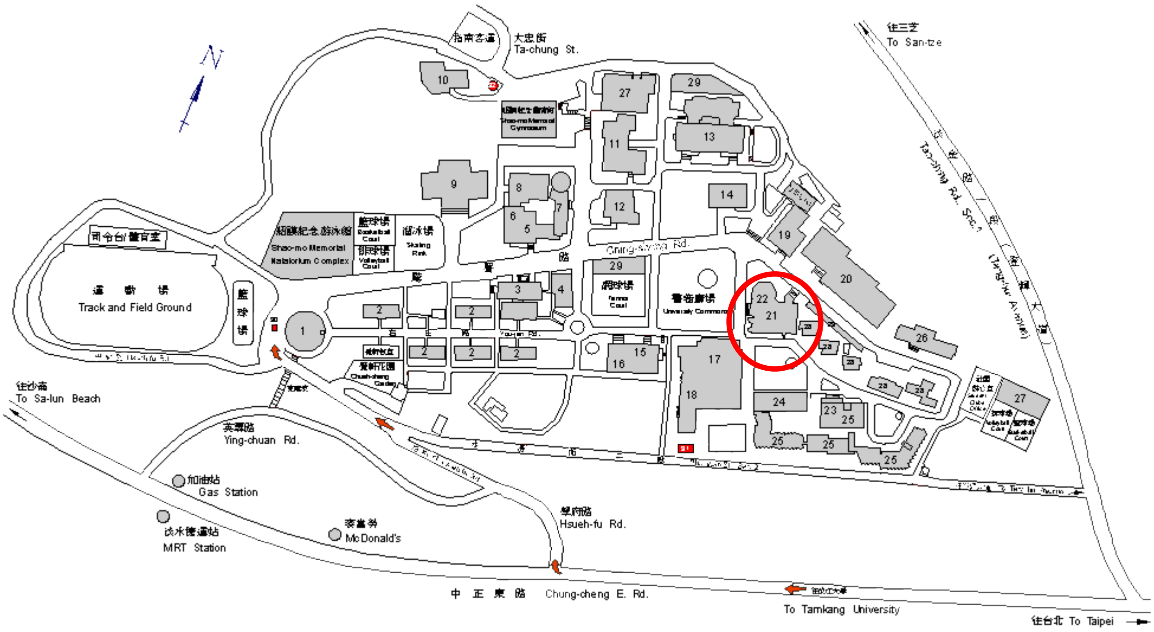
Schedule of ICBAO-2015

Day 1- June 28 (Sun.), 2015		
16:00-20:30	Registration	
18:30-20:30	Welcome Reception	
Day 2- June 29 (Mon.), 2015		
08:30-16:00	On-site Registration	
09:00-09:20	Open Ceremony Welcome address: President of TKU, Flora Chia-I Chang (張家宜校長) Speaker Introduction/ Group Photography	
09:20-10:00	Plenary Speech 1 Chair: A. B. Wang (王安邦), NTU	(P1) S. P. Sane, NCBS, India/ USA *Topic: The Biomechanics of the Flight Motor in Flapping Insects*
10:00-10:50	Session 1 Chair: A. B. Wang, NTU	(S1) Spot S. Srigrarom, UGS, Singapore (S2) L.-J. Yang (楊龍杰), TKU
10:50-11:15	Break/ Poster	
11:15-12:30	Session 2 Chair: Spot S. Srigrarom, UGS	(S3) U. Chandrasekhar, ESCI (S4) David T. W. Lin (林大偉), NUTN (S5) Y.-C. Hu (胡毓忠), NIU
12:30-14:00	Lunch/ Poster	
14:00-15:15	Session 3 Chair: S. P. Sane, NCBS	(S6) S.-K. Fan (范士岡), NTU (S7) P. C. Lin (林沛群), NTU (S8) T. Wan (宛同), TKU
15:15-15:40	Break/ Poster	
15:40-16:55	Session 4 Chair: C. K. Feng (馮朝剛), TKU	(S9) C. I. Lin(林晉毅), S. Wu, W. P. Shih (施文彬), NTU (S10) A. Verma, David T. W. Lin , VTU/NUTN (S11) S. Marimuthu (蘇希德), L.-J. Yang, TKU
16:55-18:00	TKU Lab Tour and Ornithopter Demo	
18:00-20:30	Banquet	
Day 3- June 30 (Tue.), 2015		
09:00-09:40	Plenary Speech 2 Chair: S. W. Kang (康尚文), TKU	(P2) Isao Shimoyama (下山勳), Univ. of Tokyo *Topic: Pressure Distribution Measurement on Flapping Wings*
09:40-10:30	Session 5 Chair: U. Chandrasekhar, ESCI	(S12) B. Esakki, VTU (S13) H.-C. Han (韓謝忱), Academia Sinica
10:30-10:50	Break/ Poster	
10:50-12:00	Session 6 Chair: B. Esakki, VTU	(S14) J. C. Li (李仁傑), P. Z. Chang (張培仁), NTU (S15) C. H. Liu (劉昭華), TKU (S16) A. L. Feng (馮愛蓮), L.-J. Yang, TKU
12:00-12:10	Closing Remarks	
12:10-14:00	Lunch	
Post tour		
14:00-16:00	Move to Lanyang Campus of TKU/ Introduction	
16:00-18:00	Panel discussion on Ornithopters; Chair: L.-J. Yang	
18:00-20:00	Hotel Check-in/ Dinner	
Day 4- July 1 (Wed.), 2015		
08:00-12:00	Tour to Queshan (Turtle) Island	
12:00-18:00	Lunch/ Tour in I-Lan/ Back to TKU	

Conference Venue: Ching-Sheng Memorial Hall, Tamkang University (TKU)



21, 22: Ching-Sheng Memorial Hall
20: College of Engineering
1: TKU gate

Content

Welcome Address of Prof. Flora Chia-I Chang, President, Tamkang University

Flora Chia-I Chang

Honorary Chair, Organizing Committee

President, Tamkang University

Professor, Graduate Institute of Educational Policy and Leadership, Tamkang University

Distinguished guests and dear colleagues,

On behalf of Tamkang University and the organization committee of the International Conference on Biomimetics and Ornithopters ICBAO-2015, I would like to extend my warmest welcome to all of the participants in this event.

