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PROGRAM AND ABSTRACTS

2010 ICOS ICCAIE CSSR

IEEE Conference on Open Systems

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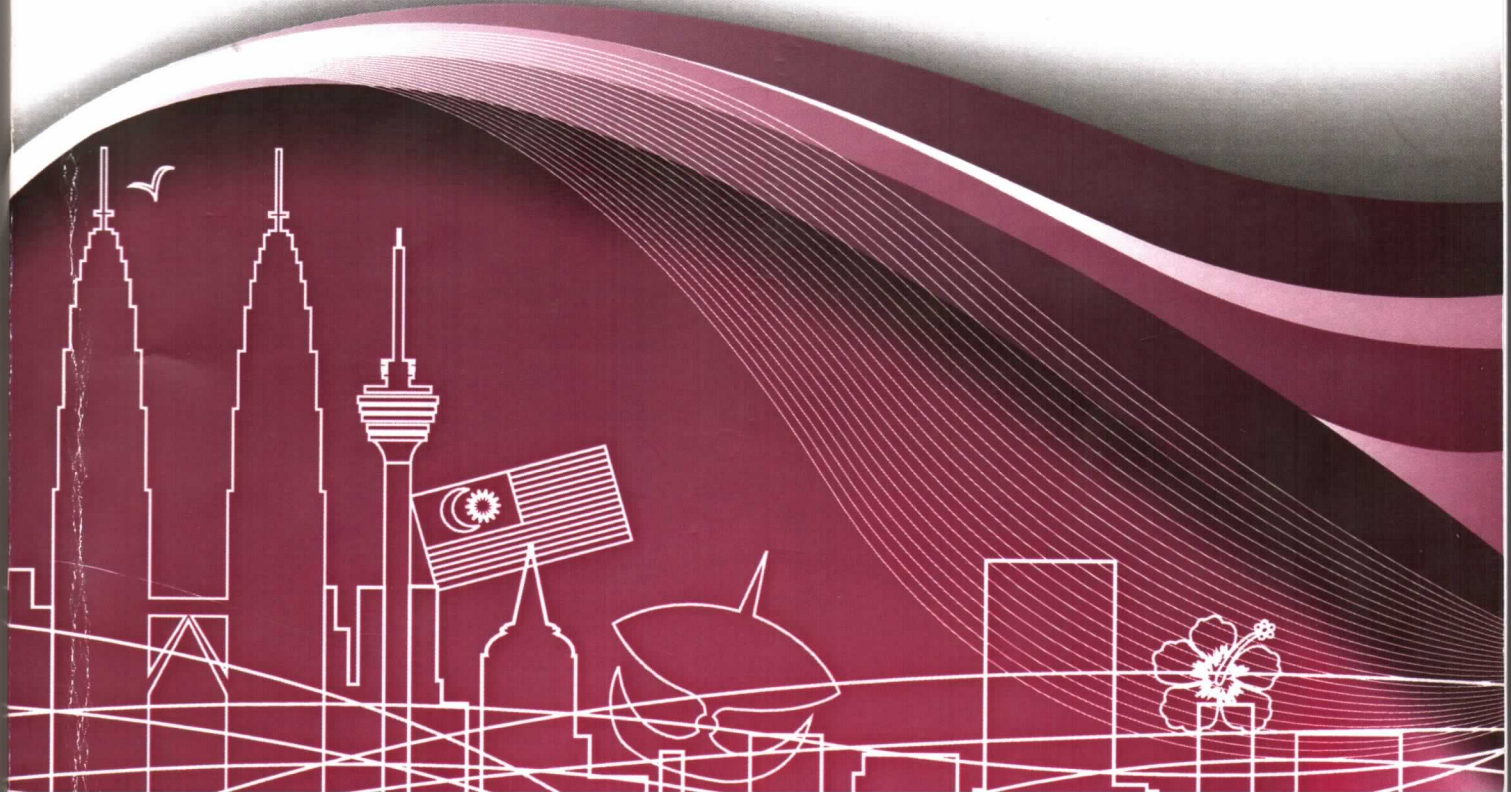

ICCAIE 2010

2010 INTERNATIONAL CONFERENCE ON COMPUTER APPLICATIONS & INDUSTRIAL ELECTRONICS

Seri Pacific Hotel, Kuala Lumpur
5-7 December 2010

TECHNICAL PROGRAM

Monday, December 6

K11: Industrial Electronics & Applications 1
Room: BALAU
Chairs: Cmr Prabhu (Multimedia University, Malaysia), Haipeng Zhang (Hangzhou Dianzi University & Dalian University of Technology, P.R. China)

2:00 ***Positive ESD Robustness of a Novel Anti-ESD TGFPTD SOI LDMOS***
Haipeng Zhang (Hangzhou Dianzi University, P.R. China); Liang Zhang (Hangzhou Dianzi University, P.R. China); Dejun Wang (Dalian University of Technology, P.R. China); Mi Lin (Hangzhou Dianzi University, P.R. China); Xiaoyan Niu (Hangzhou Dianzi University, P.R. China); Lingyan Fan (Hangzhou Dianzi University, P.R. China); Wenjun Li (Hangzhou Dianzi University, P.R. China); Guohua Liu (Hangzhou Dianzi University, P.R. China); Jie Wang (Hangzhou Dianzi University, P.R. China)

2:20 ***Low-Power Fast Static Random Access Memory Cell***
Cmr Prabhu (Multimedia University, Malaysia); Ajay Kumar Singh (Multimedia University, Malaysia)

2:40 ***Sensorless Control of Magnetic Levitation System using Sliding Mode Controller***
Mrunal Deshpande (Anna University, India); Mathur Badrilal (, India)

3:00 ***Mixed-Signal VLSI Layout Design Automation Tool for Transition Region Generation***
Eik Wee Chew (Intel Microelectronics (M) Sdn. Bhd., Malaysia); Chaw Soon Gooi (Intel, Malaysia)

3:20 ***IEEE 1451.0 Enabled Control Architecture For DC-DC Converter System***
Jayaraman Kamala (Anna University, India); Umamaheswari Baskaran (, India)

3:40 ***Effect of Change in Ratio of Electrode to Total Pitch Length in EWOD Based Microfluidic System***
Abhilash Paneri (Birla Institute Of Technology and Sciences (BITS), Pilani, India); Nitinipun Sharma (Birla Institute Of tech. & Sciences (BITS), Pilani, India)

M11: Communications Technology 1
Room: SERAYA
Chairs: Soma Bandyopadhyay (TATA Consultancy Services, India), Jehana Ermy Jamaluddin (Universiti Tenaga Nasional, Malaysia)

2:00 ***Reed-Solomon Codes for Uncompressed IP Header Protection***
L. Barukang (Lancaster University, Malaysia)

2:20 ***A Novel Bandwidth Aggregation System Using Multiple Physical Links***
Soma Bandyopadhyay (TATA Consultancy Services, India); Arpan Pal (Tata Consultancy Services, India); Shameemraj Nadaf (TCS, India)

2:40 ***Advances in Control and Data Transmission over the Power Line Using the Ultra-Wideband Technology Approach***
Jehana Ermy Jamaluddin (Universiti Tenaga Nasional, Malaysia)

3:00 ***Optimized Capacity Planning and Performance Measurement through OPNET Modeler***
Sami Habib (Kuwait University, Kuwait); Paulvanna Nayaki Marimuthu (Kuwait University, Kuwait)

3:20 ***Gain and Noise Ripple Reduction in Broadband Raman Amplifiers using HNLF Spectral Broadening***
Vineetha Kalavally (Monash University, Malaysia); Roy Karuntu (Monash University, Malaysia); Tin Win (Monash University Sunway Campus, Malaysia); Malin Premaratne (Monash University, Australia)

3:40 ***Performance of a Polling System with Finite Queues using Markov Chain***
Adnan Sohail (Vienna University of Technology, Austria); Ansar Yasin (TU Wien, Austria)

L11: Signal & Image Processing
Room: MERANTI
Chairs: Maimun Huja Husin (Universiti Malaysia Sarawak, Malaysia), Maneesha V Ramesh (Amrita Vishwa Vidyapeetham (University), India)

2:00 ***A Discriminant-based Locality Preserving Embedding In Face Recognition***
Ying Han Pang (Multimedia University, Malaysia); Andrew Teoh Beng Jin (Yonsei University, Korea); Wee How Khoh (Multimedia University, Malaysia)

2:20 ***Image based Atmospheric Correction of remotely Sensed Images***
Priti Tyagi (S. N. D. T. Women's University, India); Udhav Bhosale (University of Mumbai, India)

