2013 Seventh International Conference on Sensing Technology

December 3 - 5, 2013

Program & Abstracts

Organised by:

School of Engineering and Advanced Technology
Massey University
New Zealand
Welcome Message

We would like to take this great opportunity to welcome you all to the Seventh International Conference on Sensing Technology (ICST 2013) held from December 3 – 5, 2013 at Massey University, Wellington, New Zealand. This is the seventh conference of the series; the first two of which were held at Massey University, New Zealand, Palmerston North campus, the third one was held at National Cheng-Kung University, Tainan, Taiwan, the fourth one took place at the University of Salento, Lecce, Italy. Then the fifth one was held at Massey University, New Zealand, Palmerston North campus and the last year’s one (sixth) was held at Kolkata, India. This year the conference has attracted 248 papers, which is the highest so far and is a great success. We would like to congratulate all the authors and share this happiness with you all. In total 188 papers, not including invited and keynote speakers, will be presented over three days in parallel oral sessions and poster format.

The applications of Sensing Technology include gas sensing, medical diagnostics, industrial manufacturing, defense, national security, prevention of natural disaster and terrorism. The proper detection and reporting of events by high performance sensor systems delivers huge cross-sector benefits through increasing use of continuous real-time systems for improved automation and control. The continuing development of sensors, and the systems which support them, will undoubtedly continue to bring great value, and will assist in tackling global issues such as water quality monitoring, ageing populations and natural disasters. The cross-cutting nature of sensor systems demands interaction between researchers and industry from technologically advanced and developing countries in order to drive toward the sensors of the future. ICST 2013, as in previous years, brings together such people, and so we hope that it can provide a useful platform for interaction.

We would like to extend our sincere thanks to organizations and individuals who have played a key role in ICST this year. Firstly we would like to thank all of the authors as they are main ingredient for any conference to succeed. In addition, the Technical Programme Committee has done a tremendous and wonderful job. We are very much indebted to everybody in the Technical Programme Committee for accepting the invitation to lend their help, support,
time and effort to make this conference a great success. We would also like to extend our special thanks to the keynote and invited speakers for their time and support.

The conference is being organized by the School of Engineering and Advanced Technology, Massey University. We thank the department’s management for extending their continued support for the conference.

We do sincerely believe that ICST 2013 will provide a platform for discussion on the advancement of technical and scientific issues of different sensing technological problems and interaction among the participants will be stimulating, productive and encouraging.

We wish you all a pleasant stay during the conference at Wellington and hope you enjoy your time while you are in New Zealand.

S. C. Mukhopadhyay, A. Mason and K.P.Jayasundera
Technical Programme Committee

International Advisory Committee

H. Ewald, University of Rostock, Germany
K.T.V. Grattan, City University London, UK
Maki K. Habib, The American University in Cairo, Egypt
A. Lay-Ekuakille, University of Salento, Italy
E. Lewis, University of Limerick, Ireland
C. Lin, Lightel, USA
A. Madni, BEI Technologies, Inc., USA
E. Petriu, University of Ottawa, Canada
H. Saha, Jadavpur University, India
D.P. Tsai, National Taiwan University, Taiwan
S. Ueno, Kyushu University, Japan

General Chair

S. Mukhopadhyay, MU, NZ

Technical Program Co-Chairs

A. Mason, LJMU., UK
K.P. Jayasundera, MU, NZ

Regional Programme Chairs

America: G. Chattopadhyay, Jet Propulsion Laboratory, USA
Europe: I. Matias, Public University of Navarra, Spain
Middle-East: C. Gooneratne, King Abdullah University of Science and Technology, Saudi Arabia
Asia: Ray Y.M. Huang, National Cheng Kung University, Taiwan
Webmaster

L. M. Lightband, Massey University, New Zealand

Publicity Chair

Kevin Y.H. Kuo, Institute for Information Industry, Taiwan

Finance Chair

D. Punchihewa, Massey University, New Zealand

Technical Programme Committee

Badr Abdullah, Liverpool John Moores University, United Kingdom  
Babak Ahsant, Southern Illinois University Carbondale, USA  
Ibrahim Al-Bahadly, Massey University, New Zealand  
Azam Ali, AgResearch Ltd, New Zealand  
Cesare Alippi, Politecnico di Milano, Italy  
Raúl Aragonés, Universitat Autònoma de Barcelona, Spain  
Francisco Arregui, Universidad Publica de Navarra, Spain  
Takehito Azuma, Utsuminiya University, Japan  
Donald Bailey, Massey University, New Zealand  
Keith Betterridge, AgResearch, New Zealand  
Prahlada Rao Bhaskara B, CDAC, bangalore, India  
Aniruddha Bhattacharjya, Amrita School of Engineering, Bangalore, India  
Nabarun Bhattacharyya, CDAC, India  
Richard Blakey, Liverpool John Moores University, United Kingdom  
Daniel Brenk, Siemens CT, Germany  
Graham Brooker, University of Sydney, Australia  
James Brusey, Coventry University, UK  
Serge Camou, NTT Corporation, Japan  
Dale Carnegie, Victoria University of Wellington, New Zealand
Lawrence Carter, The University of Auckland, New Zealand
Goutam Chakraborty, Iwate Prefectural University, Japan
Tapas Chakravarty, Tata Consultancy Services, India
Goutam Chattopadhyay, CalTech, JPL, USA
J.Y. Chang, National Tsing Hua University, Taiwan
Chia-Pang Chen, National Taiwan University, Taiwan
Nan-Kueang Chen, National United University, Taiwan
Nanguang Chen, National University of Singapore, Singapore
Bryan Chin, Auburn University, USA
K. Chomsuwan, King Mongkut's University of Technology Thonburi, Thailand
Chang-Hsin Chuang, Southern Taiwan University of Science and Technology, Taiwan
Cheng-Long Chuang, Southern Taiwan University of Science and Technology, Taiwan
Joan Condell, University of Ulster, UK
Eduardo Cordova-Lopez, Liverpool John Moores University, UK
Andrea Cusano, University of Sannio, Italy
Jeff Cullen, Liverpool John Moores University, UK
Saakshi Dhanekar, Indian Institute of Technology (IIT) Delhi, India
Robin Dykstra, Victoria University of Wellington, New Zealand
Maria Fazio, University of Messina, Italy
Aymen Flah, ENIG, GABES, Tunisia
Elena Gaura, Coventry University, UK
Boby George, Indian Institute of Technology Madras, India
Boris Ginzburg, Soreq NRC, Israel
Chinthaka Gooneratne, King Abdullah University of Science and Technology, SA
Voicu Groza, University of Ottawa, Canada
Maki Habib, The American University in Cairo, Egypt
Michael Haji-Sheikh, Northern Illinois University, USA
Panikos Heracleous, ATR, Japan
Yueh-Min Huang, National Cheng Kung University, Taiwan
Chi-Hung Hwang, Instrument Technology Research Center, Taiwan
Ikuo Ihara, Nagaoka University of Technology, Japan
S. Ikezawa, Waseda University, Japan
Raymond Jagessar, University of Guyana, Guyana
Gotan Jain, Arts, Commerce & Science College, India
Krishanthi Jayasundera, Massey University, New Zealand
J.A. Jiang, National Taiwan University, Taiwan
Keith Jones, Industrial Research Limited, New Zealand
Dah Jing Jwo, National Taiwan Ocean University, Taiwan
John V Kennedy, GNS Science, New Zealand
Dmitry Kirsanov, St. Petersburg State University, Russia
Soami Daya Krishnananda, Dayalbagh Educational Institute, India
Olga Korostynska, Liverpool John Moores University, UK
Jagadish Kumar, Indian Institute of Technology, India
R. Kunnemeyer, University of Waikato, New Zealand
Kevin Kuo, Institute for Information Industry, Taiwan
Aime' Lay-Ekuakille, University of Salento, Italy
Elfed Lewis, University of Limerick, Ireland
T. Liu, National Chiao-Tung University, Taiwan
A. Loayssa, Public University of Navarra, Spain
Soleimani Manuchehr, University of Bath, United Kingdom
Iliana Marinova, Technical University of Sofia, Bulgaria
Ignacio Matias, Universidad Publica de Navarra, Spain
Tanveer Mir, University of Toyama, Japan
Tayeb Mohammed-Brahim, Rennes 1 University, France
Ananda Mohan, University of Technology Sydney (UTS), Australia
J.K. Mukherjee, BARC, India
Subhas Mukhopadhyay, Massey University, New Zealand
Mustapha Nadi, Nancy University Henri Poincare, France
Toru Namerikawa, Keio University, Japan
Thomas Newe, University of Limerick, Ireland
Poul Nielsen, University of Auckland, New Zealand
Stoyan Nihtianov, Delft University of Technology, Netherlands
Sinead O'Keeffe, University of Limerick, Ireland
Montserrat Ortoneda Pedrola, LJMU, UK
J. Pereira, E.S.T., Portugal
Ian Platt, Lincoln Ventures Ltd, New Zealand
Octavian Postolache, Instituto de Telecomunicações /ISCTE-IUL, Lisbon, Portugal
Daluwathu Preethichandra, Central Queensland University, Australia
Amal Punchihewa, Massey University, New Zealand
Ramesh Rayudu, Victoria University of Wellington, New Zealand
Candid Reig, Universitat de València, Spain
Shubhajit Roychowdhury, Indian Institutes of Information Technology, India
Chirosree RoyChaudhuri, B.E. College, India
Mukul Sarkar, Indian Institute of Technology, Delhi, India
Giorgio Sberveglieri, University of Brescia, Italy
H.C. Seat, Université de Toulouse, France
Mohamed Serry, The American University in Cairo, Egypt
Akash Singh, IBM, USA
P. Slobodian, Tomas Bata University in Zlín, Czech Republic
Manuchehr Soleimani, University of Bath, UK
Dan Mihai Stefanescu, Romanian Measurement Society, Romania
Kevin Stevens, Quest Integrity NZL Limited, New Zealand
Qingquan Sun, The University of Alabama, USA
N. Suryadevara, Massey University, New Zealand
Andrew Tabener, The University of Auckland, New Zealand
L. Tang, Massey University, New Zealand
K. Tashiro, Shinshu University, Japan
O.P. Thakur, NSIT, Delhi University, India
G.Y. Tian, Newcastle University, UK
Din Ping Tsai, National Taiwan University, Taiwan
Bipan Tudu, Jadavpur University, India
Ioan Tuleasca, The Open Polytechnic in New Zealand, New Zealand
Ion Tutanescu, University of Pitesti, Romania
Paritosh Tyagi, Central Pollution Control Board, India
Arijit Ukil, Tata Consultancy Services, India
Massimo Villari, University of Masina, Italy
R. Viswanathan, University of Mississippi, USA
Hiroyuki Wakiwaka, Shinshu University, Japan
Joseph Walsh, Institute of Technology, Tralee, Ireland
Daniel Watzenig, Graz University of Technology, Austria
Ian Woodhead, Lincoln Ventures Ltd, New Zealand
Ruqiang Yan, Southeast University, China
Jianxin Yi, University of Science and Technology of China, China
Mohd Amri Md Yunus, UTM, Malaysia, Malaysia
Hubert Zangl, Graz University of Technology, Austria
A. Zia, Massey University, New Zealand
Jun Zou, The Chinese University of Hong Kong
**Keynote Speaker**