ICBAO-2015 is to bring forth the merging of the two important technologies: “Biomimetics” and “Ornithopters (flapping unmanned air vehicles)” and to provide a platform for exchanging and bridging the latest development of both fields worldwide. So I think it is not only the right time for our colleagues to demonstrate some research results of Tamkang University about this filed, but also to highlight the technical and academic wonders from several countries including India, Japan, Singapore and Taiwan in ICBAO-2015.

Founded in 1950, Tamkang University is the oldest private university in Taiwan, now she consists of 10 colleages, 51 departments located in 4 campuses (Tamsui, Taipei, Langyang and Cyber.) Based on the “Triple Objectives of Education”, which include globalization, information-oriented education and future-oriented education, Tamkang University always keeps eye on the social needs and international academic trends. Therefore, in this international conference, we’d like to provide an opportunity for exchanging the cutting-edge information of “Biomimetics” and “Ornithopters, and to promote the international connection or cooperation among all the participants.

We appreciate all the invited speakers for presenting your latest outstanding works. I believe this conference will be very successful. Thanks for your participation with warm heart, and may all of you have a good time in Taiwan.

Organization Committee

Honorary Chairman:	
Prof. Flora Chai-I Chang	Tamkang University
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Prof. Jing-Min Tang	Tamkang University
Prof. Chyan-Chyi Wu	Tamkang University

Plenary Speaker 1 (P1)

Sanjay P. Sane, National Center for Biological Sciences (NCBS), India/ USA

Topic: The Biomechanics of the Flight Motor in Flapping Insects

- Author or coauthor of 2 papers published in "Science" (1999, 2007).
  Sane, S.P., Dieudonné, A., Willis, M.A., Daniel, T. L., Antennal mechanosensors mediate flight control in moths, Science, 315, 863-866, 2007.
  Dickinson, M.H., Lehmann, F.O., Sane, S.P., Wing rotation and the aerodynamic basis of insect flight, Science, 284, 1954-1960, 1999.
- According to Scopus: total citation number of his top 7 papers is 2476.
- The Ramanujan Fellowship (2009).
- Journal of Experimental Biology Travel Fellowship (2006).
- Society of Experimental Biology Young Scientist Travel Award (2005).
- NSF Post-doctoral Fellowship for Interdisciplinary Informatics (# 0306154, 2003-2005).
- Editor Board of "Biology letters", "Frontiers in Neural Circuits", "Journal of Neurophysiology", "Journal of Bionic Engineering" since 2010.

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Abstract

To be able to fly, insects must flap their wings at very rapid rates and yet with very accurate control of their wing kinematics. In flies and many other insects, this is achieved by large indirect flight muscles which insert into the insect thorax and vibrate it at high frequency. These vibrations create strain patterns within the thorax which are then transmitted via a complex wing hinge to power the overall amplitude of the wing motion. The finer aspects of wing kinematics, such as stroke plane or angle of attack are controlled by a separate set of muscles which directly insert into the wing hinge. The biomechanics of the insect thorax thus offers fascinating insights into the inner workings of the flight motor and the transmission. Our recent investigations show that the thorax contains mechanical linkages that connect the wing pair. In flies, another set of linkages connect the wings to halteres, which are the reduced hind wings of flies that act as gyrosensory organs. These mechanical linkages ensure that there is a very precise phase relationship between the wing and haltere motion. This accuracy of wing and haltere phase relationship is essential for flight; disrupting it causes a loss of flight ability. In my talk, I will describe in detail these findings in the context of their importance in the evolution of insect flight, and its relevance to engineering applications.

Plenary Speaker 2 (P2)

Isao Shimoyama (下山勲), University of Tokyo, Japan

Topic: Pressure Distribution Measurement on Flapping Wings

Isao Shimoyama was born in Japan in 1955. He received the B.E., M.E, and Dr. of Engineering degrees in mechanical engineering from The University of Tokyo in 1977, 1979, and 1982, respectively. He joined The University of Tokyo in 1982 and is presently Professor, Director of Information and Robot Technology Research Initiative. His current Research interest is in Robotics, MEMS and nano-on–microsystems

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Abstract

We have made MEMS cantilever sensors with high sensitivity for micro-force/ pressure measurement. The piezo-resistors were formed at the foot of the cantilevers for detecting small strain caused by the force acting on the cantilevers. The relationship between pressure on the piezo-resistive cantilever and the sensor output was calibrated in advance. The micro-force sensor with 100um on a side and 0.3um in thickness, can detect differential pressure less than 1 Pa, equivalent to the wing load of a butterfly. The gap between the cantilever and the wall is small enough, so that the little air leak is exhibited through the gap. Since the material of the cantilever is single crystal silicon, the sensor has good properties, such as linearity, durability, no hysteresis.

We attached the differential pressure sensor to wings of butterflies which took off the ground with free flight. The resistance change of the piezo-resistor of the cantilever was read out through a pair of thin gold wires which did not largely affect the insect motion. In addition, a video was shot at the same time to obtain the relationship between pressure on a wing and motion of an insect.

Our measurements show that the differential pressure rose and fell periodically and symmetrically in accordance with wing motion. The magnitude of the differential pressure increased as the position shifted from the wing root to the tip during takeoff.

