a preliminary design of a substituting four-bar mechanism in order to speed up the balance board experiments and to extend the limits of the parameter study. The mechanism can be tuned quickly and easily in order to imitate the motion of the balance board with different radii and platform heights. The mechanism is designed such that the agreement of the kinematic behavior is almost perfect for tilt angles within the region of ±30 °. The dynamic behavior of the mechanism and the balance board are compared based on theoretically derived stability diagrams associated with the underlying mechanical models. The balancing process is modeled by a proportional-derivative delayed feedback controller in order to account with the reaction time delay of the subject. It is shown that the stability regions of the balance board and the mechanism for different parameter settings are in good agreement, therefore the mechanism can be used as a substituting device for balance board.

[1] Ambrus Zelei, Ph.D.: Department of Applied Mechanics, Budapest University of Technology and Economics and MTA-BME Lendület Human Balancing Research Group, Muegyetem rkp 3., BUDAPEST, H-1111, HUNGARY (zelei@mm.bme.hu), the author presented this contribution at the conference.

[2] Csenge A. Molnár, B.A. (M.Sc. student): Department of Applied Mechanics, Budapest University of Technology and Economics and MTA-BME Lendület Human Balancing Research Group, Muegyetem rkp 3., BUDAPEST, H-1111, HUNGARY (molnarcsenge@gmail.com).

[3] Tamás Insperger, Ph.D.: Department of Applied Mechanics, Budapest University of Technology and Economics and MTA-BME Lendület Human Balancing Research Group, Muegyetem rkp 3., BUDAPEST, H-1111, HUNGARY (insperger@mm.bme.hu).

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Numerical and experimental modal analysis of laminated glass beams

Alena Zemanová, Tomáš Plachý, Jaroslav Schmidt, Tomáš Janda, Jan Zeman, Michal Šejnoha

Abstract: This paper presents a numerical and experimental modal analysis of laminated glass beams, i.e. a multilayer composite structure made of glass panes bonded to an interlayer foil. These polymer foils provide shear coupling of glass layers, damping of vibration, and play a key role in post-breakage performance. In this contribution, three-layer beams with Polyvinyl butyral (PVB) or Ethylene-vinyl acetate (EVA) interlayer are investigated. Using a finite element discretization and the Newton method, we solve numerically an eigenvalue problem which is complex and nonlinear due to the frequency/temperature-sensitive viscoelastic behavior of polymers. In our experimental investigations, a roving hammer test was carried out to identify the mode shapes, natural frequencies, and damping. The validation shows that there is a good agreement of numerical predictions and experimental data in natural frequencies. However, the errors in loss factors can be high, because these values are very sensitive to the material properties of polymer, frequency, temperature, and boundary conditions. These effects are discussed in our study.

[1)] Alena Zemanová, Ph.D.: Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (alena.zemanova@fsv.cvut.cz), the author presented this contribution at the conference.

[2)] Tomáš Plachý, Assistant Professor: Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (plachy@fsv.cvut.cz).

[3)] Jaroslav Schmidt, B.A. (M.Sc. student): Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (jarasit@gmail.com).

[4)] Tomáš Janda, Ph.D.: Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (tomas.janda@fsv.cvut.cz).

[5)] Jan Zeman, Associate Professor: Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (jan.zeman@cvut.cz).

[6)] Michal Šejnoha, Professor: Czech Technical University in Prague, Faculty of Civil Engineering, Thakurova 7/2077, 166 29 Prague 6, CZECH REPUBLIC (sejnom@fsv.cvut.cz).

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Effects of mild hallux valgus on forefoot biomechanics during walking: a finite element analysis

Yan Zhang, Jan Awrejcewicz, Shudong Li, Yaodong Gu

Abstract: Hallux valgus (HV) is a common foot deformity characterized by progressive lateral deviation of the hallux with medial deviation of the first metatarsal. In this study, foot models of a normal subject and a mild HV hallux valgus patient were developed to evaluate the effects of mild HV on forefoot biomechanics during walking. Three-dimensional finite element model of a normal foot and a mild HV foot were constructed. Finite element analysis was conducted in ANSYS Workbench 17.0. The biomechanical performances were compared at three gait instants, first-peak, mid-stance, and second-peak. The equivalent stress on five metatarsals increased while the resultant joint force and the contact pressure of the first metatarsophalangeal joint (MTP) decreased in mild HV foot in comparison of normal foot. At push-off instant, the normal foot presented a concentrated pressure under the more distal portion of the metatarsal and the hallux, while the HV foot exhibited a more evenly distributed pattern with concentrated pressure under more proximal location of the metatarsal and the hallux. The predicted alternations in joint loading and plantar pressure distribution pattern of the HV foot indicated that HV feet may have deficient capability of body weight transfer at the first MTP during walking.

