MENYELESAIKAN MASALAH PERANCANGAN JUJUKAN PEMASANGAN MENGGUNAKAN ALGORITMA PENAPIS KALMAN DISELAKUKAN

AINIZAR BINTI MUSTAPA

SARJANA SAINS

UNIVERSITI MALAYSIA PAHANG

PENGAKUAN PENYELIA

Kami dengan ini mengisytiharkan bahawa kami telah menyemak tesis ini dan pada pendapat kami, tesis ini adalah memadai dari segi skop dan kualiti untuk penganugerahan Sarjana Sains.

____

(Tandatangan Penyelia)

Nama Penuh : PROF. MADYA. DR. ZUWAIRIE BIN IBRAHIM

Jawatan : PROFESOR MADYA

Tarikh :

____

(Tandatangan Penyelia Bersama)

Nama Penuh : ZULKIFLI BIN MD. YUSOF

Jawatan : PENSYARAH KANAN

Tarikh :

PENGAKUAN PELAJAR

Saya dengan ini mengisytiharkan bahawa kerja dalam tesis ini adalah berdasarkan kerja asal saya kecuali petikan yang telah diakui dengan sewajarnya. Saya juga mengisytiharkan bahawa ia tidak sebelum ini atau serentak diserahkan untuk ijazah lain di Universiti Malaysia Pahang atau mana-mana institusi lain.

____

(Tandatangan Pelajar)

Nama Penuh : AINIZAR BINTI MUSTAPA

Nombor Pelajar : MMF15009

Tarikh :

MENYELESAIKAN MASALAH PERANCANGAN JUJUKAN PEMASANGAN MENGGUNAKAN ALGORITMA PENAPIS KALMAN DISELAKUKAN

AINIZAR BINTI MUSTAPA

Tesis yang dikemukakan sebagai memenuhi keperluan
untuk penganugerahan Ijazah Sarjana Sains

Kolej Kejuruteraan

UNIVERSITI MALAYSIA PAHANG

JULAI 2020

PENGHARGAAN

Syukur Alhamdulillah ke hadrat Allah S.W.T. kerana di atas limpah dan kurniaNya, tesis ini berjaya disiapkan walaupun menempuhi pelbagai dugaan dan rintangan. Selawat dan salam ke atas junjungan besar Nabi Muhammad S.A.W. yang diutuskan Allah sebagai *rahmatan lil 'alamin*, guru dan contoh tauladan terbaik untuk manusia sepanjang zaman.

Saya ingin mengucapkan jutaan terima kasih kepada Prof. Madya Dr. Zuwairie bin Ibrahim dan Encik Zulkifli bin Md. Yusof, selaku penyelia dan penyelia bersama atas kesabaran, sokongan, nasihat dan bimbingan untuk kejayaan penghasilan tesis ini. Tidak dilupakan ribuan terima kasih kepada Dr. Ismail bin Ibrahim serta rakan-rakan seperjuangan kerana memberi inspirasi dan dorongan di sepanjang pengajian.

Terima kasih kepada pihak Kementerian Pengajian Tinggi Malaysia kerana telah menganugerahkan saya biasiswa MyBrain15 bagi melanjutkan pelajaran ke peringkat Sarjana. Terima kasih juga kepada Kolej Kejuruteraan UMP, Kolej Teknologi Kejuruteraan (Fakulti Teknologi Kejuruteraan Pembuatan dan Mekatronik) UMP, serta Institut Pengajian Pasca Siswazah UMP atas panduan dan sokongan penuh terhadap kajian ini. Terima kasih kepada Isuzu Hicom Malaysia Sdn. Bhd. kerana memahami dan menyokong cita-cita saya sebagai seorang kakitangan syarikat yang berhasrat menyambung pelajaran ke peringkat Sarjana.

Jutaan penghargaan dan terima kasih kepada ibu (Puan Paridah), ayah (Allahyarham Mustapa), suami (Encik Rismayuddin), anak-anak (Aisyah Rayhana, Aminah Raysha dan Allahyarham Ahmad Raykarl) dan seluruh keluarga atas doa, kesabaran, sokongan, toleransi, cinta dan kasih sayang kalian, sehingga tesis dan pengajian ini berjaya disempurnakan.

Akhir kata, ucapan terima kasih ini ditujukan kepada semua yang terlibat secara langsung dan tidak langsung dalam memberikan sumbangan cadangan dan bantuan dalam menyiapkan tesis ini. Semoga kajian dan tesis ini dapat dijadikan wadah ilmu yang berguna untuk tatapan generasi akan datang.