Session Chair of P1 and Session 1

A. B. Wang, Institute of Applied Mechanics, National Taiwan University, Taiwan

An-Bang Wang is a Professor of Institute of Applied Mechanics, National Taiwan University, Taiwan. He received Dr.-Ing.-degree, Friedrich-Alexander-Universitat, Erlangen-Nurnberg, Germany, 1991. He is the Director of Optomechatronics Education Resource Center, Ministry of Education, Taiwan since 2002. His research topics include opto-eletro-bio-medical measurement, thermo-fluidic control, display technology, and energy-saving.

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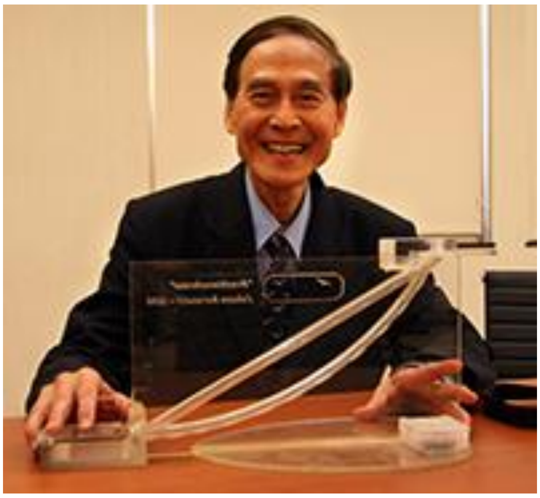
Session Chair of Session 4

C. K. Feng, Department of Aerospace Engineering, Tamkang University, Taiwan



Chao-Kung Feng is a Professor Emeritus of Aerospace Engineering, Tamkang University, Taiwan. He received M. S. from UCSD, Engineer Degree from Stanford University and Ph.D. from UCLA in 1971. He has ever been the Vice President for Academic Affairs, Dean of Engineering College, and Chairman of Aerospace Engineering at Tamkang University. His research topics include high-speed aerodynamics, similarity method, perturbation method and engineering mathematics.

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Session Chair of P2

S. W. Kang, Department of Mechanical and Electromehanical Engineering, Tamkang University, Taiwan

Shung-Wen Kang is a Professor of Mechanical & Electromechanical Engineering, Tamkang University, Taiwan. He received Ph.D. from Louisiana Tech University in 1991. He has ever been the chairman of Mechanical & Electromechanical Engineering and Dean of R&D, Tamkang University. His research topics include loop heat pipe (LHP), capillary pump loop (CPL), oscillating heat pipe (OHP), pulsating heat pipe (PHP), thermosyphon, vapor chamber, heat spreader, mini/micro heat pipe, nano-fliud in heat pipe.

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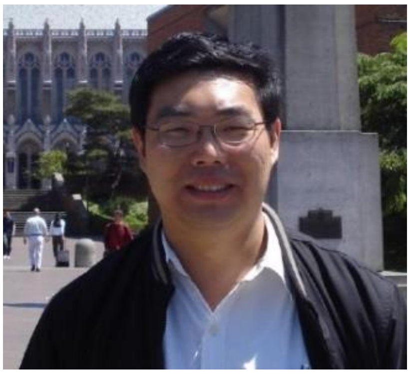
(S1) Spot S. Srigrarom, University of Glasgow Singapore (UGS), Singapore

Topic: Design and Development of UGS Flapping Wing MAVs



Spot S. Srigrarom is currently working at University of Glasgow Singapore in partnership with Singapore Institute of Technology, as an associate professor in Aerospace Systems. Prior to this, he worked for the Boeing commercial airplane company in Seattle during his graduate study. Before joining UGS-SIT, Dr. Spot was at Nanyang Technological University (NTU) and SIM University. He was a visiting professor at MIT, Univ. of Toronto, National Cheng Kung University (Taiwan), Konkuk University (Korea) and Kasetsart Univ. (Thailand). He is an associate editor of Journal of Unmanned Systems Technology (JUST). He has published about 40 journal and 30 conference papers (as of 2012). His research areas are:

- Unsteady Aerodynamics, Flapping Wing MAV
- Bio-inspired Fluid Mechanics Flying/Swimming studies
- Unmanned Aerial Vehicle/Micro Aerial Vehicle (UAV)
- Vision-based Navigation, Swarming of UAVs
- Rotary Wing Aerodynamics, Blade designs
- Wind/tidal turbine designs for renewable energy
- Fluid-Structure Interaction, Aero-/Hydro-elasticity
- CFD and FEA applications for industrial/practical problems

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Abstract

This paper presents our ongoing development of a near-resonance type flapping wing autonomous micro air vehicle (MAV). Our proposed resonance type flapping wing utilizes the near resonance phenomenon of a two-degree of freedom elastic system, that is, the wing is supported by the springs for flapping and feathering motions. Being oscillated close to the resonance frequency of the system, only by the torque in flapping motion, the amplitude gained is a few times higher than that of normal case. Next, we examine the unsteady flow characteristics and flight dynamics of the albatross-like flapping wings by means of CFD. The flow around the flapping wing was predicted by using ANSYS Fluent® unsteady three-dimensional compressible Navier-Stokes equations. From CFD results, we designed, built and flew our University of Glasgow Singapore (UGS) flapping wing MAVs using fabrication method such as laser cutting and Rapid Prototyping. The first prototype was made from acrylic using a laser cutting machine. The wings were made up of carbon rods and kite material Ripstop. First test showed that the wings were too heavy for the mechanism to work. The second prototype was a smaller single gear crank design which was fabricated using a 3D printer. Initial test proved that the second prototype could withstand the high frequency flapping and near resonance amplitude as designed. With remote control, the second prototype was able to take off, climb, cruise and land in flapping mode successfully.