*Friendly Photons: Optical Sensors in Life Science and Medicine*

Prof. Brian T. Cunningham, Ph.D., FIEEE

**Abstract**

Biology is increasingly a science that relies upon new developments in sensor engineering to provide detailed information about cell function, to perform disease diagnosis, to quantify gene expression, and to image tissue. Of the many transduction methods available for applications including point-of-care diagnostics, personalized medicine, and medical imaging, approaches based upon optics have had a tremendous impact due to a combination of non-invasiveness, robustness, miniaturization, and low cost.

This presentation will describe recent developments in the Nano Sensors Group at the University of Illinois at Urbana-Champaign in the design, fabrication, and application of optical biosensors. For portable biosensing applications, we have demonstrated the use of the internal camera of a smartphone as a high resolution spectrophotometer for performing a variety of label-free and label-based assays. For biosensing applications in pharmaceutical research, we have developed label-free biosensors based upon external cavity lasers that are capable of detecting small molecule drugs binding to large proteins by detecting picometer-scale changes in the lasing wavelength. The talk will describe a new microscope imaging modality called “Photonic Crystal Enhanced Microscopy (PCEM)” that is capable of imaging and quantifying the strength of cell attachment to a PC biosensor surface with sub-cell spatial resolution, that is being used to study fundamental processes including chemotaxis, proliferation, and stem cell
differentiation. The ability of nanostructured surfaces such as photonic crystals or arrays of metal nanodomes to generate spatially confined, high intensity electromagnetic hot spots is being used to enhance the output of surface-enhanced Raman scattering (SERS) for drug molecules, and surface-based fluorescence assays for cancer biomarker proteins. Such nanostructures can be inexpensively manufactured from plastic, glass, or silicon to enable single-use applications, such as incorporating sensors into intravenous drug delivery tubing, or rapid multiplexed disease biomarker testing using only a droplet of serum. Finally, we have recently demonstrated the application of narrowband resonant optical filters operating in the infrared spectrum as a new histological imaging modality, called Discrete Frequency IR (DFIR) absorption spectroscopy, for rapid chemical imaging for applications in pathology and forensics.

These projects represent only a narrow slice of the potential for optics-based sensors in research and medical practice, but serve to demonstrate the tremendous potential for utilizing light-matter interactions in the life sciences.

**Author’s Short Biography**

**Brian Cunningham** is a Professor in the Department of Electrical and Computer Engineering and the Department of Bioengineering at the University of Illinois at Urbana-Champaign, where he has been a faculty member since 2004. His group focuses on the development of nanophotonic surfaces, plastic-based nanofabrication methods, and novel instrumentation approaches for biodetection with applications in pharmaceutical screening, life science research, environmental monitoring, disease diagnostics, and point-of-care patient testing. At Illinois, Prof. Cunningham serves as the Director of the Bioengineering Graduate Program and Director of the
NSF Center for Agricultural, Biomedical, and Pharmaceutical Nanotechnology (CABPN). Prof. Cunningham was the founder and the Chief Technical Officer of SRU Biosystems (Woburn, MA), a life science tools company that provides high sensitivity plastic-based optical biosensors, instrumentation, and software to the pharmaceutical, academic research, genomics, and proteomics communities. Prof. Cunningham was recognized with the IEEE Sensors Council 2010 Technical Achievement Award for the invention, development, and commercialization of biosensors utilizing photonic crystals. He is a Fellow of the IEEE and the AIMBE.

Prior to founding SRU Biosystems in June, 2000, Dr. Cunningham was the Manager of Biomedical Technology at Draper Laboratory (Cambridge, MA), where he directed R&D projects aimed at utilizing defense-related technical capabilities for medical applications. In addition, Dr. Cunningham served as Group Leader for MEMS Sensors at Draper Laboratory, where he directed a group performing applied research on microfabricated inertial sensors, acoustic sensors, optical switches, microfluidics, tissue engineering, and biosensors. Concurrently, he was an Associate Director of the Center for Innovative Minimally Invasive Therapy (CIMIT), a Boston-area medical technology consortium, where he led the Advanced Technology Team on Microsensors. Before working at Draper Laboratory, Dr. Cunningham spent 5 years at the Raytheon Electronic Systems Division developing advanced infrared imaging array technology for defense and commercial applications. Dr. Cunningham earned his BS, MS, and PhD degrees in Electrical and Computer Engineering at the University of Illinois. His thesis research was in the field of optoelectronics and compound semiconductor material science, where he contributed to the development of crystal growth techniques that are now widely used for manufacturing solid state lasers, and high frequency amplifiers for wireless communication.
Abstract

The Mars Science Laboratory (MSL) rover, Curiosity, touched down on the surface of Mars on August 5, 2012. It was built to conduct an investigation of modern and ancient habitable environments. The MSL science payload was specifically assembled to assess habitability and includes a gas chromatograph-mass spectrometer and gas analyzer that will search for organic carbon in rocks, regolith fines, and the atmosphere (SAM); an x-ray diffractometer that will determine mineralogical diversity (CheMin); focusable cameras that can image landscapes and rock/regolith textures in natural color (Mastcam, MAHLI); an alpha-particle x-ray spectrometer for in situ determination of rock and soil chemistry (APXS); a laser-induced breakdown spectrometer to remotely sense the chemical composition of rocks and minerals (ChemCam); an active neutron spectrometer designed to search for water in rocks/regolith (DAN); a weather station to measure modern-day environmental variables (REMS); and a sensor designed for continuous monitoring of background solar and cosmic radiation (RAD). This broad and diverse payload, coupled with a rich field site at Gale Crater, already has established the importance of water in shaping the geology and geochemistry around the landing area, addressed long-standing questions regarding Mars' atmospheric composition and evolution, and made serendipitous discoveries not anticipated from orbital data studied prior to landing.
In this talk, an overview of the Curiosity instruments and their science drivers will be discussed with details of the challenges the engineers faced to land the rover at its intended location.

The research described herein was carried out at the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA, under contract with National Aeronautics and Space Administration.