ABSTRAK

Perancangan jujukan pemasangan (*Assembly Sequence Planning* - ASP) memainkan peranan penting dalam reka bentuk dan pembuatan produk. Jujukan pemasangan mempengaruhi keseluruhan produktiviti kerana ia menentukan kepantasan dan ketepatan produk itu dipasang. Objektif utama ASP adalah untuk menentukan jujukan pemasangan komponen untuk memendekkan masa pemasangan atau menjimatkan kos pemasangan. Walau bagaimanapun, ASP juga dikenali sebagai masalah pengoptimuman gabungan klasik yang sukar. Dengan peningkatan bilangan komponen bagi sesuatu produk, ASP menjadi lebih sukar dan algoritma berasaskan grafik tradisional tidak dapat menyelesaikannya dengan berkesan. Terdapat pelbagai metaheuristik yang wujud pada masa kini. Walau bagaimanapun, tidak semua metaheuristik dibangunkan untuk beroperasi di ruang carian diskret. Salah satu contoh algoritma metaheuristik ialah Kalman. Maka, bagi tujuan menyelesaikan masalah pengoptimuman gabungan (*Combinatorial Optimization Problem* - COP) yang diskret menggunakan metaheuristik serta menilai prestasi algoritma yang dicadangkan, satu kajian kes ASP telah dijalankan. Prestasi algoritma penapis Kalman diselakukan (*Simulated Kalman Filter* - SKF) lanjutan yang dinamakan penapis Kalman diselakukan binari (*Binary Simulated Kalman Filter* – BSKF), penapis Kalman diselakukan dimodulasi sudut (*Angle Modulated Simulated Kalman Filter* – AMSKF), dan penapis Kalman diselakukan dinilai jarak (*Distance-Evaluated Simulated Kalman Filter* - DESKF) dibandingkan dengan hasil kajian lalu yang menggunakan algoritma carian graviti binari (*Binary Gravitational Search Algorithm* - BGSA), algoritma pengoptimuman kerumunan zarah binari (*Binary Particle Swarm Optimization* - BPSO), algoritma carian graviti berbilang keadaan (*Multi-State Gravitational Search Algorithm* - MSGSA), algoritma carian graviti berbilang keadaan dengan peraturan tertanam (*Multi-State Gravitational Search Algorithm with an Embedded Rule* - MSGSAER), algoritma pengoptimuman kerumunan zarah berbilang keadaan (*Multi-State Particle Swarm Optimization* - MSPSO), dan algoritma pengoptimuman sekawan zarah berbilang keadaan dengan peraturan tertanam (*Multi-State Particle Swarm Optimization with an Embedded Rule* - MSPSOER) dalam menyelesaikan masalah ASP. Dengan menggunakan satu kajian kes ASP, hasil eksperimen menunjukkan AMSKF mengatasi BSKF, DESKF dan enam algoritma lain daripada kajian lalu dengan kelebihan sehingga 0.95% dalam mencari penyelesaian yang optimum.

ABSTRACT

Assembly sequence planning (ASP) plays an important role in the product design and manufacturing. Assembly sequence influences overall productivity because it determines how fast and accurate the product is assembled. One of the main objective of ASP is to determine the sequence of component installation to shorten assembly time or save the assembly costs. However, ASP is also known as a classical hard combinatorial optimization problem. With the increasing of the quantity of product components, the ASP becomes more difficult and the traditional graph-based algorithm cannot solve it effectively. There are various metaheuristics exist in literature nowadays. However, not all metaheuristics were originally developed to operate in discrete search space. Example of metaheuristics algorithm is Kalman. In order to solve discrete combinatorial optimization problems (COPs) using metaheuristics, and evaluate the performances of the proposed algorithms, a case study of ASP is conducted. The performance of the extended Simulated Kalman Filter (SKF) named Binary Simulated Kalman Filter (BSKF), Angle Modulated Simulated Kalman Filter (AMSKF), and Distance Evaluated Simulated Kalman Filter (DESKF) are compared against previous studies which applied the Binary Gravitational Search Algorithm (BGSA), the Binary Particle Swarm Optimization (BPSO), the Multi-State Gravitational Search Algorithm (MSGSA), the Multi-State Gravitational Search Algorithm with an Embedded Rule (MSGSAER), the Multi-State Particle Swarm Optimization (MSPSO), and the Multi-State Particle Swarm Optimization with an Embedded Rule (MSPSOER) in solving ASP problem. Using a case study of ASP, the experimental results showed the AMSKF outperformed the BSKF, the DESKF and the six other approaches from previous studies by up to 0.95% in finding the optimal solutions.

KANDUNGAN

PENGAKUAN

TAJUK

PENGHARGAAN ii

ABSTRAK iii

ABSTRACT iv

KANDUNGAN v

SENARAI JADUAL vii

SENARAI RAJAH ix

SENARAI SIMBOL x

SENARAI SINGKATAN xi

BAB 1 PENGENALAN 1

1.1 Latar Belakang Kajian 1
1.2 Pernyataan Masalah 3
1.3 Objektif Kajian 3
1.4 Skop Kajian 4
1.5 Manfaat Kajian 4
1.6 Ringkasan Tesis 5

BAB 2 KAJIAN LITERATUR 6

2.1 Pengenalan 6
2.2 ASP 6
2.3 Kekangan ASP 7
2.4 Objektif ASP 9
2.5 ASP untuk Mengurangkan Masa Pemasangan 15
2.6 Model Matematik 16

2.7 Pengoptimuman Kawanan Zarah (PSO) 19
2.8 Algoritma Carian Graviti (GSA) 21
2.9 Algoritma Penapis Kalman 24
2.10 Algoritma Penapis Kalman Diselakukan (SKF) 27
2.11 Ringkasan 30

BAB 3 METODOLOGI 31

3.1 Pengenalan 31
3.2 Algoritma Penapis Kalman Simulasi Binari (BSKF) 32
3.3 Algoritma Penapis Kalman Diselakukan Modulasi Sudut (AMSKF) 33
3.4 Algoritma Penapis Kalman Diselakukan Dinilai Jarak (DESKF) 34
3.5 Aplikasi Algoritma SKF Lanjutan dalam ASP 48
3.6 Parameter bagi BSKF, AMSKF, dan DESKF untuk ASP 46
3.7 Ringkasan 46

BAB 4 KEPUTUSAN DAN PERBINCANGAN 47

4.1 Pengenalan 47
4.2 Keputusan Aplikasi BSKF, AMSKF, dan DESKF untuk ASP 48
4.3 Keputusan Aplikasi BSKF, AMSKF, dan DESKF dibandingkan dengan algoritma lain untuk ASP 51
4.4 Ringkasan 56