(S2) L.-J. Yang (楊龍杰), Department of Mechanical and Electromehanical Engineering, Tamkang University, Taiwan

Topic: Toward Long-Endurance Flight- Tamkang's Aspect of Micro Ornithopters

Lung-Jieh Yang received his M.S. degree from Tamkang University, Taiwan in 1991 and Ph.D. degree from the Institute of Applied Mechanics, National Taiwan University, Taiwan in 1997. He is currently a professor and Chairman of the Department of Mechanical & Electro-mechanical Engineering. He is also the editor-in-chief of Journal of Applied Science and Engineering (ISSN 1560-6686), and Chairman of Popular Science & Education Affairs Committee of Aeronautical & Astronautical Society of Republic of China (AASRC). His current research interests include flapping micro-air-vehicles (MAVs), micro-fluidics, and polymer MEMS technologies.

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Abstract

Regarding to the 20-cm wingspan flapping micro-air-vehicles (MAVs) or ornithopters, how to prolong the operation time and improve the flight control is very critical to their roadmap of development. Based on using the available technology and commercial transducer devices, this work presents four new features of ornithopters and proves them feasible in the Tamkang's "Golden snitch". The 1st feature is repeatable short take-off and landing (re-STOL) so that the ornithopter can stop flapping in the air and automatically falls on the ground with resetting to the good gesture of take-off. The 2nd feature is to recharge the onboard Lithium battery by flexible photo-voltaic (PV) thin film on the tail. Recharging can be done either during flight or on the ground if the background light intensity is enough for PV devices to work. The 3rd feature is toward the semi- or fully autonomous flight control of ornithopters. It is realized by integrating gram-weighted microelectronic devices including Arduino-based micro-processors, MEMS inertial measurement units (IMUs) and mini servo actuators. Longitudinal pitching control and altitude control are shown herein. The 4th feature is to develop new flapping mechanisms with large flap angle and no phase lag between two flapping wings. The above four newly developed features of ornithopters can preliminarily solve their current four shortcomings, i.e., vulnerable to gust wind, short flight endurance, hard to autonomously control and small payload, to great extent.

(S3) U. Chandrasekhar, Engineering Staff College of India (ESCI), India

Topic: Additive Manufacturing and 3D Printing in the Development of Bio Mimicking MAV

U. Chandrasekhar is a scientist and academician with about 30 years of experience in activities related to design, analysis, testing and rapid manufacturing of aero gas turbine projects. Currently he is the Director of ESCI, the autonomous educational wing of the Institution of Engineers (India). He received his graduation (NIT, Suratkal) and post graduation degrees (IIT Chennai) in mechanical engineering. He received PhD for his research in additive manufacturing carried out at DRDO. His areas of research include analysis of gas turbines, additive manufacturing, micro air vehicles and harsh environment sensors.

He served as the Project Director for National Projects of DRDO with focus on metal prototyping and also harsh environment sensors. In this role he facilitated rapid prototyping and rapid tooling activities of several aerospace projects connected with unmanned air vehicles, communication systems, turbofan and turbojet engines.

He received Gold Medal from former President of India Dr. AP J Abdul Kalam for his academic achievements. He received commendation medal from the Scientific Advisor to the Defense Minister in recognition of his contributions to rapid manufacturing of complex aeronautical systems. He led a group of senior academicians from World Bank TEQIP funded institutions to R&D labs and universities in Canada and enabled bilateral programs for enhancing teaching and research in Indian technical institutions.

He serves on the editorial board of international RP journal and Springer IE journal for Mechanical Engineering. He was instrumental in starting the rapid prototyping society of India under the aegis of National Design & Research Forum. He is mentoring a few start-up companies interested in the development of 3D printers. He addressed several national and international forums on topics relevant to additive manufacturing.

Currently he serves as an expert member of the advisory panel of the Principal Scientific Advisor to evolve the national policy on additive manufacturing. For the past 1 year he has been serving the Institution of Engineers (India) as the Director of ESCI, Hyderabad.

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Abstract

Fused deposition modelling (FDM) and stereolithography (SLA) are among the foremost additive manufacturing (AM) technologies that have found prolific use in the design and development cycles of a wide gamut industries including aeronautics. Consistent growth in the accuracy of AM technology has facilitated its progressive transformation from its initial status of a design-visualisation tool to that of a competitive manufacturing solution. Emergence of AM as a viable manufacturing solution prompted researchers to apply various AM techniques in the complete spectrum of product development. This paper describes the use of AM parts in design and development of bio mimicking micro air vehicles (MAV). Despite the fact that AM parts made through FDM and SLA have shown considerable geometrical fidelity, they have limited mechanical strength due to which their direct application in MAV development is not possible. Particularly in case of mechanisms for MAV applications, significant mechanical loads are prevalent both during all the phases of operation starting from vehicle launch to landing. Hence enhancing the surface integrity and strength of the thermoplastic AM parts is essential to render them suitable for MAV operations. Scope of the research includes studies on surface preparation and surface activation of ABS (P 400) and photopolymer (SL 5530) parts, electroless and electro deposition of metallic layers, strength characterisation of metallised RP parts, process optimisation experiments, simulation works and proof-of-concept studies. Due to layered nature of AM and 3D printing, the AM parts exhibit surface voids that in turn leads to absorption of the electro deposition chemicals. Chemical and mechanical treatment of as-built AM parts is an important element of the present study. Mechanical characterisation tests include evaluation of tensile strength, residual stress, flexural strength, and impact strength. The proposed research is interdisciplinary in nature as it demands synergistic application of the concepts of material science, mechanical engineering and aeronautics, for fulfilling the projected research goals. Interfacial adhesion between metallic layers and the thermoplastic AM substrates is a subject of intense phenomenological studies and the present proposal aptly evaluates this phenomenon with reference to functional test requirements. Published work on the development of bio mimicking MAVs or ornithopters has reported the use of EDM and injection molding. However these conventional fabrication processes necessitate the use of extensive tooling and during the process of design optimisation when mechanisms need to be modified, the consequential changes in the tooling can be costly and time consuming. The present work demonstrates the integrated use of CAD and AM in realisation of mechanisms for bio mimicking MAVs