2:40 ***Signal Processing for Wireless Geophone Network to Detect Landslides***
Abishek Thekkeyil Kunnath (Amrita Vishwa Vidyapeetham, India); Maneesha V Ramesh (Amrita Vishwa Vidyapeetham (University), India); Vijayan Selvan (Amrita University, India)

3:00 ***Fast and Accurate Human Detection for Video Applications using Edgelets***
Chowdhury Mohammed (Monash University, Malaysia); Ye Chow Kuang (Monash University Malaysia, Malaysia); Melanie Ooi (Monash University, Malaysia)

3:20 ***Development of Shape Pattern Recognition for FPGA-Based Object Tracking System***
Maimun Huja Husin (Universiti Malaysia Sarawak, Malaysia); Fauziliana Osman (UNIMAS, Malaysia); Mohamad Faizrizwan Mohd Sabri (UNIMAS, Malaysia); Wan Azlan Wan Zainal Abidin (Universiti Malaysia Sarawak, Malaysia); Al-Khalid Othman (UNIMAS, Malaysia); Ade Syaheda Wani Marzuki (Universiti Malaysia Sarawak, Malaysia)

3:40 ***Image Index Model for Retrieval using Hadusdorff Distortion***
Janet B (National Institute of Technology, India); Reddy A v (, India)

K12: Industrial Electronics & Applications 1 (cont)
Room: BALAU
Chairs: Cmr Prabhu (Multimedia University, Malaysia), Haipeng Zhang (Hangzhou Dianzi University & Dalian University of Technology, P.R. China)

4:20 ***Multiple Feedforward Classifiers by Bagging for Ion-Sensitive Field Effect Transistor Sensor Response***
Wan Fazlida Abdullah (Universiti Teknologi MARA, Malaysia); Masuri Othman (Univrsity Kebangsaan Malaysia, Malaysia); Mohd Alauddin Mohd Ali (Universiti Kebangsaan Malaysia, Malaysia); Md. Shabiul Islam (University Kebangsaan Malaysia, Malaysia)

4:40 ***Design of Garment Hanger Dryer***
Rodney Tan (UCSI University, Malaysia)

5:00 ***Towards the Conceptual Design and Construction of an Unmanned Small-Scale Air-Land-Water Vehicle***
Arhami (Univeriti Tun Hussein Onn Malaysia, Malaysia); Khalid Hasnan (Universiti Tun Hussein Onn Malaysia, Malaysia); Abas Ab. Wahab (Universiti Tun Hussein Onn Malaysia, Malaysia)

5:20 ***Auto-Syringe System for Chemical Applications***
Abdulwahid A. Al-Saif (, Saudi Arabia)

5:40 ***The TDFC Method for Control Unstable Chaotic Behavior in Boost Converter***
Ataollah Abbasi (University of shahed, Iran); Mehrdad Rostami (Shahed University, Iran); Hamid Fathi (Amirkabir University of Technology, Iran); Jafar Abdollahi (University of shahed, Iran); Hamid Abbasi (University of tehran, Iran)

6:00 ***RTU Hardware Design for SCADA Systems Using FPGA***
Soroush Shirali (University of Shahid Beheshti, Iran); Shahab Ensafi (University of Shahaid Beheshti, Iran); Mahsa Naseri (Electronic engineering, Iran)

M12: Communications Technology 1 (cont)
Room: SERAYA
Chairs: Soma Bandyopadhyay (TATA Consultancy Services, India), Jehana Ermy Jamaluddin (Universiti Tenaga Nasional, Malaysia)

4:20 ***An Overview of Scheduling Algorithms in Mobile Ad-Hoc Networks***
Nur Idawati Md Enzai (Universiti Teknologi MARA, Malaysia); Rosheila Darus (UiTM, Malaysia); Siti Sara Rais (Universiti Teknologi MARA Terengganu, Malaysia)

4:40 ***Optimized Routing in a Location Aware System for Wireless Sensor Networks***
Javed Baloch (University of Leeds, United Kingdom); Brian Hoyle (University of Leeds, United Kingdom)

5:00 ***Modeling and Simulation of near-earth Wireless Sensor Networks for Agriculture based Application using OMNeT++***
Latifah Munirah Kamarudin (University Malaysia Perlis, Malaysia)

5:20 ***Analysis of RSC Turbo Codes in MB-OFDM UWB system with Channel Estimation***
Norulhusna Ahmad (Universiti Teknologi Malaysia, Malaysia)

5:40 ***Cluster Based Peers Configuration with Multiple Physical Parameters using HCNP in Peer-to-Peer Overlay Networks***
Saira Aslam (College of EME, National University of Science & Technology, Pakistan); Irum Kazmi (College of EME, NUST, Pakistan); Muhammad Javed (College of EME, NUST, Pakistan); Muhammad Shahzad Anwar (College of EME, NUST, Pakistan)

6:00 ***Demonstration of Spectral Slicing WDM System using Light Emitting Diode (LEDs) Light Source***
Nasim Ahmed (University Malaysia Perlis, Malaysia)

L12: Signal & Image Processing (cont)
Room: MERANTI
Chairs: Maimun Huja Husin (Universiti Malaysia Sarawak, Malaysia), Maneesha V Ramesh (Amrita Vishwa Vidyapeetham (University), India)

4:20 ***Expression Invariant Face Recognition Using Multi-Stage 3D Face Fitting with 3D Morphable Face Model***
Abdallah Alomari (University Putra Malaysia, Malaysia); Fatimah Khalid (Universiti Putra Malaysia, Malaysia); Rahmita Wirza O.K. Rahmat (University Putra Malaysia, Malaysia); Muhamad Taufik Abdullah (University Putra Malaysia, Malaysia)

4:40 ***Digital Watermarking Algorithm Using LSB***
Abdullah Bamatraf (Tun Hussein Onn University, Malaysia); Rosziati Ibrahim (Tun Hussein On University, Malaysia); Mohd Najib Mohd Salleh (University Tun Hussein Onn Malaysia, Malaysia)

5:00 ***Noise Removal from Printed Text and Handwriting Images using Coordinate Logic Filters***
Sayed Mohammad Mostafavi Isfahani (Sabzevar Tarbiat Moallem University, Iran); Iman Abaspur Kazerouni (Sabzevar Tarbiat Moallem University, Iran); Javad Haddadnia (Sabzevar Tarbiat Moallem, Iran)

5:20 ***Offline Arabic Handwritten Word Recognition using Zernike Moments and Hidden Markov Models***
Idris El-Feghi (Al-Fateh University, Libya); Fatma Elmahjoub (Higher institute of industry, Libya); B. Alswady Alswady (Inam Company for Electrical Investments, Libya); Abdullah Baiou (EE -Fateh University, Libya)

5:40 ***Human Motion Tracking on Broadcast Golf Swing Video using Optical Flow and Template Matching***
Kwoh Fung Sim (Universiti Malaysia Perlis, Malaysia); Kenneth Sundaraj (University Malaysia Perlis, Malaysia)

6:00 ***Proposed Technique for Aircraft Recognition in Intelligent Video Automatic Target Recognition System (IVATRs)***
Syed Faisal Ali (Universiti Teknologi PETRONAS (UTP), Malaysia); Jafreezal Jaafar (Universiti Teknologi PETRONAS, Malaysia); Aamir S Malik (Universiti Teknologi Petronas, Malaysia)

Tuesday, December 7

K21: Software Engineering & AI
Room: BALAU
Chairs: Shivanand M Handigund (Bangalore Institute of Technology, Bangalore (India), India), Prabhakar Mishra (PES Institute of Technology, Bangalore, India)

8:40 ***A Novel Path Planning Algorithm for Autonomous Robot Navigation***
Prabhakar Mishra (PES Institute of Technology, Bangalore, India); Kushal Mall (PESIT, India)

9:00 ***Fuzzy PD+I and Fuzzy PID Controllers Design for a Nonlinear Quarter Car Suspension System***
Sajad Tabatabaei (Mahshahr Islamic Azad University, Iran); Mokhtar Sha Sadeghi (Shiraz University of Technology, Iran); Alireza Barzegar (B.Sc. Control Egineering, Iran); Pegah Roosta (B.Sc. Control Engineering, Iran)

9:20 ***Object Categorization using Cartesian Genetic Programming (CGP) and CGP-Evolved Artificial Neural Network***
Sumayyea Salahuddin (NWFP University of Engineering and Technology Peshawar, Pakistan); Maryam Mahsal Khan (University of Engineering & Technology, Peshawar, Pakistan)

9:40 ***Fuzzy Self-Tuning Gain Scheduled Control Design for an Autopilot Missile***
Sajad Tabatabaei (Mahshahr Islamic Azad University, Iran); Mokhtar Sha Sadeghi (Shiraz University of Technology, Iran); Shahab-o-din Tohidi (Shiraz University of Technology, Iran); Parinaz Sadat Mirjafari (University of Tehran, Iran)