BAB 5 KESIMPULAN 58

5.1 Kesimpulan 58
5.2 Sumbangan Kajian 59
5.3 Cadangan untuk Masa Hadapan 60

RUJUKAN 62

LAMPIRAN A SENARAI PENERBITAN 77

SENARAI JADUAL

Jadual 2.1	PM bagi Rajah 2.2	8
Jadual 2.2	Ringkasan kajian ASP menggunakan kaedah pengkomputeran (2000-2016)	12
Jadual 3.1	PM untuk kajian kes	40
Jadual 3.2	CT bagi pelbagai komponen dalam pemasangan	41
Jadual 3.3	Parameter eksperimen untuk pendekatan yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF dengan 10, 20, 30 agen, untuk 1,000 dan 5,000 lelaran	46
Jadual 4.1	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada BSKF untuk 1,000 lelaran.	48
Jadual 4.2	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada AMSKF untuk 1,000 lelaran.	48
Jadual 4.3	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada DESKF untuk 1,000 lelaran.	48
Jadual 4.4	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada BSKF untuk 5,000 lelaran	49
Jadual 4.5	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada AMSKF untuk 5,000 lelaran	49
Jadual 4.6	Keputusan untuk kaedah yang dicadangkan berdasarkan kepada DESKF untuk 5,000 lelaran	49
Jadual 4.7	Kompilasi keputusan terbaik kaedah yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF	49
Jadual 4.8	Keputusan terbaik dan jujukan pemasangan yang berkaitan dengan kaedah yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF	50
Jadual 4.9	Parameter yang digunakan untuk pendekatan yang dicadangkan berdasarkan BPSO, MSPSO, MSPSOER, BGSA, MSGSA dan MSGSAER	52
Jadual 4.10	Keputusan daripada kaedah yang dicadangkan berdasarkan BPSO, MSPSO, MSPSOER, BGSA, MSGSA dan MSGSAER bersama kaedah baru yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF	53

Jadual 4.11 Keputusan mengikut turutan terbaik dan jujukan pemasangan yang berkaitan dengan pendekatan yang dicadangkan berdasarkan BPSO, MSPSO, MSPSOER, BGSA, MSGSA dan MSGSAER terhadap pendekatan yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF. 55

SENARAI RAJAH

Rajah 2.1	Contoh pandangan meletup bagi proses pemasangan	7
Rajah 2.2	PD bagi pemasangan	8
Rajah 2.3	Kekerapan objektif ASP seperti yang diterbitkn dalam kertas kajian	11
Rajah 2.4	Algoritma metaheuristik untuk ASP	14
Rajah 2.5	Algoritma PSO	20
Rajah 2.6	Algoritma GSA	22
Rajah 2.7	Kitaran penapis Kalman yang berterusan	27
Rajah 2.8	Carta alir algoritma SKF	30
Rajah 3.1	Carta alir kaedah penyelidikan yang dijalankan	31
Rajah 3.2	Fungsi pemetaan	32
Rajah 3.3	Carta aliran algoritma BSKF	33
Rajah 3.4	Contoh plot g(x)	34
Rajah 3.5	Carta alir algoritma AMSKF	35
Rajah 3.6	Kedudukan ejen. (a) Pada permulaan proses carian (b) Semasa tengah-tengah proses carian (c) Pada akhir proses carian	36
Rajah 3.7	Carta alir algoritma DESKF	38
Rajah 3.8	Contoh jujukan pemasangan yang diwakili oleh zarah	38
Rajah 3.9	PD untuk kajian kes	39
Rajah 3.10	Proses pembentukan jujukan pemasangan setiap zarah atau ejen yang boleh diperbaiki untuk BSKF	43
Rajah 3.11	Proses pembentukan jujukan pemasangan setiap zarah atau ejen yang boleh diperbaiki untuk AMSKF	44
Rajah 3.12	Proses pembentukan jujukan pemasangan setiap zarah atau ejen yang boleh diperbaiki untuk DESKF	45
Rajah 4.1	Keputusan masa pemasangan minimum (Min) untuk kaedah yang dicadangkan berdasarkan BPSO, MSPSO, MSPSOER, BGSA, MSGSA dan MSGSAER, serta kaedah baru yang dicadangkan berdasarkan BSKF, AMSKF, dan DESKF	54
Rajah 5.1	ASP menggunakan algoritma metaheuristik	61

SENARAI SIMBOL

A	Matrik pertukaran keadaan
A_a	Masa pemasangan
B	Matrik yang berkaitan dengan input kawalan pilihan kepada keadaan
β	Pemalar β
G	Pemalar graviti
H	Matrik yang mentafsir pemetaan dari vektor keadaan kepadavektor pengukuran
K_t	Perolehan Kalman
P_{t-1}	Anggaran ko-varian pada masa t-1
$P_{t\|t-1}$	Jangkaan (keutamaan) anggaran ko-varian
P_t	Terkini (kebarangkalian) anggaran ko-varian
Q	Ko-varian proses yang mempengaruhi ralat disebabkan proses
R	Ko-varian pengukuran yang mempengaruhi bunyi daro pengukuran
rand	Nombor rawak
ω	Berat inersia
$\boldsymbol{X}_{\boldsymbol{best}}(t)$	Nilai layak yang terbaik dari setiap lelaran
$\boldsymbol{X}_{\boldsymbol{true}}$	Penyelesaian terbaik (sehingga kini)
$\hat{\boldsymbol{x}}_{t-1}$	Keadaan anggaran [ada masa t-1
$\hat{\boldsymbol{x}}_{t\|t-1}$	Jangkaan (keutamaan) anggaran keadaan
$\hat{x}_t$	Terkini (kebarangkalian) anggaran keadaan
ψ	Set komponen yang telah dipasang