Author’s Short Biography

Dr. Goutam Chattopadhyay
Jet Propulsion Laboratory, California Institute of Technology
4800 Oak Grove Drive, Pasadena, CA 91109, USA.

Dr. Goutam Chattopadhyay is a Principal Engineer/Scientist at the NASA’s Jet Propulsion Laboratory, California Institute of Technology, and a Visiting Professor at the Division of Physics, Mathematics, and Astronomy at the California Institute of Technology, Pasadena, USA. He received the B.E. degree in electronics and telecommunication engineering from the Bengal Engineering College, Calcutta University, Calcutta, India, in 1987, the M.S. degree in electrical engineering from the University of Virginia, Charlottesville, in 1994, and the Ph.D. degree in electrical engineering from the California Institute of Technology (Caltech), Pasadena, in 1999. From 1987 until 1992, he was a Design Engineer with the Tata Institute of Fundamental Research (TIFR), Pune, India.

His research interests include microwave, millimeter-, and submillimeter- wave heterodyne and direct detector receivers, frequency sources and mixers in the terahertz region, antennas, SIS mixer technology, direct detector bolometer instruments, high
frequency radars, and applications of nanotechnology at terahertz frequencies. He has more than 200 publications in international journals and conferences and holds more than ten patents. Among various awards and honors, he was the recipient of the Best Undergraduate Gold Medal from the University of Calcutta in 1987, the Jawaharlal Nehru Fellowship Award from the Government of India in 1992, and the IEEE MTT-S Graduate Fellowship Award in 1997. He also received more than 25 NASA technical achievement and new technology invention awards. He is a Fellow of IEEE.
Abstract

Health and physical condition of the human body can be ascertained by making suitable measurements on the physical, electrical, chemical and acoustic signals emanating from it. Any disease or injury causes one or more of these signals to differ from their expected normal form. Quite often information reflecting the functioning or malfunctioning of the underlying biological system is entwined in a complex manner in these signals and hence such information has to be extracted. Conventionally, many of these signals were ascertained in an invasive manner. For example, to obtain the constituents of blood, blood is extracted from a patient and details obtained through a chemical assay. Present trend is to obtain as much information as possible, through noninvasive means. This paper reviews the state of the art in noninvasive measurement of biological parameters that are clinically relevant through the use of appropriate optical sensors. Emphasis is given on the research outcomes of the group to which the author is associated with.

Author’s Short Biography

Prof. V. Jagadeesh Kumar
Professor of Electrical Engineering and Head, Central Electronics Centre, Indian Institute of Technology Madras, Chennai 600036, India
Advanced sensing technologies for superconducting devices test at CERN

Dr. Pasquale Arpaia, European Organization for Nuclear Research (CERN) and University of Sannio, Italy.

Abstract

Realizing and tuning the largest machine ever built by the human kind, the Large Hadron Collider (LHC) at CERN, fostered a powerful challenge in advanced sensing technologies. As a matter of fact, LHC is the coldest massive site of the universe, with a vacuum level lower than free space (one tenth than the moon surface) and a temperature minor than the universe average. This target has been achieved by measuring several physical quantities in unexplored ranges, but above all by unprecedented precision.

In this talk, some of most interesting results of this technological research effort, as well as its further most recent development, are highlighted. In particular, after a short survey on sensing technologies contribution to the Higgs boson hunting, the state of the art of CERN research techniques based on wires and cryogenic dc current transformers for measuring magnetic fields and superconducting critical currents, respectively, are described.

Author’s Short Biography

Pasquale Arpaia took MD and PhD in Electrical Engineering at University of Napoli Federico II (Italy). He is professor of Instrumentation and Measurements at University of Sannio and Team Leader at European Organization for Nuclear Research (CERN). He was also scientific associate at Engine Institute of CNR.
He is Associate Editor of the Elsevier Journal Computer Standards & Interfaces, and in the past also of IEEE Transactions on Electronics Packaging and Manufacturing. In last years, he was scientific responsible of more than 30 awarded research projects in cooperation with industry, with related patents and licences, and funded 4 academic spin off companies. He acted as scientific evaluator in several international research call panels. He has served as organizing and scientific committee member in several IEEE and IMEKO Conferences.

His main research interests include digital instrumentation and software frameworks for measurements in particle accelerators, evolutionary diagnostics, distributed measurement systems, ADC modelling and testing. In these fields, he published 2 books, several book chapters, and more than 170 scientific papers in journals and national and international conference proceedings. His PhD students were awarded in 2006 and 2010 at IEEE I2MTC and in 2012 at IMEKO World Conferences.
Proposal of a sub-cent RFID using metal-patch - Problems and ways to overcome them

Prof. Goutam Chakraborty, Iwate Prefectural University, Japan

Abstract

RFID tags are used everywhere, from passports to prepaid cards to inventories. In this talk, first the various uses of RFID tags will be discussed in brief, pointing out the key-technologies and their respective pros and cons. The main reasons hindering the wide spread deployment of passive RFID tags are high cost and limited range. The present talk will focus on developing a sub-cent RFID capable of operating from a reasonable distance, though with some compromise on the information content. The resonance behavior of backscatter from a metal patch on a metallic ground plane, separated by a dielectric, could be used as an information storing tag. The dimensions of such a tag define the poles and zeros shaping the scattered signal. By analyzing the scattered signal, the resonating frequency could be assessed. In this talk, we will discuss the possibility of using such a passive tag as a information storing device and the problems of correctly retrieving the information. The limitation of the information content could be addressed using multiple patches, either stacked on top of each other, or located transversely. Since there are ample applications of read-only RFID with limited information content, the present technology is expected to fill a substantial part of the niche of sub-cent tags.

The challenge is to retrieve the resonant frequencies - from single or multiple patches - in the presence of clutter (unwanted scatter) from surrounding objects. The situation becomes especially difficult in the presence of large metallic objects creating significant amounts of clutter. We have proposed ways to separate resonating part of the signal from clutter, following which soft-computing technique is used to find exact resonating frequency. Multilayer Perceptron trained with error back propagation is used to make very accurate estimation of the resonant frequencies in real-time. Experimental results and possibilities of real World deployment will be discussed.
**Author’s Short Biography**

*Goutam Chakraborty* received his Ph.D. in 1993 from Tohoku University, Japan. Presently he is Professor and head of the Intelligent Informatics lab., Department of the Software and Information Science, Iwate Prefectural University, Japan. His main research interests are Soft Computing algorithms and their applications to solve pattern recognition, data-mining, signal analysis, prediction, scheduling and optimization including applications in wired and wireless Networking problems.
Feature selection for pattern analysis and mining of sensors’ data

Prof. Basabi Chakraborty Iwate Prefectural University, Japan

Abstract

The data collected by different sensors need to be analyzed for various recognition problems, such as human activity recognition from wearable sensors, odor recognition from chemical sensors (E-nose) or detection of explosives from calorimetric sensor array. Feature selection is an important step towards dimensionality reduction of high dimensional data and facilitates further analysis by selecting important information while discarding unwanted or redundant information. Feature subset selection techniques also help in finding good sensor subsets and can be applied to optimize sensor locations in wireless sensor networks. In this talk, I will discuss soft computing based approaches for feature subset selection and present some proposed algorithms useful for pattern recognition or mining of real life sensors’ data with simulation experiments and results.

Author’s Short Biography

Basabi Chakraborty received her B. Tech, M.Tech and Ph.D degrees in Radio Physics and Electronics from University of Calcutta, India. She worked in National Center for Knowledge based Computing Systems and Technology affiliated to Indian Statistical Institute, Calcutta, India until 1990. From 1991 to 1993 she worked as a visiting researcher in Advanced Intelligent Communication Systems Laboratory in Sendai, Japan. She received another Ph. D in Information Science from Tohoku University, Sendai in 1996. Currently she is a faculty in Software and Information Science department of Iwate Prefectural University, Japan. Her main research interests are in the area of Pattern Recognition, Image Processing, Soft Computing Techniques, Biometrics, Data Mining, Social Network Analysis and Cognitive Science. She is a senior member of...
IEEE, member of ACM, Japanese Neural Network Society (JNNS), Japanese Society of Artificial Intelligence (JSAI), executive committee member IEEE JC WIE (Women in Engineering) and ISAJ (Indian Scientists Association in Japan).
Imaging Dielectric Structures Using Transmission Line Waveguides

Dr. Ian Platt, Lincoln Ventures Ltd, New Zealand

Abstract

Many sensing applications use imaging of target materials to map specific parameters of interest. Most often such imaging employs electromagnetic radiation over a wavelength regime chosen to highlight the physical properties sought. In this talk, a recently developed form of imaging using the electromagnetic field generated by a guided pulse propagating along a pair of transmission lines will be presented. The interaction of the incident electric field with the polarisable material of the sample can be used to map its composition, particularly its water distribution since water has a high permittivity compared to most other naturally occurring materials. Examples where this technique has been used to determine the structural properties of timber and the integrity of road sub course material will be given along with emerging applications in areas where other forms imaging are not feasible.