10:00 ***Articulatory Δ and ΔΔ Parameters effect on HMM-based classifier for ASR***
Foyzul Hassan (United International University, Bangladesh); Qamrun Eity (Ahsanullah University of Science and Technology, Bangladesh); Mohammed Rokibul Alam Kotwal (United International University, Bangladesh); Manoj Banik (Ahsanullah University of Science and Technology, Bangladesh); Mohammad Mahedi Hasan (Blueliner Bangladesh, Bangladesh); Sharif Mohammad Musfiqur Rahman (United International University, Bangladesh); Ghulam Muhammad (King Saud University, Saudi Arabia); Mohammad Huda (United International University, Bangladesh)

10:20 ***Statistical Analysis Learning Approach: The Use of Artificial Intelligence In Network Data Visualization System***
Doris Wong Hooi Ten (University Sains Malaysia, Malaysia)

L21: Human Factors & Ergonomics
Room: MERANTI
Chairs: Mehdi Moallem (Isfahan University of Technology, Iran), Anitawati Mohd Lokman (Universiti Teknologi MARA, Malaysia)

8:40 ***Preliminary Study on Factors that Influence Skin Characteristics of UiTM Staffs***
Saiful Suliman (Universiti Teknologi MARA, Malaysia); Yuslinda Wati Mohamad Yusof (Universiti Teknologi MARA, Malaysia)

9:00 ***An Effective Segmentation Method for Single Stroke Online Cursive Arabic Words***
Moayad Potrus (Universiti Sains Malaysia, Malaysia); Umi Ngah (Universiti Sains Malaysia, Malaysia); Harsa Mat Sakim (Universiti Sains Malaysia, Malaysia)

9:20 ***Fuzziness in Analytic Network Process under Interval Number for Criteria and Alternatives***
Napsiah Ismail (Universiti Putra Malaysia, Malaysia); Hannaneh Rashidi-Bajgan (Mazandaran University of Science and Technology, Iran); Taravatsadat Nehzati (University Putra Malaysia, Malaysia)

9:40 ***Finding an Optimal Learning Path in Dynamic Curriculum Sequencing with Flow Experience***
Norliza Katuk (, New Zealand); Hokyoung Ryu (Massey University, New Zealand)

10:00 ***A Genetic Algorithm for Capital Budgeting Problem with Fuzzy Parameters***
Hannaneh Rashidi-Bajgan (Mazandaran University of Science and Technology, Iran); Napsiah Ismail (Universiti Putra Malaysia, Malaysia); Taravatsadat Nehzati (University Putra Malaysia, Malaysia); Javad Rezaeian (Mazandran University of Science and Technology, Babol, Iran)

10:20 ***Exploring Kansei Structure and Visualization of Cell-phone Design Cluster***
Anitawati Mohd Lokman (Universiti Teknologi MARA, Malaysia); Nurul Ain Satibi (Universiti Teknologi MARA, Malaysia)

M21: Trusted Computing & Wireless Systems
Room: SERAYA
Chairs: Ali Dehghantanha (Asia- Pacific University College of Technology and Innovation, Malaysia), Nasrin Sadeghianpour Hamami (Multimedia University, Malaysia)

8:40 ***Mitigating Botware Attacks on E-banking Websites Utilizing Trusted Platform Module***
Ali Dehghantanha (Asia- Pacific University College of Technology and Innovation, Malaysia)

9:00 ***Rootkit Resistant File-system based on TPM***
Teh Jia Yew (Universiti Putra Malaysia (UPM), Malaysia); Khairulmizam Samsudin (Universiti Putra Malaysia, Malaysia); Nur Izura Udzir (Universiti Putra Malaysia, Malaysia)

9:20 ***An Empirical Study on Secure Communication for Grid Information Service***
Razieh Mokhtarnameh (Multimedia University, Malaysia); Ho Sin Ban (Multimedia University, Malaysia); Nithiapidary Muthuvelu (Multimedia University, Malaysia)

9:40 ***A Method to Evaluate Web Services Anomaly Detection Using Hidden Markov Models***
Gholamali Rahnavard (New Mexico State University, USA); Meisam Najjar (, Iran); Somaye Taherifar (Shahid Chamran University of Ahvaz, Iran)

10:00 ***Model Driven Security Framework for Definition of Security Requirements for SOA Based Applications***
Muhammad Qaiser Saleem (University Technology Petronas, Malaysia); Jafreezal Jaafar (Universiti Teknologi PETRONAS, Malaysia); Mohd Fadzil Hassan (Universiti Teknologi PETRONAS, Malaysia)

10:20 ***Packet Analysis using Packet Filtering and Traffic Monitoring Techniques***
Siti Hajar Che Haris (University Malaysia Perlis, Malaysia)

L22: Human Factors & Ergonomics (cont)
Room: MERANTI
Chairs: Mehdi Moallem (Isfahan University of Technology, Iran), Anitawati Mohd Lokman (Universiti Teknologi MARA, Malaysia)

11:00 ***Framework for New Generation Web Form and Form Filling for Blind User***
Kian Kok Cheung (University Malaysia Sarawak, Malaysia); Edwin Mit (Universiti Malaysia Sarawak, Malaysia); Chong Eng Tan (Universiti Malaysia Sarawak, Malaysia)

11:20 ***User Perception on Public Payphone Icons and Their Representation in Malaysia***
Chee Weng Khong (Multimedia University, Malaysia); Chui Yin Wong (Multimedia University, Malaysia); Stanley Richardson (Multimedia University, Malaysia)

11:40 ***Cognitive Mapping on User Interface Design***
Chui Yin Wong (Multimedia University, Malaysia)

12:00 ***Investment supervision in stock market***
Umm-e- Laila (Sir Syed Unievrsity of Engineering and Technology, Pakistan)

M22: Trusted Computing & Wireless Systems (cont)
Room: SERAYA
Chairs: Ali Dehghantanha (Asia- Pacific University College of Technology and Innovation, Malaysia), Nasrin Sadeghianpour Hamami (Multimedia University, Malaysia)

11:00 ***Privacy-Enhanced Trusted Location Based Services (PE-TLBS) Framework based on Direct Anonymous Attestation (DAA) protocol***
Hanunah Othman (University Teknologi MARA, Malaysia); Habibah Hashim (Universiti Teknologi MARA, Malaysia); Jamalul-lail Ab Manan (MIMOS Berhad, Malaysia); Mohd Ameer Yuslan Razmi (Universiti Teknologi MARA, Malaysia)

11:20 ***Wireless Physical Layer Security Using Encryption and channel Pre-Compensation***
M Tahir (IIUM, Malaysia); Sigit Jarot (International Islamic University Malaysia, Malaysia); Mohammad Umar Siddiqi (International Islamic University Malaysia, Malaysia)

11:40 ***Trusted Computing Based Microkernel***
Sharipah Setapa (Researcher, Malaysia); Mohd Anuar Mat Isa (MIMOS Berhad, Malaysia); Nazri Abdullah (Researcher, Malaysia); Jamalul-lail Ab Manan (MIMOS Berhad, Malaysia)

12:00 ***Joint Resource Allocation in Multi-Radio Multi-Channel Wireless Mesh Networks with Practical Sectored Antennas***
Nasrin Sadeghianpour Hamami (Multimedia University, Malaysia); Teong Chee Chuah (Multimedia University, Malaysia); Su Wei Tan (Multimedia University, Malaysia)

12:20 ***Energy Consumption Balancing in Wireless Sensor Networks***
Farruh Ishmanov (Yeungnam University, Korea)

12:40 ***A new routing algorithm for Wireless Sensor Networks***
Javad Zamani (Islamic Azad University - Zanjan Branch, Zanjan, Iran); Jaber Karimpour (University of tabrize, Iran)

K22: Software Engineering & AI (cont)
Room: BALAU
Chairs: Shivanand M Handigund (Bangalore Institute of Technology, Bangalore (India), India), Prabhakar Mishra (PES Institute of Technology, Bangalore, India)

11:00 ***Performance Comparison between Adaptive Neuro-Controller and Adaptive Parametric Black Box Controller***
Siti Maryam Sharun (University Malaysia Perlis, Malaysia); Mohd Yusoff Mashor (UNIMAP, Malaysia); Norhayati Mohd Nazid (University Malaysia Perlis, Malaysia); Sazali Yaacob (Universiti Malaysia Perlis, Malaysia); WAN NUR HADANI Wan jaafar (UNIMAP, Malaysia)