SENARAI SINGKATAN

ACO	*Ant Colony Optimization*
	Pengoptimuman koloni semut
AMSKF	*Angle Modulated Simulated Kalman Filter*
	Penapis Kalman diselakukan dimodulasi sudut
ASP	*Assembly Sequence Planning*
	Perancangan jujukan pemasangan
AUTOPASS	*Automated Parts Assembly System*
	Sistem pemasangan bahagian automatik
BGSA	*Binary Gravitational Search Algorithm*
	Algoritma carian graviti binari
BPSO	*Binary Particle Swarm Optimization*
	Pengoptimuman kerumunan zarah binari
BSKF	*Binary Simulated kalman Filter*
	Penapis Kalman diselakukan binari
CAD	*Computer-Aided Design*
	Sistem reka bantu komputer
CEC	*Congress on Evolutionary Computation*
	Kongres untuk pengiraan evolusi
COP	*Combinatorial optimization problem*
	Masalah pengoptimuman gabungan
CT	*Coefficient Table*
	Jadual kerangka
DESKF	*Distance-Evaluated Simulated Kalman Filter*
	Penapis Kalman diselakukan dinilai jarak
GA	*Genetic Algorithm*
	Algoritma genetik
GDP	*Geometric design processor*
	Pemproses rekaan geometri
GSA	*Gravitational Search Algorithm*
	Algoritma carian graviti
GSAA	*Combination GA and SA*
	Kombinasi GA dan SA

GSACO	*Combination GA, SA and ACO* Kombinasi GA, SA dan ACO
IA	*Immune Algorithm* Algoritma imun
MA	Memetic Algorithm Algoritma pemikiran
MSGSA	*Multi-State Gravitational Search Algorithm* Algoritma carian graviti berbilang keadaan
MSGSAER	*Multi-State Gravitational Search Algorithm with an Embedded Rule* Algoritma carian graviti berbilang keadaan dengan peraturan tertanam
MSPSO	*Multi-State Particle Swarm Optimization* Pengoptimuman kerumunan zarah berbilang keadaan
MSPSOER	*Multi-State Particle Swarm Optimization with an Embedded Rule* Pengoptimuman kerumunan zarah berbilang keadaan Dengan peraturan tertanam
PADL	*Part and assembly description language* Bahasa penerangan bahagian dan perhimpunan
PD	*Precedence Diagram* Rajah utama
PM	*Precedence matrix* Matrik utama
PSO	*Particle Swarm Optimization* Pengoptimuman kerumunan zarah
PSOSA	*Combination PSO and SA* Kombinasi PSO dan SA
SA	*Simulated Annealing* penyepuhlindapan diselakukan
SKF	*Simulated Kalman Filter* Penapis Kalman diselakukan
TSP	Travelling Salesman Problem Masalah jurujual mengembara

RUJUKAN

Ab. Aziz, N. A., Mubin, M., Ibrahim, Z., and Nawawi, S. W. (2015). Statistical analysis for swarm intelligence — simplified. International Journal of Future Computer and Communication, 4(3), 193–197.

Akaike, H. (1969). Fitting autoregressive models for prediction. Annals of the Institute of Statistical Mathematics, 21(1), 243–247.

Akaike, H. (1978). A bayesian analysis of the minimum AIC procedure. Annals of the Institute of Statistical Mathematics, 30(1), 9–14.

Atashpaz-Gargari, E., and Lucas, C. (2007). Imperialist competitive algorithm: An algorithm for optimization inspired by imperialistic competition. Proceedings of the 2007 IEEE Congress on Evolutionary Computation, 4661–4667.

Bai, Y. W., Chen, Z. N., Bin, H. Z., and Hun, J. (2005). An effective integration approach toward assembly sequence planning and evaluation. Int J Adv Manuf Technol 27(1–2), 96–105.

Bi, X., and Wang, Y. (2011). An improved artificial bee colony algorithm. Proceedings of the 3rd International Conference on Computer Research and Development, 2, 174–177.

Blum, C. and Roli, A. (2003). Metaheuristics in combinatorial optimization: overview and conceptual comparison, ACM Computing Surveys, 35, 268–308.

Bonneville, F. C., Perrard, J. M. and Henrioud (1995). A genetic algorithm to generate and evaluate assembly plans, in Proceedings of IEEE Symposium on Emerging Technologies and Factory Automation, 2 , 231-239.

Boothroyd, G. (1994). Product design for manufacture and assembly, Computer Aided Design, 26, 50-59.

Cao, P. B. and Xiao, R. B. (2007). Assembly planning using a novel immune approach. Int J Adv Manuf Technol 31(7–8), 770– 782.

Chakrabarty, S. and Wolter, J. (1997). A structure-oriented approach to assembly sequence planning, IEEE Transactions on Robotics and Automation, 13, 14-29.

Chang, C. C. and Tseng, H. E. and Meng, L. P. (2009). Artificial immune systems for assembly sequence planning exploration. Eng Appl Artif Intell 22(8), 1218–1232.

Chen, G., Zhou, J., Cai, W., Lai, X., Lin, Z. and Menassa, R. (2006). A framework for an automotive body assembly process design system. CAD Comput Aided Des 38(5), 531–539.

Chen, R. S., Lu, K. Y. and Yu, S. C. (2002). A hybrid genetic algorithm approach on berbilang-objective of assembly planning problem. Eng Appl Artif Intell 15(5), 447–457.

Chen, S. F., Liu, S. F. and Liu Y. J. (2001). An adaptive genetic assembly-sequence planner. Int J Comput Integr Manuf 14(5), 489–500.

Chen, W. C., Tai, P. H., Deng, W. J. and Hsieh, L. F. (2008). A three-stage integrated approach for assembly sequence planning using neural networks. Expert Syst Appl 34(3), 1777–1786.