Author’s Short Biography

Dr Ian Platt started his scientific career as a theoretical physicist studying the propagation of electromagnetic waves in plasmas, in which he earned a PhD from La Trobe University Australia. Over the intervening 25 years he has been employed as a researcher in this field by the University of Massachusetts (US), the United States Air Force, Telecom Australia, La Trobe University, UK Ministry of Defence (now QinetiQ) and RLM Systems (a joint venture between Lockheed Martin and Tenix). Since joining Lincoln Agritech in 2004 his interest in electromagnetic propagation has revolved around the development of new sensor devices including, Time Domain Reflectometry moisture measurement and imaging, Structural sensing using Optical Fibres
and Time Domain Reflectometry, Radar application to remote sensing and Stochastic modeling for use in DSP applications.
Edge Mining: Making sense of sensor data

Prof. James Brusey, Coventry University, UK

Abstract

In this talk, I will look at the concept of edge mining --- data mining that takes place at the edge of a wireless sensor network. Initially, we want our sensor networks to be as flexible as possible but as the area matures, automating information extracting into continuous analytics and pushing such analytics to the edge or leaf nodes of a network can reduce the infrastructural cost of the sensor network and thus enable many applications that would otherwise be infeasible. The talk will be rooted in my experience with deploying wireless sensor nets and deriving meaningful information from the resultant data streams.

Author’s Short Biography

James Brusey received his BApSc with distinction and PhD from RMIT University in 1996 and 2003, respectively. His PhD won the Australian Computer Science Association award for Best Thesis in 2004. He has over 15 years experience in the IT industry, part of which was as an independent consultant. More recently, he has worked as a Senior Research Associate at Cambridge University’s Institute for Manufacturing with funding from the Auto-ID Center. Since 2007, James has worked as a Senior Lecturer at Coventry University in wireless sensor networks and a Senior Research Fellow of the Cogent Computing Applied Research Centre. During this period, he has helped to establish Cogent as a world class research centre with a broad portfolio of successful, industry-sponsored projects related to wireless sensor projects. In 2012, he was awarded a readership in Pervasive Computing.

His current research interests include exploring issues with the practical deployment of wireless sensor networks, thermal comfort in buildings and car cabins.
A miniaturised silicon biosensor system for the detection of triglycerides and urea

Prof. Enakshi Bhattacharyya, Indian Institute of Technology Madras, India

Abstract

Biosensors bring together the strengths of biochemical interactions combined with electronic detection and can be used for medical diagnostics, environmental analysis, food quality control, drug detection, etc. Silicon based sensors have the advantages of being compact and thus requiring small sample quantity for testing, ease in signal processing and possibility of circuit integration and also lower costs if made by batch processing. Electrolyte–Insulator-Semiconductor capacitors (EISCAP) show a shift in the measured capacitance voltage (CV) characteristic with changes in the pH of the electrolyte. Many biological reactions, especially enzyme mediated ones, involve changes in the pH of the electrolyte and an EISCAP can be effectively used for the detection of biological compounds. We started with developing an EISCAP sensor that was able to detect presence of urea in milk and triglycerides (TGs) in blood serum. Miniaturization of the sensor to reduce the sample volume and the analysis time can lead to low cost diagnostic biochips. We discuss the problems encountered on miniaturizing the EISCAPs and ways to address them. These include the scaling of the device, choice and integration of the electrode for stable measurements, improved process for immobilization of the enzymes and the measurements on the miniaturized EISCAPs. Finally, a complete biosensor system, for the detection of TGs, based on the miniaturized EISCAP with an embedded counter electrode and the bio-receptor as well as a readout system is discussed. Estimation of TGs in blood serum samples using the sensor is compared with clinical data.

Author’s Short Biography

Enakshi Bhattacharya did her MSc (Physics) from IIT Bombay in 1980, PhD from TIFR Mumbai in 1985 and Post-doctoral work at the National Renewable Energy Laboratory (then...
SERI), USA from 1986-88. She was a faculty member in the Department of Physics, IIT Kanpur during 1988-91. Since 1991, she has been on the faculty of the Department of Electrical Engineering at IIT Madras and was a Visiting Scientist at the Micromachined Products Division of Analog Devices, USA from 1999-2000. She is interested in all forms of silicon: single crystal, poly, amorphous and porous and her current research areas are MEMS/NEMS and Biosensors.
Metal oxide nanostructures for gas sensing and optoelectronic applications

Dr. John Kennedy, GNS Science, New Zealand

Abstract

I will present an overview of our recent R & D activities on fabrication, characterization and application of metal oxide nanostructures. Our group has developed new lost cost synthesis technique (arc discharge) to produce metal nanostructures such as ZnO, WO₃ and TiO₂ for UV and gas sensor applications. High purity ZnO nanorods have been obtained with diameters of 10 - 50 nm and lengths of 0.5 – 2 μm. It is demonstrated that the nanorods intercross with each other to form 3D networks which makes it more suitable for sensor application. Prototype UV photo detectors and gas sensors have been fabricated using ZnO nanostructures in collaboration with New Zealand sensor manufacturing industries.

Author’s Short Biography

Dr. John Kennedy is a Principal Scientist at National Isotope Centre, GNS Science (Institute of Geological and Nuclear Science), New Zealand Crown Research Institute. He is currently investigating metal and metal oxide nanoparticle growth and their structural, electrical, optical and magnetic properties, metallic nanoclusters, Graphene and multiferroics nanostructures. His team is working on developing a proof-of-concept sensor devices. He has published 150 journal papers and attended more than 35 conferences related to advanced materials. John leads the GNS Science core science
programme of ion beam applications which focuses on research and
development of ion beam technology for industry and environment
sectors. He is a Principal Investigator in the high value manufacturing
technology industry focused Materials Accelerator at University of
Auckland. He is also a Principal Investigator in the MacDiarmid
Institute for Advanced Materials and Nanotechnology (Centre of
Research Excellence) and Research Associate at Victoria University of
Wellington and The University of Auckland.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00 - 09:30</td>
<td>S0: Opening Ceremony</td>
</tr>
<tr>
<td>09:30 – 10:00</td>
<td>Tea Break</td>
</tr>
<tr>
<td>10:00 - 11:30</td>
<td>S1: Keynote Address I</td>
</tr>
<tr>
<td>11:30 - 11:40</td>
<td>Break</td>
</tr>
<tr>
<td>11:40 – 13:10</td>
<td>S2A: Gas and Chemical Sensors 1,</td>
</tr>
<tr>
<td></td>
<td>S2B: Novel Applications 1,</td>
</tr>
<tr>
<td></td>
<td>S2C: Biosensors 1,</td>
</tr>
<tr>
<td></td>
<td>S2D: Wireless Sensor Networks 1</td>
</tr>
<tr>
<td>13:10 – 14:00</td>
<td>Lunch break</td>
</tr>
<tr>
<td>14:00 – 16:00</td>
<td>S3: Invited Session I</td>
</tr>
<tr>
<td>16:00 – 16:20</td>
<td>Tea Break</td>
</tr>
<tr>
<td>16:20 – 17:50</td>
<td>S4A: Gas and Chemical Sensors 2,</td>
</tr>
<tr>
<td></td>
<td>S4B: Image, Vision and Range Sensors 1,</td>
</tr>
<tr>
<td></td>
<td>S4C: Biosensors 2,</td>
</tr>
<tr>
<td></td>
<td>S4D: Wireless Sensor Networks 2</td>
</tr>
</tbody>
</table>

**Wednesday, December 4th**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00 - 10:25</td>
<td>S5: Keynote 2</td>
</tr>
<tr>
<td>10:25 - 10:45</td>
<td>Tea Break</td>
</tr>
<tr>
<td>10:45 – 12:15</td>
<td>S6A: Temperature, Humidity and Flow Sensors,</td>
</tr>
<tr>
<td></td>
<td>S6B: Signal Analysis,</td>
</tr>
<tr>
<td></td>
<td>S6C: Biosensors 3,</td>
</tr>
<tr>
<td></td>
<td>S6D: Mechanical Sensors 1</td>
</tr>
<tr>
<td>12:15 – 14:00</td>
<td>S7: Combined Lunch and Short Oral 1</td>
</tr>
<tr>
<td>14:00 – 15:30</td>
<td>S8: Invited Session 2</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>15:30 - 15:50</td>
<td>Tea break</td>
</tr>
</tbody>
</table>