11:20 ***Minimal Instruction Set FPGA AES Processor using Handel - C***
Jia Hao Kong (University of Nottingham Malaysia Campus, Malaysia); Li Minn Ang (University of Nottingham, Malaysia campus, Malaysia); Kah Phooi Seng (University of Nottingham, Malaysia campus, Malaysia); Achonu Oluwole Adejo (University of Nottingham Malaysia, Malaysia)

11:40 ***Measuring testability of Aspect oriented programes***
Parteek Sharma (RIMT Instituite of Engineering & Technology, India); Mohit Kumar (RIMT-IET Mandi Gobindgarh, India); Harsh Sadawarti (RIMT Institute of Engg. & Technology, Mandi Gobindgarh, India)

12:00 ***Communication Issues in Parallel Conjugate***
Leila Ismail (UAE University, UAE)

12:20 ***Implementation of (15, 9) Reed Solomon Minimal Instruction Set Computing on FPGA using Handel-C***
Jia Jan Ong (University of Nottingham Malaysia Campus, Malaysia); Li Minn Ang (University of Nottingham, Malaysia campus, Malaysia); Kah Phooi Seng (University of Nottingham, Malaysia campus, Malaysia)

12:40 ***An Ameliorated Methodology for the Abstraction of Object Class Structures for an Information System***
Shivanand M Handigund (Bangalore Institute of Technology, Bangalore (India), India); Shweta Bhat (Bangalore Institute of Technology, Bangalore, India)

N31: Industrial Electronics & Applications 3
Room: CENGAL
Chairs: Dilmi Smain (university of Blida, Algeria), Takao Tsukutani (Matsue College of Technology, Japan)

2:00 ***Heat Exchanger Modeling using NARX Model with Binary PSO-based Structure Selection Method***
Ihsan M. Yassin (Universiti Teknologi Mara, Malaysia); Mohd Nasir Taib (Universiti Teknologi MARA, Malaysia); Hasliza Abu Hassan (Universiti Industri Selangor, Malaysia); Azlee Zabidi (Universiti Teknologi MARA, Malaysia); Nooritawati Md Tahir (Universiti Teknologi MARA, Malaysia)

2:20 ***Synergetic Brain Model for Human-Like Motion Patterns Recognition***
Ibrahim Za'balawi (Multimedia University, Malaysia); ChuKiong Loo (Multimedia University, Malaysia); Eng Kiong Wong (Multimedia University, Malaysia)

2:40 ***EEG Based Home Lighting System***
Nurfatehah Wahy (Universiti Teknologi Mara, Malaysia); Wahidah Mansor (Universiti Teknologi MARA, Malaysia)

3:00 ***The Design and Testing of an Electronic Nose Prototype for Classification Problem***
Mazlina Mamat (Universiti Kebangsaan Malaysia, Malaysia); Salina A Samad (Universiti Kebangsaan Malaysia, Malaysia)

3:20 ***Electrical Tunable Multiple-Mode Universal Biquadratic Circuits***
Yasuaki Sumi (Tottori University of Environmental Studies, Japan)

3:40 ***Logical Effort using Particle Swarm Optimization Algorithm - An Examination on the 4-Stage Half Adder Circuit***
Aiman Johari (Universiti Teknologi Mara, Malaysia); Syazilawati Mohamed (Universiti Teknologi MARA, Malaysia); Hasliza Abu Hassan (Universiti Industri Selangor, Malaysia); Abdul Karimi Halim (Universiti Teknologi MARA, Malaysia); Ihsan M. Yassin (Universiti Teknologi Mara, Malaysia)

M31: Industrial Electronics & Applications 2
Room: SERAYA
Chairs: Sheetal Bhandari (International Institute of information Technology, India), Ahmad Asari Sulaiman (Universiti Teknologi MARA, Malaysia)

2:00 ***Multilayer Structure of Ring Resonator Filter for Digital Broadcasting***
M. Ali. Maghpur Muhammad (UiTM, Malaysia); Robi'atun Adayiah Awang (Universiti Teknologi Mara, Malaysia); Ahmad Asari Sulaiman (Universiti Teknologi MARA, Malaysia); Noor Hasimah Baba (Universti Teknologi Mara, Malaysia); Mohamad Huzaimy Jusoh (Universiti Teknologi MARA, Malaysia); Mohd Ain (Universiti Sains Malaysia, Malaysia)

2:20 ***On Design of Differential Voltage Controlled Oscillators with Single Ended Control Line***
Mehdi Ayat (Iran University of Science and Technology, Iran); Reza Ebrahimi Atani (University of Guilan, Iran); Sattar Mirzakuchaki (Iran University of Science and Technology, Iran); Alireza Abdollahi Taromsari (The University of Guilan, Iran)

2:40 ***X-Band Dielectric Resonator Bandpass Filter***
Ahmad Asari Sulaiman (Universiti Teknologi MARA, Malaysia); Mohd Ain (Universiti Sains Malaysia, Malaysia); Mohamad Ariff Othman (Universiti Sains Malaysia, Malaysia); Ali Othman (Universiti Sains Malaysia, Malaysia)

3:00 ***Space Radiation Effects in QCA Binary Wire***
Mojdeh Mahdavi (Islamic Azad University of Shahryar Shahr-e-Qods Branch, Iran); Mohammad Amin Amiri (Iran University of Science & Technology, Iran); Sattar Mirzakuchaki (Iran University of Science and Technology, Iran)

3:20 ***Logic-Based QCA Realization of a 4×4 S-Box***
Mohammad Amin Amiri (Iran University of Science & Technology, Iran); Mojdeh Mahdavi (Islamic Azad University of Shahryar Shahr-e-Qods Branch, Iran); Sattar Mirzakuchaki (Iran University of Science and Technology, Iran)

3:40 ***A Framework of Telemetry Technology Application in Robotic Area Using MATLAB Toolboxes for Education***
Luhur Budi Saesar (UTHM, Malaysia)

L31: Communications Technology 2
Room: MERANTI
Chairs: Habibah Hashim (Universiti Teknologi MARA, Malaysia), Kumbesan Sandrasegaran (University of Technology, Sydney, Australia)

2:00 ***Comparative Performance Evaluation of LDPC Coded and Turbo Coded OFDM Systems in SUI Multipath Channel Models***
Muhammad Shahzad Anwar (College of EME, NUST, Pakistan); Muhammad Zeeshan (College of EME, NUST, Pakistan); Saira Aslam (College of EME, National University of Science & Technology, Pakistan); Muhammad Ajaz (College of EME, NUST, Pakistan); Muhammad Salman (College of Electrical & Mechanical Engineering, National University of Sciences & Technology, Pakistan)

2:20 ***Joint Delay-Aware Opportunistic Scheduling Algorithm with Reduced Feedbackto Exploit Multiuser Diversity***
Rachod Patachaianand (University of Technology Sydney, Australia); Kumbesan Sandrasegaran (University of Technology, Sydney, Australia); Faisal Madani (University of Technology Sydney, Australia)

2:40 ***Estimation of the Doppler spread and the time delay spread for the Wireless Communication Channel***
Zaiton Sharif (Universiti Teknologi Malaysia, Malaysia); Ahmad Zuri Bin Sha'ameri (Universiti Teknologi Malaysia, Malaysia)

3:00 ***Opportunistic Downlink Sum-Rate with Multiple Feedback Thresholds***
Rachod Patachaianand (University of Technology Sydney, Australia); Kumbesan Sandrasegaran (University of Technology, Sydney, Australia)

3:20 ***Speed Estimation Using Transmit Power Control Commands***
Rachod Patachaianand (University of Technology Sydney, Australia); Kumbesan Sandrasegaran (University of Technology, Sydney, Australia)

3:40 ***Color-based Bottom-up Saliency for Traffic Sign Detection***
Anh Cat Le Ngo (The University of Nottingham, Malaysia Campus, Malaysia); Kenneth Ang Li-Minn (The University of Nottingham, Malaysia Campus, Malaysia); Jasmine Seng Kah Phooi (The University of Nottingham, Malaysia Campus, Malaysia); Guoping Qiu (University of Nottingham, United Kingdom)

K31: Signal & Image Processing 3
Room: BALAU
Chairs: Yasmin Hanum Md Thayoob (Universiti Tenaga Nasional, Malaysia), Sanjay Nilkanth Talbar (Shri Guru Gobind Singhji Insitute of Engineering and Technology, India)

2:00 ***Curvelet-based Illumination Invariant Feature Extraction for Face Recognition***
Sue Inn Ch'ng (Nottingham University Malaysia Campus, Malaysia)

2:20 ***Gait classification with different covariate factors***
Hu Ng (Multimedia University, Malaysia); Hau Lee Tong (Multimedia University, Malaysia); Wooi Haw Tan (Multimedia University, Malaysia); Timothy Tzen Vun Yap (Multimedia University, Malaysia); Junaidi Abdullah (Multimedia University, Malaysia)