(S4) David T. W. Lin (林大偉), National University of Tainan (NUTN), Taiwan

Topic: New Choice of Stealth Technology- The Fabrication of Metamaterials Based on the Fully Inkjet Printing Technology

David T. W. Lin is a Professor and Chairman of Graduate Institute of Mechatronic System Engineering, National University of Tainan, Taiwan. He received Ph.D. from National Cheng-Kung University in 2004. He is also the Chairman of ICMS-2015, -2009, Deputy Chairman of Secretariat of Aeronautical & Astronautical Society of Republic of China (AASRC), and the Associate Editor in Chief, Smart Science. His research topics include geothermal system, optimization, LED, heat transfer, pressure vessel.

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Abstract

Metamaterials will be an excellent wave-controlled device such as steal technology, photo-absorbed device, planar lens, and ultrasonic sensors. This present will introduce the fabrication of metamaterials by the fully ink-jet printing technology on the flexible polyimide (PI) substrate. S-parameters of this device of metamaterials are obtained from the vector network analyzer. The pattern of this case is a double-cell split ring resonator. The size of the split ring resonator responses the frequency band in 5.5-6 GHz. It can be converted to obtain the permittivity and magnetic permeability. This fabricated process is robust and cheaper than MEMS process

(S5) Y.-C. Hu (胡毓忠), National I-Lan University(NIU), Taiwan

Topic: Flexible Proximity Sensor

Yuh-Chung Hu is a Professor and Chairman at Mechanical & Electromechanical Engineering, National I-Lan University, Taiwan. He received Ph.D. from National Taiwan University of Science and Technology in 1999. He has ever been the Chair of Dept. of Mechatronic Engineering at Huafan University, Taiwan. His research topics include flexible sensors, micro/nano electromechanical systems, automation, and solid mechanics.

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Abstract

This paper proposes a flexible proximity sensor array fabricated by resembling print screen. Each unit of the sensor is composed of a polyvinylidene fluoride (PVDF) layer sandwiched in between top- and bottom-electrode layers which are made of conductive silver ink. The sensing mechanism bases on the pyroelectricity of the PVDF layer. The aforesaid sandwiched sensor units are sprayed simultaneously on a flexible polyimide (PI) substrate layer by layer to form a sensor key-panel. The resembling print screen process is very low-cost. The prototype demonstrates that it is sensitive to human fingers, and therefore one of its applications is becoming for a flexible non-contact proximity key-panel for the user interface of instruments or machines. It may also be applied to proximity sensing or thermal radiation sensing. The proposed flexible proximity key-panel is also suitable for massive roll-to-roll process.

(S6) S.-K. Fan (范士岡), National Taiwan University (NTU), Taiwan

Topic: Constructing Biomimetic Heterogeneous Microcomponents on an Electro-Microfluidic Platform

Shih-Kang Fan received the B.S. degree from National Central University, Taiwan, in 1996, and the M.S. and Ph.D. degrees from the University of California, Los Angeles (UCLA), USA in 2001 and 2003, respectively.

Between 2004 and 2012, he was an Assistant Professor with the Institute of Nanotechnology at National Chiao Tung University (NCTU), Taiwan. From 2009 to 2012, he was an Associate Professor in the Institute of Nanotechnology, the Department of Material Sciences and Engineering, and the Department of Mechanical Engineering at NCTU. Since 2012, he has been an Associate Professor with the Department of Mechanical Engineering at National Taiwan University, Taiwan. His research interest focuses on electro-microfluidics.

Dr. Fan was a recipient of several young investigator awards in Taiwan, including the "TBF Chair in Biotechnology" from Taiwan Bio-Development Foundation and "Young Scholar's Creativity Award" from Foundation for the Advancement of Outstanding Scholarship in 2014, the "Research Award for Junior Research Investigators" from Academia Sinica in 2012, and the "Ta-You Wu Memorial Award" from National Science Council in 2011.

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Abstract

Synthesis and assembly of multi-functional, heterogeneous, and encoded microcomponents, or building blocks, are essential to engineering hierarchical, complex, and three-dimensional structures. The elaborately organized architectures devise metamaterials that hold new physical properties unusual in nature or artificial tissues that reappear physiological functions by imitating natural and biological arrangements. Here we demonstrate synthesis and assembly of microcomponents by electrowetting-on-dielectric (EWOD) and dielectrophoresis (DEP) on a robotic electro-microfluidic platform. The platform is capable of (1) driving different droplets of hydrogel prepolymers before cross-linking, (2) arranging particles or cells in the droplets, and (3) forming microcomponents by cross-linking droplets in different shapes. In the presentation, we will demonstrate the synthesis and assembly of different hydrogel microcomponents containing different dyes and particles. The heterogeneous structures with cell adhesive GelMA (gelatin methacrylate) and non-adhesive PEG-DA (Poly(ethylene glycol) diacrylate) surfaces are prepared for cell culture. The culture of fibroblasts NIH/3T3, neonatal mouse cardiomyocyte, and endothelia HUVEC on the engineered structures synthesized and assembled on the robotic electro-microfluidic platform will be reported.