**Thursday, December 5th**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00 – 10:30</td>
<td>S10A: Optical Sensors 1, S10B: Magnetic Sensors 1, S10C: Mechanical Sensors 2, S10D: Healthcare Applications 2</td>
</tr>
<tr>
<td>10:30 – 10:50</td>
<td>Tea Break</td>
</tr>
<tr>
<td>12:20 – 14:00</td>
<td>S12: Combined Lunch and Short Oral 2</td>
</tr>
<tr>
<td>14:00 – 15:20</td>
<td>S13A: Built Environment, S13B: Magnetic Sensors 2, S13C: Environmental Monitoring 2, S13D: Dielectric Measurement</td>
</tr>
<tr>
<td>15:20</td>
<td>S14: Closing Ceremony And Prize Distribution</td>
</tr>
</tbody>
</table>
Venue

The ICST 2013 conference will be held at Massey University Wellington campus. The technical sessions will be at the Lecture Theatre LT200, 5C11, 5C18, and 5C19.
Banquet
The Banquet will be held at AMORA hotel

170 Wakefield Street
Wellington

http://www.amorahotels.com/
**Detailed programme including abstracts**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tuesday, December 3</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 09:00 - 09:30 | **S0: Opening Ceremony**  
Chairs: Subhas Mukhopadhyay, Massey University, New Zealand  
Alex Mason, Liverpool John Moores University, United Kingdom |
| 10:00 - 11:30 | **S1: Keynote 1**  
Chair: Subhas Mukhopadhyay (Massey University, New Zealand) |
| 10:00 to 10:45 | **Friendly Photons: Optical Sensors in Life Science and Medicine**  
*Brian Cunningham, University of Illinois at Urbana-Champaign* |
| 10:45 to 11:30 | **Science with Mars Rover Curiosity**  
*Goutam Chattopadhyay, CalTech, JPL, USA* |
| 11:30 - 11:40 | **Interval**  
Allow delegates to move between sessions |
| 11:40 - 13:10 | **S2A: Gas and Chemical Sensors 1**  
Chair: Satoshi Ikezawa (Waseda University, Japan) |
| 11:40 | **Selectivity of organic nanocomposite sensor for detection of aldehydes**  
*Ashwini Mallya (Indian Institute of Science, India); Praveen Ramamurthy (Indian Institute of Science, India)* |

An organic molecule based sensor for detection of aldehydes is fabricated and tested. Organic molecules chemiresistor sensors are...
low cost sensors and operate at low temperature. A chemiresistor sensor for detection of volatile organic compounds is fabricated. The sensing element is a blend of o-phenylene diamine (OPD) - carbon black nanocomposite. The selectivity of the sensor to volatile organic compounds (VOC) -aldehyde, ketone and alcohol is studied. The sensor response was recorded at a higher concentration of 8000 ppm. The sensor shows good response to aldehydes. The higher response for aldehyde is attributed to the interaction of the carbonyl oxygen of aldehydes with amine group of OPD. The surface morphology of the sensing element is studied by scanning electron microscopy. The interaction of the VOCs with the OPD-CB nanocomposite is also studied by molecular dynamics studies. The interaction energies of the analyte with OPD-CB nanocomposite were calculated. It is observed that the interaction energies for aldehydes are higher than for other anlaytes. Thus the OPD-CB sensor shows selectivity to aldehydes. The selectivity of the sensor to aldehydes shows that it can be used as an aldehyde sensor.

11:58 Integration of ZnO Nanoflakes with MEMS Platform and its Application as Gas Sensor

Partha Bhattacharyya (Bengal Engineering and Science University, Shibpur, India)

MEMS based gas sensors offer superior performance compared to conventional ceramic gas sensors owing to their low power consumption, high sensitivity, faster response and compatibility to CMOS circuits. The design of microheater on the thin membrane of the MEMS structure is crucial to achieve the required temperature. In this paper a meander shaped microheater has been designed using Intellisuite v8.2 and fabricated using a nickel alloy (DiliverP1) on micromachined silicon platform (2mmx2mm). A low temperature chemical deposition technique (using Sodium Zincate bath) has been adopted to deposit the sensing layer on top of the microheater. Structural morphology of ZnO was studied by FESEM. The hexagonal nanoflake like structures having average size of 50-70nm were
formed. Resistive planar contacts (Au-Au) have been taken and the device was then tested for its hydrogen sensing property at different bias voltages (0-3V) and with different operating temperatures (30-210 °C) taking N2 as a carrier gas. The optimum operating temperature was found ~ 150°C with a high response magnitude of ~80.7% and appreciably fast response time ~29.6s at a H2 concentration of 20000ppm. At lower concentration level (100ppm) the sensor performance was also found to be promising with RM of ~36.8% and response time of 40.8s.

12:16 Tuning the Bias Sensing Layer: A New Way to Greatly Improve Metal-Oxide Gas Sensors Selectivity

Nicolas Dufour (LAAS-CNRS, France); Audrey Chapelle (LAAS-CNRS, France); Chabane Talhi (LAAS-CNRS, France); Frederic Blanc (LAAS-CNRS, France); Bernard Franc (LAAS-CNRS, France); Philippe Menini (LAAS-CNRS, France); Khalifa Aguir (IMN2P, France)

The effects of bias current in the sensing layer of resistive Metal-Oxide (MOX) sensors toward gases have been investigated. In a first time, while the working temperature is kept constant, it has been found that tuning the polarization of the MOX thin film induces changes on its sensitivity toward different gases. Besides, the behavior of sensitivity versus bias current depends on the nature of the gas, meaning it is possible to enhance the selectivity by adjusting the polarization of sensitive layers. This underutilized parameter provides a new way of improving easily gas sensors sensitivity and above all selectivity. Therefore, in a second time, the effect of the working temperature changing added to the polarization has been studied. Thus, an optimized temperature-modulated profile has been established and it has been associated with a multivariate analysis in order to quickly and easily discriminate several gases and mixtures. It would then be interesting to polarize individually each sensor of a multi-sensor device in order to optimize the whole system performances, which may represent a breakthrough in the development of smart E-Nose.
**12:34 Soft-sensing of Liquid Desiccant Concentration Based on ELM**

Zhongtian Chen (Zhejiang University of Technology, P.R. China); Wenjian Cai (Nanyang Technological University, Singapore); Xiong Xiong He (Zhejiang University of Technology, P.R. China); Xinli Wang (Zhejiang University, P.R. China); Lei Zhao (Nanyang Technological University, P.R. China)

This paper presents a soft-sensing method for predicting the liquid desiccant concentration based on the Extreme learning machine (ELM). The soft-sensing method utilizes a black-box model including eight inputs variables and one output to predict the concentration in real-time and is a better alternative to manual measurement or expensive and complex sensors. The soft-sensing method is verified with the experimental data collected from the Liquid Desiccant Dehumidification System. The testing results show that the proposed method can predict liquid desiccant concentrations accurately with the errors are all within ±10%. The developed method will have wide applications in monitoring, real-time control and operational optimization of Liquid Desiccant Dehumidification Systems.

**12:52 Ovarian Hormone Estrone Glucuronide (E1G) Quantification-Impedimetric Electrochemical Spectroscopy Approach**

Asif Iqbal Zia (Massey University & COMSATS Institute of Information Technology, New Zealand); Anton Yudhana (Ahmad Dahlan University, Indonesia); Subhas Mukhopadhyay (Massey University, New Zealand); Pak Yu (Massey University, New Zealand); Ibrahim Al-Bahadly (Massey University, New Zealand); Chinthaka Gooneratne (King Abdullah University of Science and Technology, Saudi Arabia); Jürgen Kosel (King Abdullah University of Science and Technology, Saudi Arabia)

A study was conducted on detection and concentration measurement of the estrone glucuronide (E1G), an important metabolite of the ovarian hormone estradiol, by using Electrochemical Impedance Spectroscopy (EIS) technique. A miniature planar Inter-digital (ID)
capacitive sensor fabricated on single crystal silicon substrate with sputtered gold electrodes coupled with EIS was used to measure conductivity, permeability and dielectric properties of the said hormone metabolite. A thin film of Silicon Nitride (50 um) was coated on the sensor as passivation to avoid Faradic currents through the sensor. Impedance spectrums were obtained with various concentrations of E1G in buffer solution by exposing the samples to electrical perturbations at certain frequency range. Relationship of the sample conductance with E1G concentration was studied on basis Randle's equivalent circuit model, and results were analyzed to deduce Constant Phase Equivalent (CPE) Circuit model in order to evaluate the double layer capacitance produced at the solution-electrode interface due to kinetic processes taking place in the electrochemical cell. The sensitivity of the sensor was evaluated against concentration. The result analysis confirmed that fabricated ID sensor together with EIS can provide a rapid and successful low cost sensing system which can help a lay user to determine peak time for feminine reproductive fertility at home without submitting samples for an expensive and time consuming laboratory test.