2:40 ***Adaptive image segmentation based on Peak Signal to Noise Ratio for a license plate recognition system***
Farshid PirahanSiah (University Kebangsaan Malaysia (UKM – National University of Malaysia), Malaysia); Siti Norul Huda Sheikh Abdullah (Universiti Teknologi Malaysia, Malaysia); Shahnorbanun Sahran (Universiti Kebangsaan Malaysia, Malaysia)

3:00 ***Biomedical Image Coding using Dual Tree Discrete Wavelet Transform and Noise Shaping Algorithm***
Sanjay Nilkanth Talbar (Shri Guru Gobind Singhji Insitute of Engineering and Technology, India); Anil K Deshmane (College of Engineering, Osmanabad, India)

3:20 ***Surface Normal Angle for 3D Face Recognition***
Wei Jen Chew (The University of Nottingham, Malaysia); Kah Phooi Seng (University of Nottingham, Malaysia campus, Malaysia); Li Minn Ang (University of Nottingham, Malaysia campus, Malaysia)

3:40 ***MR Image Monomodal Registration Based on the Nonsubsampled Contourlet Transform and Mutual Information***
Nemir Ahmed Al-Azzawi (Universiti Sains Malaysia (USM), Malaysia); Harsa Amylia Mat Sakim (Universiti Sains Malaysia, Malaysia); Ahmed K. Wan Abdullah (Universiti Sains Malaysia, Malaysia)

J31: Computer Applications & Signal Processing
Room: KENANGA
Chairs: Mas Irfan Purbawanto Hidayat (Institute of Technology Sepuluh Nopember, Indonesia), Ibrahim Za'balawi (Multimedia University, Malaysia)

2:00 ***Adaptive Skin Color Model for Hand Segmentation***
Ahmad Yahya Dawod (Mulit Media University, Malaysia)

2:20 ***Evaluation of Bangla Word Recognition Performance Using Acoustic Features***
Shahadat Hossain (United International University, Bangladesh); Nusrat Lisa (Ahsanullah University of Science and Technology, Bangladesh); Gazi Md. Moshfiqul Islam (United International University, Bangladesh); Foyzul Hassan (United International University, Bangladesh); Mohammad Mahedi Hasan (Blueliner Bangladesh, Bangladesh); Sharif Mohammad Musfiqur Rahman (United International University, Bangladesh); Mohammed Rokibul Alam Kotwal (United International University, Bangladesh); Mohammad Huda (United International University, Bangladesh)

2:40 ***Robust Delay-Dependent α-Synchronization of a Class of Uncertain Noise-Perturbed Time-Delayed Chaotic and Hyper-Chaotic Systems***
Mokhtar Sha Sadeghi (Shiraz University of Technology, Iran); Mahdi Sojoodi (Tarbiat Modares University, Iran)

3:00 ***Sinogram Concept Approach in Image Reconstruction Algorithm of a Computed Tomography System Using MATLAB***
Zulkarnay Zakaria (Universiti Malaysia Perlis, Malaysia); Noor Hidayah Jaafar (Universiti Malaysia Perlis, Malaysia); Noor Aqma Mohd Yazid (Universiti Malaysia Perlis, Malaysia); Muhammad Saiful Badri Mansor (School of Mechatronic Engineering, Malaysia); Mohd Hafiz Fazalul Rahiman (Universiti Industri Selangor, Malaysia); Ruzairi Abdul Rahim (Universiti Teknologi Malaysia, Malaysia)

3:20 ***Radial Basis Function Neural Networks for Velocity-field Reconstruction in Fluid-Structure Interaction Problem***
Mas Irfan Purbawanto Hidayat (Institute of Technology Sepuluh Nopember, Indonesia); Bambang Ariwahjoedi (Universiti Teknologi PETRONAS, Malaysia)

3:40 ***Fuzzy PID Controller Design for a Heat Exchanger System: an Energy Efficiency Approach***
Sajad Tabatabaei (Mahshahr Islamic Azad University, Iran); Pegah Roosta (B.Sc. Control Engineering, Iran); Mokhtar Sha Sadeghi (Shiraz University of Technology, Iran); Alireza Barzegar (B.Sc. Control Egineering, Iran)

H31: Signal & Image Processing 2
Room: TANJUNG
Chairs: Roslina Mohamad (University Teknologi Mara, Malaysia), Siti Norul Huda Sheikh Abdullah (Universiti Teknologi Malaysia, Malaysia)

2:00 ***Performance Analysis of Convolutional Interleaver on TMS320C6711 Digital Signal Processing Kit***
Roslina Mohamad (University Teknologi Mara, Malaysia); Nuzli Mohamad Anas (Mimos Berhad, Malaysia)

2:20 ***Speeding up Fractal Image De-Compression***
Abolfazl Hosseini (Tarbiat Modares University, Iran); Besharat Rezaei Shookooh (University of Islamic Azad, Iran); Saeid Shahhosseini (Islamic Azad University Shahr-e-Rey branch, Iran); Shahriar Beizaee (Islamic Azad University Shahr-e-Rey branch, Iran)

2:40 ***Automatic Visual Inspection Classify Metal Parts Based on Morphology and Fuzzy Rules***
Siti Norul Huda Sheikh Abdullah (Universiti Teknologi Malaysia, Malaysia); Haider Sh Hashim (University Kebangsaan Malaysia, Malaysia); Anton Satria Prabuwono (Universiti Kebangsaan Malaysia, Malaysia)

3:00 ***Ultra Low Power Implementation of 2-D DCT for Image/Video Compression***
Thoudam Singh (Indian Institute of Technology, Delhi, India)

3:20 ***A Visual Base Image Coding Using Unequal Error Protection in High Error Rate Channels***
Saeid Shahhosseini (Islamic Azad University Shahr-e-Rey branch, Iran); Abolfazl Hosseini (Tarbiat Modares University, Iran)

3:40 ***Bangla Phoneme Recognition for Different Acoustic Features***
Mohammed Rokibul Alam Kotwal (United International University, Bangladesh); Foyzul Hassan (United International University, Bangladesh); Manoj Banik (Ahsanullah University of Science and Technology, Bangladesh); Gazi Md. Moshfiqul Islam (United International University, Bangladesh); Md. Rakibuzzaman (United International University, Bangladesh); Mohammad Mahedi Hasan (Blueliner Bangladesh, Bangladesh); Ghulam Muhammad (King Saud University, Saudi Arabia); Mohammad Huda (United International University, Bangladesh)

C32: CSSR : Engineering Applications 3 (cont)
Room: BALL**ROOM** C

4:20 ***Improvement of superheated steam generator by induction heating***
Hideo Tomita (Tokyo Denki University, Japan); Yuki Makimura (Tokyo Denki University, Japan)

N32: Industrial Electronics Applications 3 (cont)
Room: CENGAL
Chairs: Dilmi Smain (university of Blida, Algeria), Takao Tsukutani (Matsue College of Technology, Japan)

4:20 ***Electronically Tunable First-Order All Pass Sections Using OTAs***
Takao Tsukutani (Matsue College of Technology, Japan)

4:40 ***Simulation on Simulink AC4 Model (200hp DTC Induction Motor Drive) Using Fuzzy Logic Controller***
Nur Hakimah Ab Aziz (Universiti Teknikal Malaysia Melaka, Malaysia); Azhan Ab Rahman (Universiti Teknikal Malaysia Melaka, Malaysia)

5:00 ***μ-synthesis Controller Design for the GLA longitudinal Flexible Aircraft***
Dilmi Smain (university of Blida, Algeria); Bouzouia Brahim (Centre de Développement des Téchnologies Avancées, Algeria)

5:20 ***Intelligent Identification of Uncertainty Bounds for Robust Servo Controlled System***
Safanah M Raafat (IIUM, Malaysia); Rini Akmeliawati (International Islamic University, Malaysia)

5:40 ***Application of Bandpass Filter as a Sensor for Rice Characterization***
Kok Yeow You (, Malaysia); Li Ling You (, Malaysia)

J32: Computer Applications & Signal Processing (cont)
Room: KENANGA
Chairs: Mas Irfan Purbawanto Hidayat (Institute of Technology Sepuluh Nopember, Indonesia), Ibrahim Za'balawi (Multimedia University, Malaysia)

4:20 ***Challenges in Building Domain Ontology For Minority Languages***
Panceras Talita (Universiti Malaysia Sarawak (UNIMAS), Malaysia); Alvin W Yeo (Universiti Malaysia Sarawak, Malaysia); Narayanan Kulathuramaiyer (UniMas, Malaysia)

4:40 ***Computer Supported Cooperative Work (CSCW) in Orthography System Development***
Sook Kuan Chin (University of Malaysia Sarawak, Malaysia); Alvin W Yeo (Universiti Malaysia Sarawak, Malaysia)