Chen, W.C., Tai, P. H., Deng, W. J. and Hsieh, L. F. (2008). A three-stage integrated approach for assembly sequence planning using neural networks, Expert Syst Appl, 34, 1777 – 1786.

Cheng, S., and Shi, Y. (2011). Diversity control in particle swarm optimization. Proceedings of the 2011 IEEE Symposium on Swarm Intelligence, 1–9.

Choi, Y. K., Lee, D. M. and Cho, Y. B. (2008). An approach to berbilang-criteria assembly sequence planning using genetic algorithms, The International Journal of Advanced Manufacturing Technology, 42, 180-188.

Choi, Y. K., Lee, D. M., and Cho, Y. B. (2009). An approach to berbilang-criteria assembly sequence planning using genetic algo-rithms. Int J Adv Manuf Technol 42(1–2), 180–188.

De, L. P., Latinne, P. and Rekiek, B. (2001). Assembly planning with an ordering genetic algorithm, Int J Prod Res, 39, 3623 – 3640.

DeLit, P., Latinne, P., Rekiek, B. and Delchambre, A. (2001). As-sembly planning with an ordering genetic algorithm. Int J Prod Res 39(16), 3623–3640.

Derbel, F. (2001). Modeling fire detector signals by means of system identification techniques. IEEE Transactions on Instrumentation and Measurement, 50(6), 1815–1821.

Derrac, J., García, S., Molina, D., and Herrera, F. (2011). A practical tutorial on the use of nonparametric statistical tests as a methodology for comparing evolutionary and swarm intelligence algorithms. Swarm and Evolutionary Computation, 1(1), 3–18.

Dorigo, M., Maniezzo, V., and Colorni, A. (1996). Ant system: Optimization by a colony of cooperating agents. IEEE Transactions on Systems, Man and Cybernetics, Part B (Cybernetics), 26(1), 29–41.

Eusuff, M., Lansey, K., and Pasha, F. (2006). Shuffled frog-leaping algorithm: A memetic meta-heuristic for discrete optimization. Engineering Optimization, 38(2), 129-154.

Farmer, J. D., Packard, N. H., and Perelson, A. S. (1986). The immune system, adaptation, and machine learning. Physica D: Nonlinear Phenomena, 22(1–3), 187-204.

Gao, L., Qian, W. R., Li, X. Y. and Wang, J. F. (2010). Application of memetic algorithm in assembly sequence planning, Int J Adv Manuf Technol, 49, 1175-1184.

Gao, L., Qian, W., Li, X. and Wang, J. (2010). Application of memetic algorithm in assembly sequence planning. Int J Adv Manuf Technol 49(9–12), 1175–1184.

Gao, X. Z., Wang, X., and Ovaska, S. J. (2010). A hybrid harmony search method based on OBL. Proceedings of the 13th IEEE International Conference on Computational Science and Engineering, 140–145.

Glover, F. (1989). Tabu search - Part I. ORSA Journal on Computing, 1(3), 190–206.

Guan, Q., Liu, J. H. and Zhong, Y. F. (2002). A concurrent hierarchi-cal evolution approach to assembly process planning. Int J Prod Res 40(14), 3357–3374.

Guo, Y. W., Li, W. D., Mileham, A. R.. and Owen, G. W. (2009). Applications of particle swarm optimization in integrated process planning and scheduling, Robot Comput Integr Manuf, 25, 280-288.

Holland, J. H. (1975). Adaptation in natural and artificial systems : An introductory analysis with applications to biology, control, and artificial intelligence. Ann Arbor : University of Michigan Press.

Homem de Mello, L. S. and Arthur, C. D. (1990). AND/OR graph representation of assembly plans, IEEE Transactions on Robotics and Automation, 6, 188-199.

Hong, D. S. and Cho, H. S. (1995). A neural network based computational scheme for generating optimized robotic assembly sequences, Engineering Application Artificial Intelligence, 8, 129-145.

Huang, H. H., Wang, M. H. and Johnson, M. R. (2000). Disassembly sequence generation using a neural network approach, Journal of Manufacturing Systems, 19, 73-82.

Hui, C., Yuan. L. and Kai-Fu, Z. (2009). Efficient method of assembly sequence planning based on GAAA and optimizing by assembly path feedback for complex product. Int J Adv Manuf Technol 42(11–12), 1187–1204.

Ibrahim, I., Ibrahim, Z., Ahmad, H., Md Yusof, Z., Nawawi, S. W., Mohamad, M. S., Mubin, M. and Mokhtar, N. (2014). An Assembly Sequence Planning Approach with Binary Gravitational Search Algorithm, Frontiers in Artificial Intelligence and Applications, 15, 179-193.

Ibrahim, Z., Abd Aziz, N. H., Ab Aziz, N. A., Razali, S., Shapiai, M. I., Nawawi, S. W., and Mohamad, M. S. (2015). A Kalman filter approach for solving unimodal optimization problems. ICIC Express Letters, 9(12), 3415–3422.

Ibrahim, Z., Nawawi, S. W., Razali, S., Muhammad, B., Mohd Azmi, K. Z., Aspar, Z., and Ab Aziz, N. A. (2015). Simultaneous computation of model order and parameter estimation of a heating system based on particle swarm optimization for autoregressive with exogenous model. ICIC Express Letters, 9(4), 1159–1165.

Julai, S., Tokhi, M. O., Mohamad, M., and Latiff, I. A. (2010). Active vibration control of a flexible plate structure using particle swarm optimization. Proceedings of the 9th IEEE International Conference on Cybernetic Intelligent Systems, 1–6.

Kalman, R. E. (1960). A new approach to linear filtering and prediction problems. Journal of Basic Engineering, 82(1), 35–45.