**S2B: Novel Applications 1**

**Chair: Kevin J Stevens (Quest Integrity NZL Ltd, New Zealand)**

**11:40 A digital delivery system of scent for video game application**

_Ibrahim Al-Bahadly (Massey University, New Zealand)_

The aim of this work is to develop a system that can deliver the sense of smell in video game applications to individual gamers for a more immersive video game experience. Currently, there are no such products that deliver this experience in the gaming market. The prototype consists of an aerosol scent canister designed to produce in game specific scents such as gunfire and burning rubber. The canister contains an actuator that is connected to a circuit board. The circuit board is in contact with a USB cord that is compatible with the PC and gaming consoles. A signal from a computer program triggers the
actuator to switch the canister scent emission on by using power generated from an AC adaptor.

11:58 Identification of Single Bacteria using Micro Raman Spectroscopy

Martin De Biasio (Carinthian Tech Research AG, Austria); Raimund Leitner (CTR AG, Austria); Gerald McGunnigle (Carinthian Tech Research AG, Austria); Dirk Balthasar (TOMRA Sorting Solutions GmbH, Austria); Jürgen Popp (Friedrich-Schiller-Universität Jena, Germany); Petra Rösch (Friedrich-Schiller-University, Germany)

We present Raman micro-spectroscopic measurements of Escherichia coli, Bacillus thuringiensis and Staphylococcus cohnii. Several authors have reported successful methods for classifying single bacteria using Raman microspectroscopy. The aim of this paper is to evaluate which features of the spectra are useful for the classification. PCA obtained the best performance with 3 PCs. We also tested classifiers based on two and three narrow band filters chosen by exhaustive search. These gave an accuracy comparable or greater than that of the PCA based classifier.

12:16 A Novel and Cost Effective Resistive Rain Sensor for Automatic Wiper Control: Circuit Modelling and Implementation

Mukul Joshi (College of Engineering Pune, India); Kaustubh Jogalekar (College of Engineering, Pune, India); Dayanand Sonawane (College of Engineering, Pune, India); Vinayak Sagare (Automotive Research Institute of India, India); Madhuri Arunkumar Joshi (College of Engineering, Pune, India)

Safety and driver comfort are the essential goals of new trends in automobile industry. An automatic wiper controller, helps not only in increasing safety by reducing distractions but also increases the overall comfort. Such an automatic control is available however it has limitations of high cost and low efficiency. In this work, we have proposed an automatic wiper controller, based on resistive rain sensor which is cost effective, efficient and has a wide range of output. An
equivalent electrical and mathematical model of the sensor is developed, simulated and practically verified. The rain sensor has a predetermined geometry. Hence the rain water forms a film on the sensor surface causing its resistance to change non-linearly. To increase the overall efficiency of system, it is necessary to linearize the sensor response. It is achieved using electrical equivalent model of the sensor and with appropriate linearization circuit. Further, a customized embedded system is developed using PIC microcontroller to achieve motor speed variation based on sensor output. The proposed system is rigorously tested on a small segment car ('Indica V2') for its performance. It is observed that, the developed system works satisfactorily under various rain scenarios.

12:34 Automated Monitoring of Foraging Behaviour in Free Ranging Sheep Grazing a Biodiverse Pasture

Alex Mason (Liverpool John Moores University, United Kingdom); Jenny Sneddon (Liverpool John Moores University, United Kingdom)

Little is currently known about the foraging behavior of free ranging animals, particularly in biodiverse pastures. This is despite the suggestion of recent work that animals grazing on such pastures tend to produce better quality meat. This paper presents a bespoke Wireless Sensor Network system designed to be mounted on grazing animals and collect movement information which is then coded with reference to human observations. In doing this it has been possible to calibrate the bespoke system such that, in real-time, the system can be used to deduce animal behavior (e.g. resting, grazing, foraging, etc.) remotely. When coupled with future GPS-free positional information, this system will provide valuable information for the UK agricultural industry, in addition to overcoming the challenges faced by many commercial systems which rely on energy intensive GPS technology.

12:52 Development of Anal Position Detecting System for New-Toilet system
Koshi Tokoro (Tokyo University of Science, Japan); Hiroshi Kobayashi (Tokyo University of Science, Japan)

Japan entered a super-aged society, and nursing care is a serious social problem. Especially, an excretion care causes physical and mental stress to both caregivers and recipients. In this study, we have been developing a new-toilet system for reducing the stress of the excretion care. The new-toilet system can capture feces and prevent odor dispersion by adhering tightly to buttocks. For attaching the device to buttocks, it is necessary to know the position of the anus. It is preferable that the device automatically moves to the anal position and adhere to the buttocks without caregiver's help. Therefore we developed a sensing system of the anal position using the infrared camera. This paper describes the position detecting system and its estimation.

S2C: Biosensors 1
Chair: Jagadeesh Kumar V (Indian Institute of Technology Madras, India)

11:40 Developing Non-Parametric Density Estimation on Genetic Evolution Computing as a Cloud Based Sensor Fusion Method

Tsu-Wang Shen (Tzu Chi University, Taiwan)

Biomedical cloud computing offers on-demand healthcare services. A sensor fusion method is developed based on non-parametric density estimation on genetic evolution computing. Our method provides a potential solution for decision making on flicking features when not all measurements of sensors appear at the input end. The method was applied on major depressive disorder detection as an application example and it was successfully for MDD classification regardless different combinations of sensor monitoring.

11:58 Performance Optimization of Temperature Compensated Surface Acoustic Wave Biosensors
Temperature has great influences on the surface acoustic wave (SAW) biosensors. Different substrates were tested and the methods for improving the temperature performance of the SAW biosensors were discussed here. The effects of temperature on the SAW sensors mainly result from the temperature coefficient of the SAW device and the oscillating circuit. To eliminate the impact of environment, a twin delay lines SAW biosensor operating at 198MHz, with a sensor channel and a reference channel, was fabricated on 36oY-X LiTaO3 piezoelectric crystals. The signals of the two channels were multiplied by a mixer to compensate the influences of temperature. Since the temperature may affect the quiescent point of amplifier, the open loop phase would change, resulting in a frequency shift of the SAW oscillator. Therefore, a simple and effective circuit structure with a comparator limiting the oscillation amplitude was applied to the design of the SAW oscillator. At last, the temperature performance of our design was tested. Our design was demonstrated having a great performance with a temperature coefficient about 2 ppm/oC.

12:16 Biochemical Sensing Assays based on Coalescence-induced Self-propulsion Digital Microfluidics

Volker Nock (University of Canterbury & MacDiarmid Institute for Advanced Materials and Nanotechnology, New Zealand); Mathieu Sellier (University of Canterbury, New Zealand); Yannick Muller (University of Canterbury, New Zealand); Claude Verdier (CNRS and University Joseph Fourier, France)

This work reports on coalescence-induced self-propulsion as a driving mechanism to actuate microfluidic droplet assays. We demonstrate multi-droplet translation and assay-type sensing on a digital microfluidics platform by use of surface tension gradients alone.
These gradients arise during the coalescence of two droplets of liquid having different compositions and therefore surface tensions. We demonstrate a chemiluminescence blood-detection reaction based on the mixing of two carrier droplets containing solutions of synthetic blood and luminol sensor solution. Presence of iron in the blood solution is recorded using digital imaging and analyzed via offline image processing. The results demonstrate the capability of the propulsion mechanism to propel droplets over several millimeters, thus enabling one to design a new family of chip-based biochemical sensor assays.

12:34 Electrochemical Biosensing of Organophosphates using Vertically Aligned Multiwall Carbon Nanotubes

Saroja Mantha (Research Associate, USA); Bryan Chin (Auburn University, USA); Aleksandr Simonian (Auburn University, USA)

Electrochemical biosensors using vertically aligned multiwalled carbon nanotube (VAMWNTs) on the substrates has been envisioned to enhance performance of the sensor. The carboxylated MWNTs were covalently attached to the silicon wafer surface using an amine linkage. MWNTs structure and functionality was characterized using atomic force microscopy (AFM) and resonance Raman spectroscopy. The electrochemical studies of MWNTs showed the excellent electrochemical properties with an electron transfer. In addition to enhanced electron flow, impedance spectroscopy demonstrated the decrease of charge-transfer resistance measurements with the VAMWNTs. Organophosphorus hydrolase (OPH) enzyme was immobilized on the carboxylated VAMWNTs and this nanostructure assembly was used as a sensor to detect organophosphate compounds with high sensitivity.