5:00 ***The effects of Event Selection based on Soft Constraint Violation (ESSCV) in a Modified PSO Algorithm to Solve Class Scheduling Problems***
Mohd Azri Abdul Aziz (Universiti Teknologi Mara, Malaysia); Mohd Nasir Taib (Universiti Teknologi MARA, Malaysia); Naimah Mohd Hussin (Universiti Teknologi MARA, Malaysia)

5:20 ***Discrete Mutative Particle Swarm Optimization of MFCC Computation for Hypothyroidism Diagnosis in Infants***
Azlee Zabidi (Universiti Teknologi MARA, Malaysia); Wahidah Mansor (Universiti Teknologi MARA, Malaysia); Lee Yoot Khuan (Universiti Teknologi MARA, Malaysia); Ihsan M. Yassin (Universiti Teknologi Mara, Malaysia); Rohilah Sahak (Universiti Teknologi MARA, Malaysia)

M32: Industrial Electronics & Applications 2 (cont)
Room: SERAYA
Chairs: Sheetal Bhandari (International Institute of information Technology, India), Ahmad Asari Sulaiman (Universiti Teknologi MARA, Malaysia)

4:20 ***Methodology for On the Fly Partial Reconfiguration For Computation Intensive Applications on FPGA***
Sheetal Bhandari (International Institute of information Technology, India); Avinash Rai (International Institute of Information Technology, India); Shashank Pujari (International Institute of Information Technology, India); Shaila Subbaraman (Dean-Academics, in Electronics, Walchand College of Engineering Sangli, India)

4:40 ***FPGA Implementation of an intelligent current dq PI controller for FOC PMSM drive***
Mohammad Marufuzzaman (Universiti Kebangsaan Malaysia, Malaysia); Mamun Bin Ibne Reaz (National University of Malaysia, Malaysia); Mohd Alauddin Mohd Ali (Universiti Kebangsaan Malaysia, Malaysia)

5:00 ***An Experimental Prototype of Buck Converter Fed Series DC Motor Implementing Speed and Current Controls***
Bahman Eskandari (K.N. Toosi University of Technology, Iran)

5:20 ***Real-Time Communication Between Personal Computer And Programmable Logic Controller For Networked Control System Based On Industrial Ethernet***
Handy Ali Munir (Universiti Teknologi PETRONAS, Malaysia); Nordin B Saad (Universiti Teknologi Petronas, Malaysia); Syed Alwee Aljunid (Universiti Malaysia Perlis, Malaysia); Ahmad Mujahid Ahmad Zaidi (National

Defence Unversity of Malaysia, Malaysia); Mohd Zuki Yusoff (Universiti Teknologi Petronas, Malaysia); Azhar Jaffar (PUO, Malaysia)

L32: Communications Technology 2 (cont)
Room: MERANTI
Chairs: Habibah Hashim (Universiti Teknologi MARA, Malaysia), Kumbesan Sandrasegaran (University of Technology, Sydney, Australia)

4:20 ***Statistical Fixed Range Multiple Selection Algorithm for Peer-to-Peer System***
Yeah Lun Kweh (Universiti Putra Malaysia, Malaysia); Mohamed Othman (Universiti Putra Malaysia, Malaysia); Fatimah Ahmad (University Putra Malaysia, Malaysia); Hamidah Ibrahim (Universiti Putra Malaysia, Malaysia)

4:40 ***Mobile Sink based Routing Protocol (MSRP) for Prolonging Network Lifetime in Clustered Wireless Sensor Network***
Babar Nazir (Universiti Teknologi PETRONAS Tronoh, Perak, Malaysia); Halabi Hasbullah (Universiti Teknologi PETRONAS, Malaysia)

5:00 ***Impact of aggregation headers on aggregating small MSDUs in 802.11n WLANs***
Anwar Saif (University Putra Malaysia, Malaysia); Mohamed Othman (Universiti Putra Malaysia, Malaysia); Shamala Subramaniam (Universiti Putra Malaysia, Malaysia); Nor Asila Wati Abdul Hamid (Universiti Putra Malaysia, Malaysia)

5:20 ***The Performance of Cyclostationarity-Based WRAN Classification Approach In Multipath Fading Channel***
Alfateh M.Alhassan Mossa (Universiti Teknologi PETRONAS, Malaysia)

5:40 ***Performance Evaluation on Encryption Algorithms for Site-to-Site IPSec VPN***
Ruhani Ab. Rahman (Universiti Teknologi MARA, Malaysia); Muhammad Hafiz Mazlan Zaharuddin (Universiti Teknologi Mara, Malaysia); Murizah Kassim (Universiti Teknologi MARA, Malaysia)

6:00 ***Secure Boot Process for Wireless Sensor Node***
Lukman Adnan (Universiti Teknologi Mara, Malaysia); Yusnani Mohd Yussoff (University Teknologi MARA, Malaysia); Habibah Hashim (Universiti Teknologi MARA, Malaysia)

K32: Signal & Image Processing 3 (cont)
Room: BALAU
Chairs: Yasmin Hanum Md Thayoob (Universiti Tenaga Nasional, Malaysia), Sanjay Nilkanth Talbar (Shri Guru Gobind Singhji Insitute of Engineering and Technology, India)

4:20 ***UNMC-VIER AutoVision Database***
King Hann Lim (University of Nottingham, Malaysia campus, Malaysia)

4:40 ***Car Plate Recognition based on UMACE Filter***
Siti Salwa Md Noor (Universiti Teknologi Mara, Malaysia); Nooritawati Md Tahir (Universiti Teknologi MARA, Malaysia)

5:00 ***Enhanced Snake Model and Modified H∞ for Lips Contour Detection and Tracking***
Siew Wen Chin (The University of Nottingham, Malaysia); Kah Phooi Seng (University of Nottingham, Malaysia campus, Malaysia); Li Minn Ang (University of Nottingham, Malaysia campus, Malaysia)

5:20 ***Analysis of High Frequency Wave Propagation Characteristics in Medium Voltage XLPE Cable Model***
Yasmin Hanum Md Thayoob (Universiti Tenaga Nasional, Malaysia); Azrul Mohd Ariffin (UNITEN, Malaysia); Suhaila Sulaiman (Universiti Tenaga Nasional, Malaysia)

H32: Signal & Image Processing 2 (cont)
Room: TANJUNG
Chairs: Roslina Mohamad (University Teknologi Mara, Malaysia), Siti Norul Huda Sheikh Abdullah (Universiti Teknologi Malaysia, Malaysia)

4:20 ***Predicting Mechanical Properties of Cold Rolled Low Carbon Steel Based on Magnetic Parameter Measurement using Artificial Neural Network***
Maryam Eftekhari (Isfahan University of Technology, Iran); Mohammad Adib Ghadamyari (Pajoohandeh Niroo Company, Iran); Mehdi Moallem (Isfahan University of Technology, Iran); Saeed Sadri (, Iran); Abdolrahim Sadeghi (Mobarakeh Steel Company, Iran); Davood Asefi (Najafabad Azad University, Iran); Hossein Monajati (Islamic Azad University, Najafabad Branch, Iran)

4:40 ***A 2-DoF Multi-Objective Hinf/L1 Robust Controller Design for a High Purification Distillation Column Using LMIs***
Sajad Tabatabaei (Mahshahr Islamic Azad University, Iran); Hasan Zakeri (Shiraz Univrsity of Technology, Iran); Mokhtar Sha Sadeghi (Shiraz University of Technology, Iran)

5:00 ***Designing a Joint Perceptual Encryption and Blind Watermarking Scheme Compliant with JPEG Compression Standard***
Muhammad Imran Khan (Universiti Teknologi PETRONAS, Malaysia); Varun Jeoti (University Teknologi PETRONAS, Malaysia); Aamir S Malik (Universiti Teknologi Petronas, Malaysia)

5:20 ***Optimized Support Vector Machine for Classifying Infant Cries with Asphyxia using Orthogonal Least Square***
Rohilah Sahak (Universiti Teknologi MARA, Malaysia); Lee Yoot Khuan (Universiti Teknologi MARA, Malaysia); Wahidah Mansor (Universiti Teknologi MARA, Malaysia); Ihsan M. Yassin (Universiti Teknologi Mara, Malaysia); Azlee Zabidi (Universiti Teknologi MARA, Malaysia)

Energy Consumption Balancing in Wireless Sensor Networks

Farruh Ishmanov[1], Sung Won Kim[1], and Byung-Seo Kim[2]
[1]Department of Information and Communication Engineering
Yeungnam University, Gyeongsangbukdo, Korea
[2]Department of Computer and Information Communications Engineering,
Hongik University, Chungcheongnamdo, Korea