Karaboga, D., and Basturk, B. (2007). A powerful and efficient algorithm for numerical function optimization: Artificial bee colony (ABC) algorithm. Journal of Global Optimization, 39(3), 459–471.

Kaveh, A., and Farhoudi, N. (2013). A new optimization method: Dolphin echolocation. Advances in Engineering Software, 59, 53–70.

Kaveh, A., and Talatahari, S. (2010). A novel heuristic optimization method: Charged system search. Acta Mechanica, 213(3), 267–289.

Kennedy, J., and Eberhart, R. (1995). Particle swarm optimization. Proceedings of the IEEE International Conference on Neural Networks, 4, 1942–1948.

Kirkpatrick, S., Gelatt, C. D., and Vecchi, M. P. (1983). Optimization by simulated annealing. Science, 220(4598), 671–680.

Laperriere, L. and El Marghy, A. (1994). Assembly sequence planning for simultaneous engineering, International Journal of Advance Manufacturing Technology, 9, 231-244.

Lazzerini, B. and Marcelloni, F. (2000). Genetic algorithm for generating optimal assembly plans. Artif Intell Eng 14(4), 319– 329.

Lee, S. and Shin, Y. G. (1990). Assembly planning based on geometric reasoning, Computation and Graphics, 14, 237-250.

Li, J. R., Khoo, L. P., Tor, S. B. (2003). A Tabu-enhanced genetic algorithm approach for assembly process planning. J Intell Manuf 14(2), 197–208.

Li, M., Wu, B., Hu, Y., Jin, C. and Shi, T. (2013). A hybrid assembly sequence planning approach based on discrete particle swarm optimization and evolutionary direction operation, The International Journal of Advanced Manufacturing Technology, 68, 617-630.

Li, S. X. and Shan, H. B. (2008). GSSA and ACO for assembly sequence planning: a comparative study. In: Proceedings of the IEEE international conference on automation and lo-gistics, ICAL 2008, 1270–1275.

Liang, J. J., Qu, B. Y., and Suganthan, P. N. (2014). Problem definitions and evaluation criteria for the CEC 2014 special session and competition on single objective real-parameter numerical optimization. Technical Report 201311, Computational Intelligence Laboratory, Zhengzhou University, China And Technical Report, Nanyang Technological University, Singapore.

Liu, Z., Hansson, A., and Vandenberghe, L. (2013). Nuclear norm system identification with missing inputs and outputs. Systems and Control Letters, 62(8), 605–612.

Ljung, L. (1987). System identification : Theory for the user. USA: Prentice-Hall.

Lu, C., Wong, Y. S. and Fuh, J. Y. H. (2005). An enhanced assembly planning approach using a berbilang-objective genetic algorithm. Proc Inst Mech Eng, B J Eng Manuf 220(2), 255–272.

Lu, C., Wong, Y. S., and Fuh, J. Y. H. (2006). An enhanced assembly planning approach using a berbilang-objective genetic algorithm, Proc Inst Mech Eng Part B J Eng Manuf, 220, 255-272.

Lv, H. and Lu, C. (2010). An assembly sequence planning approach with a discrete particle swarm optimization algorithm. Int J Adv Manuf Technol 50(5–8), 761.

Lv, H. G. and Lu, C. (2010) An assembly sequence planning approach with a discrete particle swarm optimization algorithm, The International Journal of Advanced Manufacturing Technology, 50, 761-770.

Lv, H. G., Lu, C. and Zha, J. (2010) A hybrid DPSO-SA approach to assembly sequence planning. In: IEEE international conference on mechatronics and automation, ICMA 2010, 5589203, 1998–2003.

Mahmoud, M. S., and Qureshi, A. (2012). Model identification and analysis of small-power wind turbines. International Journal of Modelling, Identification and Control, 17(1), 19–31.

Marian, R. M., Luong, L. H. S. and Abhary, K. (2003) Assembly sequence planning and optimization using genetic algorithms: part i. automatic generation of feasible assembly sequences, Applied Soft Computing, 2, 223-253.

Marian, R. M., Luong, L. H. S. and Abhary, K. (2006) A genetic algorithm for the optimisation of assembly sequences. Comp Ind Eng 50(4), 503–527.

Md Yusof, Z., Ibrahim, I., Ibrahim, Z., Mohd Azmi, K. Z., Abd Aziz, N. H., Ab Aziz, N. A., and Mohamad, M. S. (2016). AMSKF : Angle modulated simulated Kalman filter algorithm for combinatorial optimization problems. ARPN Journal of Engineering and Applied Sceinces, 4854-4859.

Md Yusof, Z., Ibrahim, I., Ibrahim, Z., Mohd Azmi, K. Z., Abd Aziz, N. H., Ab Aziz, N. A., and Mohamad, M. S. (2016). DESKF : Distance evaluated simulated Kalman filter algorithm for combinatorial optimization problems. ARPN Journal of Engineering and Applied Sceinces, 4911-4916.

Md Yusof, Z., Ibrahim, I., Satiman, S. N., Ibrahim, Z., Abd Aziz, N. H., and Ab Aziz, N. A. (2015). BSKF : Binary simulated Kalman filter. Third International Conference on Artificial Intelligence, Modelling and Simulation, 77–81.

Milner, J. M., Graves, S. C. and Whitney, D. E. (1994) Using simulated annealing to select least-cost assembly sequences, in Proceedings of the IEEE International Conference on Robotics and Automation, 2058 – 2063.

Mirjalili, S. (2015). The ant lion optimizer. Advances in Engineering Software, 83, 80–98.

Mitrovic-Minic, S. and Krishnamurti, V. (2006) The berbilangple TSP with time windows: Vehicle bounds based on precedence graphs. Oper Res Lett 34(1), 111–120.