12:52 An A.N.N. Model of the Perception of Sound by the Human Auditory System
The human auditory system perceives sound in a much different manner than sound is measured by modern audio sensing systems. The most commonly referenced aspects of auditory perception are loudness and pitch which relate to the objective measures of frequency and sound pressure levels. This paper describes an efficient and accurate method for the conversion of the sensed factors of frequency and sound pressure level to perceived loudness and pitch. This method is achieved through the modeling of the auditory system using artificial neural networks and will be shown to have certain advantages over previous methods.

**S2D: Wireless Sensor Networks 1**

Chair: Yueh-Min Huang (National Cheng Kung University, Taiwan)

**11:40 Intellectus: Multi-Hop Fault Detection Methodology Evaluation**

*Tiziana Campana (University College of Dublin, Ireland); Gregory O'Hare (University College Dublin, Ireland)*

Wireless Sensor Networks (WSNs) can experience problems (anomalies) during deployment, due to dynamic environmental factors or node hardware and software failures. These anomalies demand reliable detection strategies for supporting long term and/or large scale WSN deployments. Several strategies have been proposed for detecting specific WSN anomaly, yet there is still a need for more comprehensive anomaly detection strategies that jointly address network and node level anomalies. Intellectus methodology build a tool that detected a new limited set of faults: sensor nodes may dynamically fail, be isolate and reboot and local topology control. These bugs are difficult to diagnose because the only externally visible characteristic is that no data is seen at the sink, from one or more nodes. This paper evaluate Intellectus methodology by different experiment in a Testbed network. In fact, Intellectus is be able to
detect the injected fault and assess different scenarios of topology change.

11:58 **Light-Weight History-Based Medium Access Control (MAC) Protocol for Body Area Networks**

*Nesa Mouzehkesh (Charles Sturt University, Australia); Tanveer A Zia (Charles Sturt University, Australia); Saman Shafigh (Charles Sturt University, Australia); Lihong Zheng (Charles Sturt University, Australia)*

Different MAC techniques in body area networks (BAN) are to make different tradeoffs to suit for the variety of situations that may be caused by the heterogeneous traffic behavior of the BANs. Previously, we proposed a dynamic delayed MAC scheme with a fuzzy technique to add a traffic adaptive quality to the existing IEEE 802.15.4 which addresses traffic diversity in BAN applications. In this paper we investigate reducing the complexity of our previous method by integrating it with a caching technique enabling the MAC algorithm to minimize the iterations of running the fuzzy engine. We examine the efficiency of the previously fuzzy-based MAC algorithm in terms of energy to be implemented on real SHIMMER sensor platforms by evaluating the reliability and battery lifetime.


*Arash Tayebi (University of Auckland, New Zealand); Stevan Mirko Berber (University of Auckland, New Zealand); Akshya Kumar Swain (University of Auckland, New Zealand)*

Wireless Sensor Networks (WSN) are gaining a lot of attention from researchers due to their massive applications. Network security is one of the important requirements of those applications. This paper analyses possible network attacks that is essential for researchers in developing robust security countermeasure. In this study, a systematic overview of different kinds of attacks for WSNs has been carried out
and a critical analysis of the existing research results is presented. Also we propose five new attacks for WSNs. Furthermore, based on our analysis, we suggest to develop efficient attacking methods; to be called as cross-layer attacks, which combine and exploits the merits of specific attacks in different layers.

**12:34 AWSAM-3: A low power miniaturised wireless sensor mote**

*Ameer Ivoighlian (The University of Auckland, New Zealand); Kevin I-Kai Wang (The University of Auckland, New Zealand); Zoran Salcic (The University of Auckland, New Zealand)*

Wireless sensor networks have become an active topic of research over the last decades with a growing demand and interests. Wireless sensor nodes (or motes) are the fundamental unit in forming wireless sensor networks. There are many ready-made devices now available aiming for various wireless sensor network applications. In this paper, a novel mote, AWSAM-3, is presented targeting flexibility, low power consumption, miniaturisation, and long communication range. AWSAM-3 is designed with a modular hardware architecture allowing the sensor node components to be mixed and matched based on the needs of the application. Low power consumption is achieved through careful component selection, particularly the voltage regulator. Radio communication experiments show the communication range of over 1km can be achieved depending on the data rates. With its small physical size and modularity, the AWSAM-3 provides a flexible mote for creation of wireless sensor networks for research and in-field applications.

**12:52 Secured Multimedia Authentication System for Wireless Sensor Network Data related to Internet of Things**

*Jyotsna Suryadevara (Malla Reddy Institute of Engineering & Technology- & JNTU-Hyderabad, India); Bollam Sunil (Malla Reddy Institute of Engineering & Technology-, India); Nagender Kumar Suryadevara (Massey University, New Zealand)*
In this paper, the design and development of an effective secured framework for transmission of heterogeneous wireless sensor network data related to Internet of Things is presented. The description about the integrated multimedia applications network design and the secured mechanisms for reliable data transmission of smart sensors data is illustrated. Mechanisms for multimedia aware traffic analysis and data security in the integrated framework are discussed with the help of simulation of multimedia networks. The experiment results of the proposed security strategy for wireless sensor scalar data and performance analysis of the multimedia wireless sensing traffic are demonstrated using the WiSE MNet simulator.

14:00 – 14:30
Advanced sensing technologies for superconducting devices test at CERN
Pasquale Arpaia, European Organization for Nuclear Research (CERN) and University of Sannio, Italy.

14:30 – 15:00
Proposal of a sub-cent RFID using metal-patch - Problems and ways to overcome them
Goutam Chakraborty, Iwate Prefectural University, Japan

15:00 – 15:30
Feature selection for pattern analysis and mining of sensors’ data
Basabi Chakraborty Iwate Prefectural University, Japan

15:30 – 16:00
Imaging Dielectric Structure Using Transmission Line Waveguides
16:20 - 17:50
S4A: Gas and Chemical Sensors 2
Chair: Tayeb Mohammed-Brahim (University Rennes 1, France)

16:20 Combination of tailored acid-base and red/ox properties of nanocrystalline SnO2 for optimal gas sensor performance

Valeriy Krivetskiy (M. V. Lomonosov Moscow State University, Russia); Roman Rozhik (M. V. Lomonosov Moscow State University, Russia); Marina Rumyantseva (M. V. Lomonosov Moscow State University, Russia); Alexander Gaskov (M. V. Lomonosov Moscow State University, Russia)

The work presents feasibility study of theoretical concept, connecting semiconductor metal oxide chemistry and its gas sensor properties on the nanocrystalline SnO2 example. It is shown, that materials surface chemistry simultaneous modification by metal oxide structure dopants and deposition of catalytic components on the surface can be made in order to alter both gas molecule adsorption and conversion. It is achieved through controlled changes in materials surface acidity and Red/Ox activity. The approach allows improvement of materials sensitivity and selectivity of response at the same time and could be used as basis for development of sensors series (array), applicable in particular gas analysis task.

16:38 Ethanol Sensor Based on ZnO Nanoporous Prepared via Microwave Oven

Noor Ridha (Universiti Kebangsaan Malaysia (UKM), Malaysia)

The main demanding aim for many researchers is to reduce the operating temperatures as well enhance the sensing performance of metal oxide based alcohol gas sensor. Increasing the surface to volume ratio by controlling the morphology is one of the possible methods to reduce operating temperatures of sensing nanomaterials.
In this work, microwave method was used to synthesize ZnO nanoporous, which was confirmed by XRD, FE-SEM and XPS characterizations and subsequently tested for alcohol sensing performance. In addition, XRD revealed that ZnO nanoporous exhibited strong tendency to grow along (100) while generally retained the wurtzite framework. Ethanol sensing test was carried out at temperatures ranging from 25°C to 310 °C. The effects of the morphology on the alcohol sensing performance was investigated and discussed. In addition, a possible description for sensing alcohol of the species on the surface of sensor is also explained.

16:56 Highly Sensitive and Stable MOSFET-Type Hydrogen Sensor with Dual FETs

Jung-Sik Kim (University of Seoul, Korea); Bum-Joon Kim (University of Seoul, Korea)

A MOSFET gas sensor with platinum gate for hydrogen gas detection was designed, fabricated and characterized for sensing response and stability to outer environment. The dual-gate FET hydrogen sensor was integrated with a micro-heater and two Pt-gate FETs; a sensing device for hydrogen detection, and a reference device for electrical compensation. The identical output between the sensitive-FET and reference-FET was stable at the range from room temperature to 250°C due to the same temperature dependence of the current-voltage (I-V) characteristics. The Pt-FET sensor showed stable responses to hydrogen at a range of operation temperatures. The optimal operating temperature with 5,000 ppm H2 was approximately 150°C at which the sensing response as drain current change was 0.112 mA. Also, the response and recovery times were 18 sec and 19 sec, respectively. The fabricated sensor showed low power consumption (45.5 mW at 150°C) by achieving complete heat isolation. The low-power MOSFET gas sensor can be suitable for applications in portable gas monitoring units and automobiles.