Abstract— **Increasing a functional lifetime of a network is utmost important criterion in Wireless Sensor Networks (WSNs) because of limited energy resource of nodes. Since, a functional lifetime requires either all or a certain percentage of nodes to be alive altogether, energy consumption balancing is important. Energy consumption balancing (ECB) property ensures that the average energy dissipation per sensor is equal for all sensors in the network. ECB can be considered as energy efficiency property that optimally manages energy consumption of sensors to prolong network lifetime. There is a recent research trend of studying energy consumption balancing. We investigated the concept of ECB and ECB related approaches concisely. Further, we provide a classification of the ECB approaches in the literature and present their core ideas, merits and demerits. Besides, we discussed the open research issues and future research directions.**

Keywords- energy consumption balancing; network lifetime; load balancing;wireless sensor networks

I. INTRODUCTION

Recent developments in micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have led to the introduction of sensor nodes which are small, low cost and capable of sensing, communicating and computing [1]. Collaboration of these sensor nodes comprises Wireless Sensor Networks (WSNs). Because of its significant capacity, WSN opens up frontiers for many new applications. WSN is a wireless network consisting of spatially distributed sensor nodes to monitor the physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations [2]. WSNs have gained worldwide attention academically and industrially because of its great potential for many applications in various scenarios such as military target tracking and surveillance, natural disaster relief, biomedical health monitoring, hazardous environment exploration, and seismic sensing [3].

Unlike traditional networks, WSNs have distinctive features and limited resources. Dynamic topology, vast number of nodes, application and environment dependency are the distinctive features of WSNs. Resource constraints include short communication range, low bandwidth, limited processing, and limited energy resource. Energy resource is battery of sensor node which is not rechargeable in many applications [1]. Furthermore, due to the large scale of the network, it is not practical, or even not possible, to replace or recharge the batteries of the sensors. Hence, duration of battery is considered lifetime of a sensor. In this respect, energy efficiency is crucial and essential in WSN to prolong network lifetime.

Earlier researchers focused on minimizing energy consumption of individual sensor nodes to attain energy efficiency whereas later researchers realized that minimizing overall energy resource of WSNs is more important to prolong network lifetime. Minimizing energy consumption of overall network is called energy consumption balancing. Energy consumption balancing (ECB) property ensures that the average energy dissipation per sensor is equal for all sensors in the network [4]. ECB can be considered as energy efficiency property that optimally manages energy consumption of sensors to prolong network lifetime. So, main goal for ECB is uniform energy dissipation which ensures that a network remains fully functional for the maximum time. Since main objective of WSN is to obtain data about sensor field using sensor nodes that collaborate together, equal energy consumption of each sensor is essential for a fully functional network.

On the other hand, imbalanced energy consumption induces network disconnections, energy holes, and data incompleteness. Fig. 1 shows an example of energy imbalance in typical network scenario. The base station (BS) is located on the right side of WSN and sensors send data to the BS in multihop mode in Fig.1. The sensors nearer to the BS are overburdened because of relaying of other sensors' data to the BS. As a consequence, nearer sensors consume much more energy and die much faster which results in the network disconnections and data incompleteness about sensor field.

Considerable research has been focused at overcoming ECB issues, prolonging network lifetime through different ECB approaches based on network configuration and application type. This paper provides a concise overview of these ECB and ECB related approaches to prolong network lifetime proposed in the literature for WSNs. We survey state of the ECB research and summarize a collection of published mechanisms asserting their features and constraints. In the next section, we present overview of ECB and network lifetime. In Section 3, we summarize a collection of ECB approaches for WSNs and present classification of the various approaches pursued. Finally, Section 4 concludes the paper.

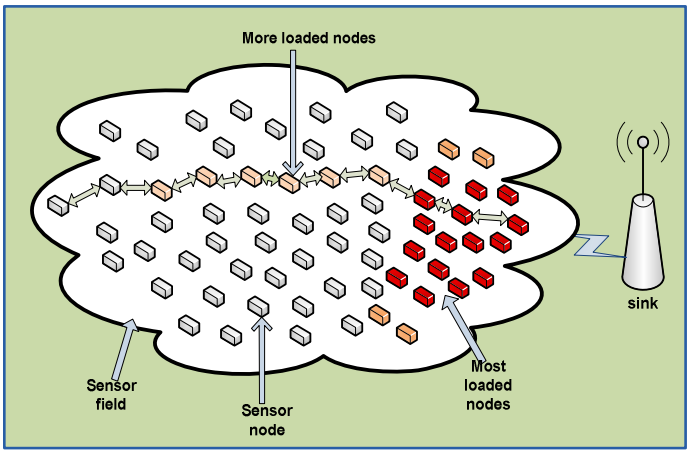

Figure.1. Example of unbalanced energy consumption among nodes using multihop mode communication in WSN.

II. ECB AND NETWORK LIFETIME OVERVIEW

Energy models in WSN mostly consider energy consumption for two tasks: processing and communication [6-8]. Amount of energy consumption of a node may differ depending on hardware (sensor node) and task in the network [5] but this is not the source of energy imbalance issues. Generally, unequal distribution of communication and data processing of the tasks among sensors results in ECB issues [9] [11-15]. This event is quite common in WSN where multihop communication is adopted. Multihop communication fulfils constraints of sensor node such as efficient energy usage and short range communication. On the other hand, it causes energy imbalance because of unequal communication load.

Further, in clustered WSN, cluster heads perform additional data processing tasks which require more energy consumption than other nodes. Overburden in communication tasks of sensors is more severe and it mainly contributes to ECB issues [13] [14]. Hence, ECB distributes and balances the load, such as computation and communication by different means of ECB mechanisms among sensors, so that average per sensor energy dissipation is equal for all sensors and network lifetime is prolonged optimally. ECB is associated with following factors:

- node distribution;
- base station option;
- application type;
- transmission power control;

1. Node distribution

Sensor node distribution strategy has strong influence on ECB in multi-hop WSN. Since it is related with the distribution of load, it shows the general picture of load distribution in the network. Hence, depending on the node distribution scheme, ECB issues and mechanisms can be different. For instance, in [17] authors proposed two node deployment schemes to attain ECB in network. The main principle is to deploy nodes in descending distance or ascending density towards a BS. On other hand, it is not viable in all applications to distribute or deploy nodes as aimed; instead some application requires random dropping of nodes or non-uniform node deployment which might make ECB issue more complicated.

2. Base station option

Base station (sink) location regulates the direction of data traffic in multi-hop WSN (see Figure 1). From this point of view, communication load is in ascending order towards BS which causes energy imbalance. On the other hand, when sink is mobile, ECB issues and mechanisms will be different. Mobile sinks change their location when the nearby sensors' energy becomes low. Moreover, multiple sinks node deployment might mitigate the ECB issues. Setting up multiple sinks helps to distribute the communication load over the network.

3. Application Type

Applications of WSN are various which imply different network parameters. Applications can be categorized into two fields: periodic and event-responded monitoring. Depending on the cases, ECB issues can be more severe for periodic monitoring applications than event-responded monitoring. Since, in periodic monitoring, data is sent periodically by the same sensors and after a certain time interval. However, in event responded monitoring, whenever event is detected, data is sent. In the latter case, sensor nodes can select their neighbors who have more energy to send data to BS so that ECB is attained among sensor nodes.

Furthermore, depending on the application, ECB can be either necessary or optional. For instance, some applications do not lose its functionality even when some percentage of nodes dies. On the other hand, some applications require full data about sensor field and even dying of a single node influence the network functionality significantly. So, in this case ECB is necessary property for network. Hence, depending on the application, ECB property might be either applicable or not.

4. Transmision power control

Transmission power control is another related factor for ECB. Simply fixed transmission power might result in extreme energy imbalance and energy inefficiency. Utilizing some intelligent transmission power control to distribute traffic optimally might be helpful to attain ECB [10].

Overview of Network Lifetime

Network lifetime is the period of time from the deployment to the instant when the network is considered nonfunctional. Since consideration of network to be nonfunctional is application specific, depending on application it is considered nonfunctional the instant when the first sensor dies, a percentage of sensors die, the network partitions, or the loss of coverage [9]. ECB is essential and important especially in applications where all nodes should be functional altogether. Although network is still functional when some percentage of nodes dies in network, it might affect to the

collaboration of nodes and sensing area. Hence, ECB is important in several aspects.

III. ECB APPROACHES

In this section, we present briefly recently published ECB approaches. We provide core ideas, limitations and merits of each approach. Further, we classify ECB approaches existing in the literature into three groups (see Fig. 2):

- Node deployment;
- Load balancing;
- Energy mapping and assigning.