(S7) P. C. Lin (林沛群), National Taiwan University (NTU), Taiwan

Topic: Model-based Dynamic Locomotion on Legged Robots

Pei-Chun Lin is an Associate Professor in the Department of Mechanical Engineering at National Taiwan University (NTU), Taipei, Taiwan. He received B.S. and M.S. degrees in mechanical engineering from NTU in 1996 and 1998, respectively, as well as an M.S. degree in electrical engineering and computer science and a Ph.D. in mechanical engineering from the University of Michigan, Ann Arbor, U.S.A. in 2005. He then worked as a postdoctoral research fellow in the Department of Materials Science and Engineering at the University of Pennsylvania before moving to NTU in 2007. He is the director of the Bio-inspired Robotics Laboratory (BioRoLa) at NTU. His research interests include bio-inspired robotics, mechanical design, sensor design/fusion, control, locomotion, and polymer applications in robotics. He is a member of IEEE, ASME, CSME (Chinese Society of Mechanical Engineers), CIAE (Chinese Institute of Automation Engineers), and RST (Robotics Society of Taiwan). He was the recipient of the 2012 Ta-You Wu Memorial Award from the National Science Council, and the 2013 Distinguished Teaching Award from National Taiwan University.

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Abstract

Dynamic and agile locomotion performed by legged animals demonstrates a feasible but still very challenging style of locomotion to be exhibited on artificial legged platforms. How animals evolved to their present forms and how they coordinate their high degree-of-freedom (DOF) active/passive joints for dynamic maneuver are still puzzles to be explored. Previously, Prof. Full and Prof. Koditschek proposed a hypothesis that a complex system, or an "anchor" which sketches the actuation joints and rigid structures, can be prescriptively controlled by a reduced-order model, or a "template" which captures the essential dynamics of the original system. This approach provides a feasible path to address dynamic problems of the complex system which is intrinsically dynamic and whose DOFs are highly coupled. Here, with the goal of exciting dynamic behaviors on empirical complex robots, we would like to address this problem by exploring simple reduced-order dynamic models and linking their behaviors to "gait-level" behaviors of the complex robot platforms. A simple reduced-order model, the rolling spring-loaded inverted pendulum (R-SLIP), is developed and served as the running template of a RHex-style hexapod robot. Experimental validation confirms that by merely deploying stable running gaits of the R-SLIP model on the physical robot with a simple open-loop control strategy, the robot can easily initiate its dynamic running behaviors with a flight phase and can move with similar body state profiles to those of the model, in all five speeds that were tested. Further, the R-SLIP model is revised to include power and damping terms, named torque-actuated

dissipative spring loaded inverted pendulum (TDR-SLIP) model, to make the model more realistic to meet the empirical robot energy conditions. In addition to the models with only one virtual leg, a two-leg sagittal-plane model is constructed that serves as the fundamental multi-leg gait-level template. It successfully excites the bounding and pronking behaviors of the "quadruped version" of the RHex-style robot. Moreover, a three-leg planar model is also constructed to develop leaping behavior of the RHex-style robot by using the same methodology.

(S8) T. Wan (宛同), Department of Aerospace Engineering, Tamkang University, Taiwan

Topic: On the Performance Analysis of Flapping Wing MAV under the Influence of Severe Weathers

Tung Wan is an Associate Professor at Aerospace Engineering, Tamkang University, Taiwan and Board Member of AIDC (Aerospace Industrial Development Corp.) He received Ph.D. from The University of Texas at Arlington. He has ever been the Secretary-General, Spokesman, Director of Personnel of Tamkang University and the Supervisor, Chairman of International Affairs Committee of Aeronautical & Astronautical Society of Republic of China (AASRC). His research topics include applied aerodynamics, computational fluid dynamics, aircraft design, aviation safety, aviation weather.

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Abstract

Most studies on flapping wing aerodynamic performance have been mainly concentrated on motion under calm and clear atmospheric conditions so far, but atmospheric disturbance such as gust wind or rainy conditions could lead to flapping MAV (Micro Aerial Vehicle) great damage. In this study, using numerical method and employ ANASYS software as the flow solver, the motions of flapping wing are combined with the dynamic mesh technique. Thus we could calculate the flapping wing aerodynamic parameters such as lift and thrust in unsteady flow and two-phase flow situations. Finally, the flapping wing behavior is simulated in gust wind conditions through existing gust wind profiles and rain simulation modules, and results show that the lift force did change with the wind speed and rain droplet size/velocity. As wind speed and rain rate become larger, the lift also varies violently and may lead to some detrimental situations. Weather influence always exists in realistic operation, and must be included in the MAV preliminary design consideration, thus current study represent a pioneering investigation in that direction.

(S9) C.-I. Lin (林晉毅), S. C. Wu, W. P. Shih (施文彬),
National Taiwan University (NTU), Taiwan

Topic: Squat and Standing Motion of a Single Robotic Leg Using Pneumatic Artificial Muscles

Wen-Pin Shih graduated from Civil Engineering, National Taiwan University (NTU) in 1997, and received Ph.D. from Cornel University in 2004. He is now a Professor in the Department of Mechanical Engineering at NTU. His research topics include design, modeling and fabrication of microelectromechanical systems (MEMS) with applications in biomedical engineering and radio frequency and optical communications; micromechanics and dynamics related to MEMS; nanomanufacturing, biosensors and nanoactuators; theoretical and experimental solid mechanics.