[1] Yan Zhang, M.Sc. (Ph.D. student): The Lodz University of Technology, 90-924 Lodz, 1/15 Stefanowskiego Str., Building A22, POLAND (zhangyannbu@gmail.com), the author presented this contribution at the conference.

[2] Jan Awrejcewicz, Professor: The Lodz University of Technology, 90-924 Lodz, 1/15 Stefanowskiego Str., Building A22, POLAND (jan.awrejcewicz@p.lodz.pl).

[3] Shudong Li, M.Sc. (Ph.D. student): Liverpool John Moores University, 70 Mount Pleasant, Liverpool L3 5UA, UNITED KINGDOM (lishudong@outlook.com).

[4] Yaodong Gu, Professor: Ningbo University, No.818 Fenghua Rd., Ningbo, CHINA (guyaodong@hotmail.com).

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Obstacle avoidance for nonholonomic systems under the controllability condition with iterated Lie brackets

Alexander Zuyev, Victoria Grushkovskaya

Abstract: The development of control algorithms for the stabilization and motion planning problems is one of the most important issues in mathematical control theory which attracts significant theoretical interest and is highly demanded by various engineering applications. Motion planning problems were intensively studied by many researchers, and there exist several classical approaches for their solution. However, the presence of obstacles in the state space significantly increases the complexity of motion planning. A powerful approach for solving the obstacle avoidance problems is to ensure the motion of a system along the negative gradient flow of a certain potential function. Up to now, this issue has been addressed only for particular classes of systems. In this paper, we consider a general class of nonholonomic systems under the controllability condition with iterated Lie brackets and present a control algorithm which ensures the collision-free motion of the system and stabilizes the dynamics at the target point. The proposed class of control functions is given by highly oscillating trigonometric polynomials with state-dependent coefficients. A rigorous analysis of the solvability of the collision avoidance problem and the proof of asymptotic stability are presented.

[1] Alexander Zuyev, Professor: Max Planck Institute for Dynamics of Complex Technical Systems, Sandtorstr. 1, 39106 Magdeburg, GERMANY (zuyev@mpi-magdeburg.mpg.de).

[2] Victoria Grushkovskaya, Ph.D.: Institute for Systems Theory and Automatic Control, University of Stuttgart, Pfaffenwaldring 9, 70569 Stuttgart, GERMANY (victoria.grushkovskaya@ist.uni-stuttgart.de), the author presented this contribution at the conference.

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Computation of periodic switching strategies for the optimal control of chemical reactors

Alexander Zuyev, Andreas Seidel-Morgenstern, Peter Benner

Abstract: An isoperimetric control problem is considered in this paper for the optimization of the performance measure for a nonlinear chemical reaction model with periodic inputs. For this problem, a family of bang-bang controls parametrized by switching times is introduced. The issue of defining these switching times is addressed for periodic boundary conditions by using the Fliess series expansion. Such a technique allows us to obtain analytical relations between the boundary conditions and control parameters for the case of small time periods. These theoretical results are illustrated by numerical simulations for a non-isothermal reaction model with two inputs.

[1] Alexander Zuyev, Professor: Max Planck Institute for Dynamics of Complex Technical Systems, Sandtorstr. 1, 39106 Magdeburg, GERMANY (zuyev@mpi-magdeburg.mpg.de), the author presented this contribution at the conference.

[2] Andreas Seidel-Morgenstern, Professor: Max Planck Institute for Dynamics of Complex Technical Systems, Sandtorstr. 1, 39106 Magdeburg, GERMANY (seidel@mpi-magdeburg.mpg.de).

[3] Peter Benner, Professor: Max Planck Institute for Dynamics of Complex Technical Systems, Sandtorstr. 1, 39106 Magdeburg, GERMANY (benner@mpi-magdeburg.mpg.de).