1. Node deployment approaches

Node deployment ECB approach aims to deploy nodes in predefined manner. Deploying denser nodes or heterogeneous nodes where load is more can tackle the problem of unbalanced load effectively [11][17][18][19][20][21]. Another kind of node deployment approach can be sink node options. Simply, deploying more data sinks in different positions or mobile sink node can mitigate the problem of unbalanced load [22-25]. In multiple sink approach is to determine energy balancing routing paths and optimal sink locations is goal to achieve ECB. Mobile sinks also can provide ECB effectively. Main constraint in such approach is to determine mobile sink movement trajectory so that energy consumption of sensors is balanced and network lifetime maximized. Although these approaches (multiple and mobile sink) can be feasible, some application might not support sink mobility or multiple sink node deployment.

2. Load balancing approaches

Load balancing approaches aim to distibute communication load among sensors by different means so that energy consumption of sensors is balanced and network lifetime is prolonged. The load balancing approaches can be divided into the following four categories (as shown in Fig. 2):

- Clustering;
- Operation and sleep scheduling;
- ECB Routing;
- Topology control

2.1. Clustering

Grouping nodes into clusters is called in the context of WSN clustering and it is widely studied by the research community. Every cluster have cluster head (CH) which gathers and aggregates data from cluster members and sends it to BS. Clustering has been shown to be effective approach for organizing the network into a connected hierarchy [26]. Unequal clustering can be utilized [27] [28] [29] [30] to tackle the problem of unequal communication. The basic idea of unequal clustering is that the clusters which are nearer to the sink should have smaller size so that CHs in these clusters can balance their high energy consumption by communicating in a shorter communication distance.

2.2. Operation and sleep scheduling

Operation scheduling is one of the energy efficient ways for WSNs. Also, it can be implemented to achieve ECB by sleep scheduling and task assigning according to residual energy while keeping sensing area covered [34][33].

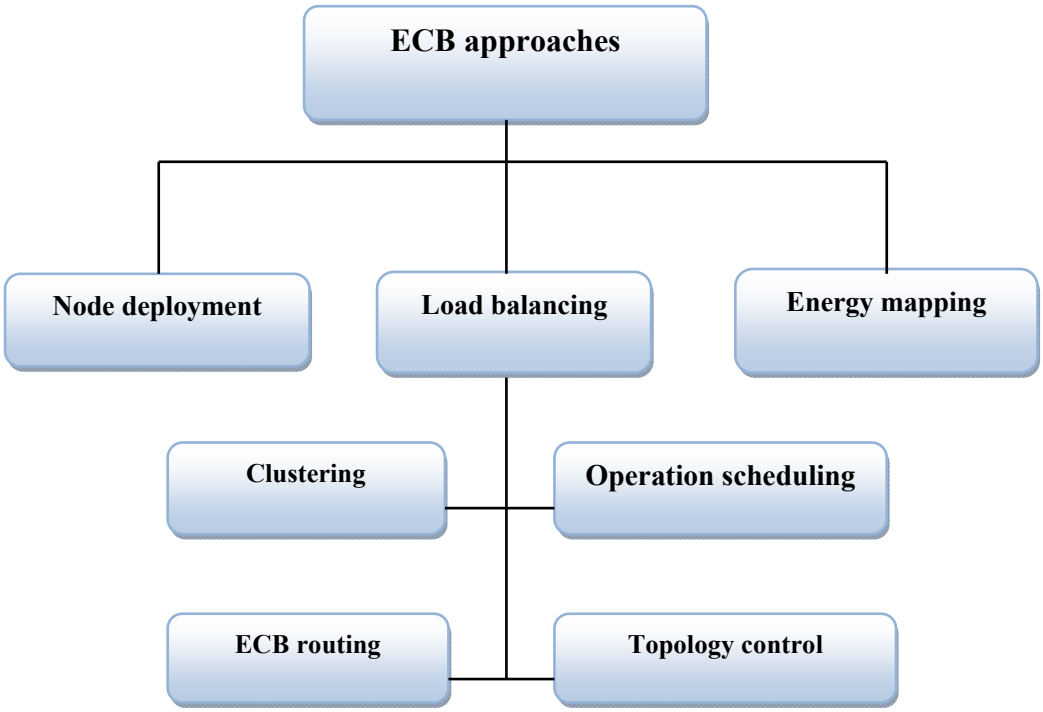

Figure 2. Classification of ECB approaches.

The main constraint in such approach is coordination of nodes sleep and operation time considering sensor field covered.

2.3. ECB routing

Routing protocols is one of the most pursued research areas in WSN. Since main objective of WSN is to gather or acquire data from environment, to find energy efficient and energy balancing path to send that data is a task of routing protocols. Ideal routing algorithms should consider not only energy efficiency, but also the amount of energy remaining in each sensor, thus avoiding non-functioning sensors due to early power depletion [31].

2.4. Topology Control

Topology control is a technique which manages nodes' transmitting ranges dynamically, in order to generate a network with the desired properties while reducing the energy consumption of the node. These desired properties may include network throughput, network lifetime, and connectivity [36]. Topology control can be efficient way to find node optimal transmission power so that power of node is used in a balanced way [40][17] . Although this approach might be efficient, it requires additional feature that node should be capable of controling power. Moreover, energy inefficiency may occur when far field region nodes send data to a longer distance to balance the load among nodes [13].

3. Energy mapping approaches

Energy mapping mechanisms deal with producing picture of energy distribution in the network so that some preventive actions are taken [41-44]. One of the potential gains of energy mapping mechanisms is that they can provide guidance to balance load by early warnings of network failure so that network lifetime is prolonged [41]. For instance, if a network manager is aware by energy map that energy of sensors in some part of the network is going to run out, then he can reconfigure the network or deploy some additional sensors in that part of the network to prolong network lifetime. In this respect, energy mapping mechanisms can be considered as indirect ECB approach to increase lifetime of network. The main constraint on mapping is to collect residual energy of a sensor periodically which causes energy inefficiency and message overhead. Hence, some authors proposed methods to reduce the number of reports. Although these methods decrease the number of reports significantly, there is tradeoff between mapping accuracy and number of reports [43] [44].

IV. COMPARISON OF ECB APPROACHES BASED ON THEIR CORE CONCEPTS

Below in Table I we present comparison of ECB approaches based on their core principle. As it is shown the se cond column shows the Global ECB for each approach which shows how much each approach can provide ECB over the network. Since node deployment approach aims to determine the load distribution and deploy the nodes accordingly, it can provide high rate of ECB.

TABLE I. COMPARISON OF ECB APPROACHES

ECB approach	Global ECB	Energy efficiency	Applicability
Node deployment	High	Case dependent	Low
Load balancing	Medium	Medium	High
Energy mapping	N/A	Medium	Medium

However, its degree of applicability is low because predetermined manner of deployment. Load balancing approaches can provide different rate of ECB depending on the cases and depending on the type of load balancing approach. It is evaluated in general in the table, specifically it might be different. Energy efficiency is also another important criterion to be considered. In general energy efficiency of the approaches is evaluated as medium. Applicability shows the degree of feasibility and monetary cost of the approaches.

V. OPEN RESEARCH ISSUES AND FUTURE RESEARCH DIRECTIONS

Although ECB research is widely pursued by research community, there are still open research issues in this area. Applicability issues should be addressed in the area of ECB deployment. Proposed deployment strategies to provide ECB should be studied in terms of applicability and cost. Cross layer design for ECB can be good point to provide ECB. Since there are already proposed load balancing approaches, based on the load balancing techniques cross layer design can be proposed. The advantage of cross layer design for ECB is that it provides general and whole block of techniques to ensure ECB in the network.

We believe that ECB should be considered together with energy efficiency. Since a power of WSNs depends on cooperation and collaboration of the sensors, role of a single sensor can be critical. In this case considering ECB together with energy efficiency can maximize the functional network lifetime. Furthermore, combination of some approaches can improve performance such as implementing load balancing approaches together with deployment approaches can enhance network lifetime significantly. Moreover, developing a framework for ECB and researching in evaluating factors affecting ECB approaches is important.

VI. CONCLUSIONS

This paper provides review of energy consumption balancing concept to maximize a functional lifetime of a network in wireless sensor networks. To give better understanding of ECB, first, overview of ECB and ECB related factors were explained. We showed that main reason for energy imbalance is unequal distribution of communication load. Second a concise literature survey is presented by providing core ideas, merits and demerits of existing ECB approaches. We categorized ECB approaches into three categories: node deployment, load balancing and energy mapping and monitoring. Further we discussed open research issues and future research directions in section IV.

We hope that this research work will be helpful and useful for those pursuing researchers in ECB mechanisms.

ACKNOWLEDGMENT

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