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Abstract

A single humanoid leg has been developed with the attempt to realize an assistive biped as a long-term goal. Human-like walking gait was demonstrated. As human gait is a complicated dynamic balancing system, the stability of the robotic leg, attributed to its own weight, was investigated. To gain a deeper insight into the stability control, motion of the robotic leg such as squat and stand with its own weight was test. For imitating human-like linear actuation and reducing energy consumption, pneumatic artificial muscles (PAMs) were adopted to drive the robotic legs. PAM, whose linear deformation is dominated by its inner pressure, behaves like human muscles. PAM actuators have the highest power-to-weight and power-to-volume ratios in comparison with other actuators; therefore, a light-weighted PAM can generate strong forces. The nonlinearity of PAMs allows stiffness control, which is more similar to human muscles than motors. The design of the leg is a four-bar linkage bionic mechanism, including a hip, a thigh, a calf, and a foot. The mechanism is referred to a human leg, but each joint can only rotate on pitch axis, which makes the robotic leg a three-degrees-of-freedom system. On each joint, we used PAMs and springs as antagonistic muscles. Zero moment point (ZMP) analysis and proportional-integral-derivative (PID) controller were adopted in the control system. The mechanical system and control algorithm were integratively simulated. To test the stability of static stand, a perturbation was intentionally applied in the simulation. The controller was implemented in LabVIEW on a personal computer and connected to the robotic leg via a data acquisition card. Many PAM-driven robots employed their actuators in an "all and none" principle, but these robots only worked in very particular conditions. To achieve dynamic stability control of the squat motion, pulse-width-modulation algorithm was adopted in this work. The squat motion was modified by lowering unwanted vibration responses of PAMs and improving the disturbance resistance.

(S10) A. Verma, David T. W. Lin,
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Topic: Fabrication of Lead Free Piezoelectric Film for the Energy Harvester

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Abstract

The effect of the aluminium nitride on Zinc oxide thin film annealed in different ambiences is presented, to achieve the low cost and environmentally friendly process for better dielectric property. Aluminium nitride powder is doped in synthesised solution which get by dissolving zinc acetate dehydrate in water directly for the better piezoelectric characteristics, which is prepared by spin coating method. Annealing temperature are in the range of 300-500 ^{o}C It is examined for the X ray diffraction and scanning electron microscopy to get the crystalline property of the film and oscilloscope to measure the power and voltage generated by the thin film when its placed in the Energy harvester.

(S11) S. Marimuthu (蘇希德), L.-J. Yang, Department of Mechanical and Electromehanical Engineering, Tamkang University, Taiwan

Topic: Development of Micro-Footprint Autopilot System to a 15-gram Flapping MAV

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Abstract

Flapping wing micro-air-vehicles (MAVs) are a relatively younger entrant to the age old family tree of flying machines and differ greatly in physical appearance, size and flight capabilities compared to the others. Majority of the flapping MAVs developed so far have a significantly low wing loading that is less than 1 g/cm^2 and are often less than 15g in gross weight. This poses a challenge in terms of the payload capacity and development of on-board control elements. To be able to successfully guide these delicate vehicles and let them on a road to autonomy, it is imperative that the control systems are developed extremely light weight, in the order of a few grams. This work describes the development and integration of a micro-footprint ATmega 328P based autopilot system weighing 1.5 grams, housing an elaborate sensor suite consisting of inertial, magnetic and altitude sensors. This system is capable of guiding the MAV according to the pre-programmed parameters by way of monitoring the state variables of the vehicle several times per second and applying corrective actions to restore the MAV along its intended trajectory. The system also includes a low power and robust 2.4 GHz spread spectrum radio that operates by specifically pairing with a manual control transmitter and is thus immune to interference from Wi-Fi, Bluetooth and other wireless networks operating in adjacent frequencies. The paired nature of the radio provides the opportunity to operate a low power color camera on-board to transmit live video to a ground based receiver, also operating on 2.4 GHz. By the virtue of the radio link, the auto-pilot system can be programmed during flight, to alter the preset target parameters like the heading, altitude of flight, etc. This gives a full range of control over the position of the MAV in case of manual control, also enabling self-guided flying in a hands-off-stick condition. The new radio system allows control over several hundred meters, vis-à-vis several hundred feet for preceding radios at our lab. The flapping MAV can be programmed to autonomously take-off and land, seek a specific direction, or maintain its altitude or execute scripted missions stored on-board its system memory. Furthermore, discussions on the possible ways to document and record the trajectory of the MAV during flight and preserve them for later analysis, is presented. Such trajectory analysis can be extensively used for the improvement of guidance algorithms by clearly pointing out the venues that require further fine-tuning.

(S12) Balasubramanian Esakki, Vel Tech University (VTU), India

Topic: Gimpses on the Development of UAV for Diverse Applications

Balasubramanian Esakki is an Associate Professor of Mechanical Engineering at Vel Tech University, Chennai, India. He received Ph.D. from Concordia University, Montreal, Canada in 2009. His research topics include Robotics, Unmanned Aerial Vehicles -Micro Aerial Vehicles, Controls, Computer Aided Design and Rapid Prototyping.

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Abstract

Unmanned aerial vehicle (UAV) have made vivid impact in diverse applications importantly aerial photography, search and rescue, traffic control, environmental and wild life monitoring, surveillance and reconnaissance, precision agriculture, air sampling, firefighting, power line inspection, and postal delivery etc. The unmanned systems industry is presently having tremendous growth as a result there is an increased demand for unmanned vehicle systems designers. Vel Tech University (VTU) is contributing to the development of unmanned systems of various applications including power line inspection, aero-biological sampling, cell phone tower radiation and electromagnetic field strength measurement and so on. VTU has received research funding from various sectors such as Department of Science and Technology (DST): Indo-Taiwan collaboration scheme, Defense Research and Development Organization (DRDO), Ministry of Medium, Small and Micro Enterprises (MSME) and Institution of Engineers, India (IEI). Our dedicated UAV team won the First Prize in a national level competition organized by Power Grid Corporation Limited and prestigious Graham Bell Award. This talk will provide the glimpses of activities pertaining to UAV design and development and also contribution to the society.