Mohd Azmi, K. Z. (2017). Opposition-based simulated Kalman filters and their application in system identification, Universiti Malaysia Pahang, Malaysia.

Mohd Azmi, K. Z., Ibrahim, Z., Pebrianti, D., Nawawi, S. W., and Ab Aziz, N. A. (2015). Simultaneous computation of model order and parameter estimation of a heating system based on gravitational search algorithm for autoregressive with exogenous inputs. ARPN Journal of Engineering and Applied Sciences, 10(2), 633–642.

Mohd Azmi, K. Z., Pebrianti, D., Ibrahim, Z., Sudin, S., and Nawawi, S. W. (2015). Simultaneous computation of model order and parameter estimation for system identification based on gravitational search algorithm. 6th International Conference on Intelligent Systems, Modelling and Simulation, 135–140.

Moor, B. De, Gersem, P. De, Schutter, B. De, and Favoreel, W. (1997). DAISY : A database for identification of systems. Journal A, 38(3), 4–5.

Motavalli, S. and Islam, A. (1997) Berbilang-criteria assembly sequencing, Computational Industrial Eng., 32 (1997), 743–751.

Muhammad, B., Ibrahim, Z., Ghazali, K. H., Mohd Azmi, K. Z., Ab Aziz, N. A., Abd Aziz, N. H., and Mohamad, M. S. (2015). A new hybrid simulated Kalman filter and particle swarm optimization for continuous numerical optimization problems. ARPN Journal of Engineering and Applied Sciences,10(22), 17171–17176.

Mukred, J. A. A., Ibrahim, Z., Ibrahim, I., Adam, A., Wan, K., Md. Yusof, Z. and Mokhtar, N. (2012) A binary particle swarm optimization approach to optimize assembly sequence planning, Advanced Science Letters, 13, 732-738.

Mustapa, A., Ibrahim, Z., Md Yusof, Z. and Ibrahim, I. (2016) Global Optimization Distance Evaluated Particle Swarm Optimization for Combinatorial Optimization Problem. The National Conference for Postgraduate Research (NCON-PGR).

Mustapa, A., Md. Yusof, Z., Adam, A., Muhammad, B. and Ibrahim, Z. (2017) Solving Assembly Sequence Planning using Angle Modulated Simulated Kalman Filter. The 4th Asia Pacific Conference on Manufacturing Systems and The 3rd International Manufacturing Engineering Conference (APCOMS-IMEC).

Pan, C., Smith, S. and Smith, G. (2006) Automatic assembly sequence planning from STEP CAD files. Int J Comput Integr Manuf 19(8), 775–783.

Passino, K. M. (2002). Biomimicry of bacterial foraging for distributed optimization and control. IEEE Control Systems Magazine, 22(3), 52–67.

Pham, D. T., Ghanbarzadeh, A., Koc, E., Otri, S., Rahim, S., and Zaidi, M. (2006). The bees algorithm–A novel tool for complex optimization. Proceedings of the 2nd International Virtual Conference on Intelligent Production Machines and Systems, 454–459.

Qin, Y. F. and Xu, Z. G. (2007) Assembly process planning using a berbilang-objective optimization method. In: Proceedings of the 2007 IEEE international conference on mechatronics and automation, ICMA 2007, 4303610, 593–598.

Rashedi, E., Nezamabadi-pour, H., and Saryazdi, S. (2009). GSA: A gravitational search algorithm. Information Sciences, 179(13), 2232–2248.

Senin, N., Groppetti, R. and Wallace, D. R. (2000) Concurrent assembly planning with genetic algorithms. Robot Comput Integr Manuf 16(1), 65–72.

Shah-Hosseini, H. (2007) Problem solving by intelligent water drops. Proceedings of the 2007 IEEE Congress on Evolutionary Computation, 3226–3231.

Shan, H., Li, S., Gong D, Lou P (2006) Genetic simulated annealing algorithm-based assembly sequence planning. In: IET conference publications, vol 524, 1573–1579.

Shan, H., Zhou, S., Sun, Z. (2009) Research on assembly sequence planning based on genetic simulated annealing algo-rithm and ant colony optimization algorithm. Assem Autom 29(3), 249–256.

Shuang, B., Chen, J., Li, Z. (2008) Microrobot based micro-assembly sequence planning with hybrid ant colony algorithm. Int J Adv Manuf Technol 38(11–12), 1227–1235.

Siddique, N., and Adeli, H. (2015) Nature inspired computing: An overview and some future directions. Cognitive Computation, 7(6), 706–714.

Simon, D. (2008) Biogeography-based optimization. IEEE Transactions on Evolutionary Computation, 12(6), 702–713.

Sinanoglu, C. and Boklu, H. R. (2005) An assembly sequence planning system for mechanical parts using neural network. Assem Autom 25(1), 38–52.

Smith, G. C. and Smith, S. S. F. (2002) An enhanced genetic algorithm for automated assembly planning. Robot Comput-Integr Manuf 18(5–6), 355–364.

Smith, S. S. F. (2004) Using berbilangple genetic operators to reduce premature convergence in genetic assembly planning. Comput Ind 54(1), 35–49.

Smith, S. S.F. and Liu, Y. J. (2001) The application of berbilang-level genetic algorithms in assembly planning. J Ind Technol 17(4), 1.

Su, Q. (2009) A hierarchical approach on assembly sequence planning and optimal sequences analyzing, Robotics and Computer-Integrated Manufacturing, 25, 224–234.

Su, Q. (2009) A hierarchical approach on assembly sequence planning and optimal sequences analyzing. Robot Comput-Integr Manuf 25(1), 224–234.