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A remark on point coordinates in multibody dynamics formulations

Ulrike Zwiers

Abstract: This paper shows that condensed point-coordinate models of rigid bodies depend greatly on the method used to generate the governing set of equations. Referring to planar multibody systems, four different methods to formulate dynamically equivalent two-point models of arbitrarily shaped rigid bodies are presented, namely, reduction of three-point models, transformation of body-coordinate models in both centroidal and non-centroidal formulation, and a direct modeling approach. The numerical analysis of a physical pendulum serving as a benchmark example reveals that the resulting two-point models partially lack characteristics common to mechanical systems such as a symmetric, positive-definite mass matrix. However, despite their remarkable differences in inertia and inertial coupling, all models are proved to be capable to predict the pendulum's motion and the reactions at the pivot point correctly.

[1)] Ulrike Zwiers, Professor: Hochschule Bochum University of Applied Sciences, Lennershofstraße 140, 44801 Bochum, GERMANY (ulrike.zwiers@hs-bochum.de), the author presented this contribution at the conference.

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Certain issues of modelling of high frequency dynamic responses by FE techniques

Arkadiusz Żak, Marek Krawczuk, Grzegorz Redlarski, Wiktor Waszkowiak

Abstract: Modelling of high frequency dynamic responses of engineering structures, especially those related to wave propagation, is a real numerical challenge. Nowadays most of numerical models, used for that purpose, are based on the application of finite element techniques. However, finite element discrete models may also be considered as possessing certain periodic structures, which may manifest themselves in particular scenarios. The source of their periodicity comes from the discontinuities of stress/strain field between finite elements, which usually are ignored by modellers as having no influence of numerical results obtained. Indeed, this behaviour remains unnoticeable, when low frequency dynamics is investigated. On the other hand at high frequency regimes its influence may be strong enough to dominate calculated structural dynamic responses distorting or even falsifying them completely. In the paper certain issues of modelling of high frequency dynamic responses by finite element techniques are discussed by the authors. In this discussion the authors focus their scientific interest on exemplary problems related to wave propagation, with a special attention paid to wave propagation in periodic structures. The authors also present and discuss methods to minimise or avoid the numerical issues mentioned.

1) Arkadiusz Żak, Associate Professor: Gdansk University of Technology, Narutowicza 11/12, POLAND (arkadiusz.zak@pg.gda.pl), the author presented this contribution at the conference.

2) Marek Krawczuk, Professor: Gdansk University of Technology, Narutowicza 11/12, POLAND (marek.krawczuk@pg.gda.pl).

3) Grzegorz Redlarski, Associate Professor: Gdansk University of Technology, Narutowicza 11/12, POLAND (grzegorz.redlarski@pg.gda.pl).

4) Wiktor Waszkowiak, M.Sc. (Ph.D. student): Gdansk University of Technology, Narutowicza 11/12, POLSKA (wiktor.waszkowiak@pg.gda.pl).

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Methods of simulation investigations of non-linear vibrations in the steering system of a motorcycle

Dariusz Żardecki, Andrzej Dębowski

Abstract: Torsional vibrations in motorcycles steering systems are especially evident operated at high dynamic loads and high speeds. Then as a result of mechanical wear, freeplay and friction non-linear dynamical effects are noticeable. The vibrations generated in the motorcycle steering system in the presence of freeplay and friction phenomena have a strong non-linear nature because of stick-slip processes. Due to the threshold character of these nonlinearities and the variability of the model structure, simulation-type investigations of such vibrations are difficult and still require extensive research. For solution these difficult problems, special methods of modeling and special methods of simulation analysis have been applied. The luz(…) and tar(…) projections with their original mathematical apparatus give new facilities for modeling and analysis strong non-linear vibrations. Among other, they can be used for synthesis substitutive formulas expressing time lag phenomena in such systems, they are very useful also when the model of the system is reduced parametrically. Application of Lissajou portraits and Poincare maps seems to be attractive methods not only for visualization of the non-linear vibrations, but also effective methods for analysis these spectacular signals what has been done in a simulation software. The elaborated method of simulation-based analysis of non-linear vibrations is illustrated by examples that deal with parametric sensitivity studies of non-linear dynamical systems with inclusion of freeplay and friction (with stiction) phenomena.

[1] Dariusz Żardecki, Assistant Professor: Military University of Technology, Gen. Sylwestra Kaliskiego 2, 01-476 Warsaw, POLAND (dariusz.zardecki@wat.edu.pl), the author presented this work at the conference.

[2] Andrzej Dębowski, M.Sc. (Ph.D. student): Military University of Technology, Gen. Sylwestra Kaliskiego 2, 01-476 Warsaw, POLAND (andrzej.debowski@wat.edu.pl).

INDEX OF AUTHORS