(S13) H.-C. Han (韓謝忱), Academia Sinica, Taiwan

Topic: From Lotus Effect to Microfluidics and Nano Organic Semiconductor

Hsieh-Cheng Han is an Assistant Technical Research Fellow at Research Center for Applied Sciences, Academia Sinica, Taiwan. He received Ph.D. from National Taiwan University in 2007. His research topics include system integration, biosensor and bio electronics, vacuum system and thin film deposition.

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Abstract

In this lecture, the speaker will report the work aims at making a contribution to develop a process approach in fabricating Salvinia-like structures for microfluidic devices, which may be used as novel biomedical devices. With this process, it can be patterned the surface structures at the nanometer scale, which combine the hydrophobic surface with the hydrophilic tips/rods. A better performance of Salvinia-leaf-like structures for the microfluidic surfaces is demonstrated by experimental results. Furthermore, by control the surface properties of varied substrate; the different energy materials crystalline direction or defect numerous can be controlled and applied as varied energy store or generation. Finally the speaker will also report how the organic materials can been protected from the water moisture deterioration and the cancer cell growth inhibition or increased by the surface energy of the different substrate.

(S14) J. C. Li (李仁傑), W. P. Shih (施文彬), P. Z. Chang (張培仁),
National Taiwan University (NTU), Taiwan

Topic: A Free-standing Graphene Oxide Membrane for Developing Biomimetic Tactile Sensors

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Abstract

Merkel cell is one kind of sensory cells as mechanoreceptor in human skin. It is sensitive to touch, stretching, and pressure due to a strain-magnification mechanism on cell membrane. To imitating Merkel cell for realizing flexible tactile sensors of high sensitivity, this study proposed a bionics design which employs graphene oxide (GO) with sacrificial copper hydroxide nanostrands (CHNs). Artificial ion channels on the GO membrane were formed. The experimental results show that the permeability of GO-based membrane is significantly increased with a wide distribution of nanochannels.

(S15) C. H. Liu (劉昭華), Department of Mechanical and Electromehanical Engineering, Tamkang University, Taiwan

Topic: Kinematic Analysis of a Flapping-wing MAV with Watt Straight-line Linkage

Chao-Hwa Liu is currently professor of Mechanical and Electro-mechanical Engineering in Tamkang University. He received his Ph. D. from University of Pennsylvania, Department of Mechanical Engineering and Applied Mechanics. His research interests are solid mechanics, kinematics of manipulators, and mechanism analysis.

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Abstract

When a flapping wing MAV cruises along a straight line, two wings perform simultaneous motion that is symmetric about the vehicle's longitudinal center axis. The symmetry of two wings may be generated by a straight-line mechanism. In this study the focus is on the symmetry generated by a Watt straight line mechanism. Since no link of this mechanism can make a full revolution, it is appended by two more links to provide a constant input speed, and it becomes a Stephenson type III six-bar linkage. Together with the two wings the vehicle has 10 links and 13 joints. Since a Watt four-bar linkage can only generate curves that approximate straight lines, the deviation of a curve from an exact straight line causes phase lag of the two wings. The goal of this study is to determine the phase lag of two wings when they are driven by a constant input speed. To achieve this goal a forward kinematic analysis of the Stephenson III linkage is performed, which refers to the procedures by which the positions, velocities, and accelerations of all other links may be determined from the position, velocity, and acceleration of the input link. Among these procedures, position analysis involves equations that are highly nonlinear and deserves special attention.

The authors developed two solution techniques for the forward position analysis of Stephenson III mechanisms: an analytic procedure leads to closed-from solutions, and a numerical technique to obtain approximate solutions. As far as the closed-form solutions are concerned, previous closed-form solutions involve polynomial equations with complicated coefficients. In the method suggested in the present study, a Stephenson III six-bar mechanism is considered as being composed of a closed-chain four-bar mechanism and an open-chain serial manipulator. Closed-form solutions are obtained by locating intersections of a circular arc with a six-degree polynomial equation, which may be easily performed using MATLAB. Moreover, for the sake of fast computation, a numerical procedure for position analysis is also suggested. Also considering a Stephenson III six-bar mechanism as the combination of a four-bar linkage and a serial manipulator, this procedure numerically determines the rotation angle of the four-bar linkage so that the distance between a point on the coupler link and a circle generated by the serial manipulator equals to a fixed length. Numerical solutions are found to agree with closed-

form solutions up to 7 digits below the decimal point and the numerical technique is used to determine phase lags of the two wings.

Using the aforementioned technique, phase lags of the two wings are found to be very insignificant. For example, for the particular size of the vehicle that has been used to build up the model, the maximum phase lag is only 0.0825°. Differences in velocity and in acceleration may also be determined. For the same vehicle the maximum difference in angular velocity of the two wings, divided by the constant input angular velocity, is 4.8085×10^{-5}; and the maximum difference in angular acceleration, divided by the square of the constant input angular velocity, is 1.82097×10^{-4}.

(S16) A. L. Feng (馮愛蓮), L.-J. Yang, Department of Mechanical and Electromehanical Engineering, Tamkang University, Taiwan

Topic: Bubble Film Flow Visualization of a 10cm Span Flapping Wing

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Abstract

A novel method utilizing bubble film to observe the flapping flow field has been developed and tested. This work is based on the concept of thin film interference where bubble film of different thickness exhibits different chromatic appearance. Herein, the bubble film was subjected to the flow field of a 10 cm wingspan flapping wing, and a color CCD camera was used to capture the chromatic patterns on the bubble film. The captured photograph was fed into MATLAB to generate RGB values per pixel and corresponding thickness values based on the standard color card for bubble thickness. The governing equations of velocity and pressure field of the two-dimensional (2D) bubble film were derived and tried to be solved. The bubble color field of the sliced 2D flapping flow is therefore expressed numerically by the processed velocity field. Some technical difficulties were addressed finally.