Talbi, E. G. (2009) Metaheuristics: From Design to Implementation, John Wiley & Sons.

Tseng, H. E. and Tang, C. E. (2006) A sequential consideration for assembly sequence planning and assembly line balancing using the connector concept. Int J Prod Res 44(1), 97–116.

Tseng, H. E., Chen, M. H., Chang, C. C. and Wang, W. P. (2008) Hybrid evolutionary berbilang-objective algorithms for integrating assembly sequence planning and assembly line balancing. Int J Prod Res 46(21), 5951–5977.

Tseng, H. E., Li, J. D. and Chang, Y. H. (2004) Connector-based approach to assembly planning using a genetic algorithm. Int J Prod Res 42(11), 2243–2261.

Tseng, H. E., Wang, W. P. and Shih, H. Y. (2007) Using memetic algorithms with guided local search to solve assembly sequence planning. Expert Syst Appl 33(2), 451–467.

Tseng, Y. J., Chen, J. Y. and Huang, F. Y. (2010) A berbilang-plant assembly sequence planning model with integrated assembly sequence planning and plant assignment using GA. Int J Adv Manuf Technol 48(1–4), 333–345.

Tseng, Y. J., Chen, J. Y. and Huang, F. Y. (2010) A particle swarm optimisation algorithm for berbilang-plant assembly sequence planning with integrated assembly sequence planning and plant assignment. Int J Prod Res 48(10), 2765–2791.

Tseng, Y. J., Yu, F. Y. and Huang, F. Y. (2011) A green assembly sequence planning model with a closed-loop assembly and disassembly sequence planning using a particle swarm optimization method, Int J Adv Manuf Technol, 57, 1183 – 1197.

Tseng, Y. J., Yu, F.Y and Huang, F. Y. (2010) A berbilang-plant assembly sequence planning model with integrated assembly sequence planning and plant assignment using GA, Int J Adv Manuf Technol, 48, 333 – 345.

Tutunji, T., Saleem, A., Salah, M., and Ahmad, N. (2013). Identification of piezoelectric ultrasonic transducers for machining processes. Proceedings of the 9th International Symposium on Mechatronics and its Applications, 9–13.

Udeshi, T. and Tsui, K. (2005) Assembly sequence planning for automated micro assembly. In: IEEE International symposium on assembly and task planning 2005, vol 2005, 98– 105.

Wang, H., Wu, Z., Liu, Y., Wang, J., Jiang, D., and Chen, L. (2009). Space transformation search: a new evolutionary technique. Proceedings of the first ACM/SIGEVO Summit on Genetic and Evolutionary Computation, 537-544.

Wang, J. F., Liu, J. H. and Zhong, Y. F. (2005) A novel ant colony algorithm for assembly sequence planning, Int J Adv Manuf Technol, 25, 1137-1143.

Wang, J. F., Liu, J. H. and Zhong, Y. F. (2005) A novel ant colony algorithm for assembly sequence planning. Int J Adv Manuf Technol 25(11–12), 1137-1143.

Wang, W. P., and Tseng, H. E. (2009) Complexity estimation for genetic assembly sequence planning. J Chin Inst Ind Eng 26(1), 44–52.

Wang, Y. and Liu, J. H. (2010) Chaotic particle swarm optimization for assembly sequence planning. Robot Comput Integr Manuf 26(2), 212–222.

Welch, G., and Bishop, G. (1995). An introduction to the Kalman filter. Technical Report 95-041. University of North Carolina at Chapel Hill.

Xiaoming, Z. and Pingan, D. (2008) A model-based approach to assembly sequence planning, International Journal of Advanced Manufacturing Technology, 39, 983–994.

Yang, X. S. (2009). Firefly algorithms for berbilangmodal optimization. Proceedings of the 5th International Symposium on Stochastic Algorithms: Foundations and Applications, Lecture Notes in Computer Science, 5792, 169–178.

Yang, X. S. (2010). A new metaheuristic bat-inspired algorithm. Nature Inspired Cooperative Strategies for Optimization (NICSO 2010), 284, 65–74.

Yang, X. S. (2012). Flower pollination algorithm for global optimization. Unconventional Computation and Natural Computation, 7445, 240–249.

Yang, X. S., and Deb, S. (2009). Cuckoo search via Levy flights. Proceedings of the 2009 World Congress on Nature and Biologically Inspired Computing, 210–214.

Yu, H., Yu, J. and Zhang, W. (2009) An particle swarm optimization approach for assembly sequence planning. Appl Mech Mater 1228, 16–19.

Zha, X.F. (2000) An object-oriented knowledge based petri net approach to intelligent integration of design and assembly planning, Artificial Intelligence in Engineering, 14, 83-112.

Zhang, J., Sun, J. and He, Q. (2010) An approach to assembly sequence planning using ant colony optimization. In: Proceedings of 2010 international conference on intelligent control and information processing, ICICIP 2010, vol part 2, 230–233.

Zhang, W. (1989) Representation of assembly and automatic robot planning by petri net, IEEE Transactions on Systems, Man, and Cybernetics, 19, 418-422.

Zhao, P. J. (2010). A hybrid harmony search algorithm for numerical optimization. Proceedings of the 2010 International Conference on Computational Aspects of Social Networks, 255–258.

Zhou, W., Zheng, J. R., Yan, J. J. and Wang, J. F. (2011) A novel hybrid algorithm for assembly sequence planning combining bacterial chemotaxis with genetic algorithm, Int J Adv Manuf Technol, 715 – 724.

Zhou, W., Zheng. J., Yan, J. and Wang, J. (2010) A novel hybrid algorithm for assembly sequence planning combining bac-terial chemotaxis with genetic algorithm. Int J Adv Manuf Technol 52(5–8), 715–724.