17:14 Semiconductor gas sensing coupled with pre-sampling system for toxic compounds and chemical threat agents detection
An innovative approach of sensitive and selective detection of trace amounts of chemical threat agents is presented in this work. The technology deals with semiconductor metal oxide gas sensors as a means of express gas detection, coupled with pre-sampling system, which is to improve sensitivity and selectivity of analysis. Examples for H2S, DMMP (phosphor-organic weapons simulant) and UDMH (highly toxic rocket engine fuel constituent) sensor detection with aided by pre-sampling system are given. The issues of sensor and adsorbent materials selection and their working parameters are discussed.

Fast and Low-Cost Online Detection of Critical Micelle Concentration based on Impedance Spectroscopy

Roman Gruden (Seuffer GmbH & Co. KG & TU Chemnitz, Germany); Olfa Kanoun (Chemnitz University of Technology, Germany)

The dosage of detergents in washing processes is decisive for efficiency. The optimal dosage can be determined by a measurement of the critical micelle concentration (CMC). Classical methods are not suitable for online applications in washing machines with automatic dosage because detergent concentrations cdet highly above the CMC are also needed and automatic dosage cannot be stopped in time. Optical methods are commonly used for such applications but they are expensive or imprecise. A new online detection method of CMC using impedance spectroscopy (EIS) is developed. Impedance values at selected frequencies are used to detect ccmc. The new method detects the CMC immediately and precisely when ccmc is reached so that automatic detergent dosing can be stopped in time and online measurement is possible.
16:20 Fully Integrated Vision Based Localization in Low Cost Robot Using Kinect

Alexandre This (ECE Paris School of Engineering, France); Badis Bouchilaoun (ECE Paris School of Engineering, France); Ronan Guyomard (ECE Paris School of Engineering, France); Charles Lahaye (ECE, France); Thomas Lange (ECE Paris School of Engineering, France)

The goal of present work is to demonstrate the possibility to build a fully integrated low cost robot using an artificial vision based localization system known to be utilizable in many environments due to its extreme versatility. To avoid complex algorithms and to bound high hardware resources, simple landmarks are exploited to reduce considerably cost and complexity of recognition system. On this base a low cost project using on the shelf components has been developed in academic environment. Global architecture of the project is shown including a Graphical User Interface (GUI), a network system, and the robot itself. The algorithm allowing 3D vision based localization on a low performance embedded computer is also presented and results are discussed.

16:38 Hyper-spectral video endoscopy system for intra-surgery tissue classification

Thomas Arnold (Carinthian Tech Research AG & University of Klagenfurt, Austria); Martin De Biasio (Carinthian Tech Research AG, Austria); Raimund Leitner (CTR AG, Austria)

Video endoscopy systems give physicians the ability to inspect internal structures of the human body by using a camera with attached endoscope optics. This technology has become a routine in clinics all over the world. Moreover, video endoscopy systems recently performed a technological change from PAL/NTSC image resolution
to HDTV. There is a vast of literature on in-vivo and in-vitro experiments with multi-spectral point and imaging instruments that document that the spectral information can be a valuable diagnostic decision support. Due to the fact that spectral imaging equipment was too slow to acquire hyper-spectral image stacks at reasonable video rates, intra-surgery hyper-spectral measurements were limited to point measurements in the past. But the availability of fast and versatile acousto-optical tunable filters with switching times in the microsecond range made the application of a hyper-spectral video endoscope technically feasible. This paper describes a demonstrator of a hyper-spectral video endoscope, the data analysis and the results of the first clinical studies. The results show that hyper-spectral video endoscopy exhibits a large potential to become an important imaging technology for medical imaging devices that provide additional diagnostic information about the tissue under investigation.

16:56 Ultrasonic Range Measurements on the Human Body

Dirk Weenk (University of Twente, The Netherlands); Bert-Jan van Beijnum (University of Twente, The Netherlands); Ed Droog (University of Twente, The Netherlands); Hermie Hermens (University of Twente, The Netherlands); Peter Veltink (University of Twente, The Netherlands)

Ambulatory range estimation on the human body is important for the assessment of the performance of upper- and lower limb tasks outside a laboratory. In this paper an ultrasound sensor for estimating ranges on the human body is presented and validated during gait. The distance between the feet is estimated based on the time of flight and compared to an optical reference. The signal to noise ratio of the received signal is used as a measure for the uncertainty of the range estimate. For example when rejecting distance estimates with a signal to noise ratio smaller than 5, the mean absolute distance difference between the ultrasound sensor and an optical reference system is 7.0 mm (sd 7.1 mm) over six walking trials.

17:14 A 3D vision system for high resolution surface reconstruction
In this paper a fast and innovative three-dimensional vision system, having high resolution in the surface reconstruction, is discussed. It is based on a triangulation 3D laser scanner with a linear beam shape. The high precision (few microns) is guaranteed by very small laser line width, small camera pixel-size and proper optical properties of the Telecentric Lens. The entire system has been tested on two kinds of sample objects such as a 20 €cent coin and a set of precision drilling tools. The main purpose of this work is the detection and reconstruction of the 3D surface of tiny objects and the measurement of their surface defects with high accuracy. Furthermore the occlusion problem is faced and solved by properly handling the camera-laser setup. Experimental tests prove the high precision of the system that can reach a resolution of 15 µm.

17:32 Analysis of Indoor Environments by Range Images

In this paper we present a reliable method to derive the differences between indoor environments using the comparison of high-resolution range images. Samples belonging to different acquisitions are firstly reduced preserving the topology of the scenes and then registered in the same system of reference through an iterative least-squares algorithm, aided by a deletion mask, whose assignment is the removal of implicit errors due to the different points of view of each orthographic acquisition. Finally the analysis of the exact range measures returns an intuitive difference map that allows the fast
detection of the positions of the altered regions within the scenes. Numerical experiments are presented to prove the capability of the method for the comparison of scenes regardless the resolution of the sensor and the input noise level of such measurements.

**16:20 Label-free Capacitance DNA Sensing**

Yi Jia (University of Puerto Rico, Mayaguez, USA); Phillip Rivera Ortiz (University of Puerto Rico – Mayaguez, Puerto Rico); Carlos Cabrera (University of Puerto Rico – Rio Piedras, Puerto Rico); Nella Vargas (University of Puerto Rico – Rio Piedras, Puerto Rico)

This paper presents the use of direct capacitance measurements for label free hybridization detection of ssDNA immobilized directly on a gold interdigitated array of microelectrodes (IDAM). Thiol modified 18 bases long Poly-dT ssDNA molecules were immobilized on the Au IDAM surface without the use of any isolative self assembled monolayer (SAM). Afterwards a Poly-dA ssDNA solution was deposited on the immobilization area to induce molecular hybridization. IDAM capacitance measurements were taken throughout the cleaning, immobilization and hybridization procedure to detect the presence of the immobilized ssDNA on the electrode surface and furthermore hybridization. Capacitance measurements using a potassium phosphate (KH2PO4 0.1mM pH=9.9) electrolyte covering the electrode array demonstrate an increase of 5.837 pF and 8.409 pF after immobilization and hybridization respectively. These results provide a simple technique for transduction of bio-molecular identification which could potentially be applied for the identification of other biological markers.

**16:38 Wireless Magnetoelastic Biosensors for the Detection of Salmonella on Fresh Produce**

Bryan Chin (Auburn University, USA)
This paper investigates the use of wireless magnetoelastic (ME) biosensors for the direct detection of Salmonella Typhimurium on fresh produce (tomatoes, spinach leaves and shell eggs). The ME biosensor consists of an ME resonator as the sensor platform and E2 phage as the bio-recognition element. The E2 phage is genetically engineered to specifically bind with S. Typhimurium. The ME biosensor, a wireless sensor, is actuated into resonance by an externally applied magnetic field. When the biosensor binds with Salmonella cells, the mass of the resonator increases, resulting in a decrease in the sensor's resonant frequency. Multiple sensors can be wirelessly and remotely monitored. Multiple measurement and control sensors were placed on fresh produce that was spiked with S. Typhimurium solutions of different known concentrations (5 × 10^1 to 5 × 10^8 CFU/ml (colony-forming unit/ml)). The resonant frequency of the sensors before and after the exposure to the spiked fresh produce was measured. The resonant frequency change of the measurement sensors was significantly different from the control sensors, indicating Salmonella contamination. Despite the different surface topographies of the fresh produce, similar ME biosensor measurement results were obtained for the three fresh produces. Scanning electron microscopy was used to confirm binding of the Salmonella to the biosensor surface and the resulting resonant frequency changes.

16:56 A microflow cytometer chip driven by the absorbent force of on-chip superabsorbent materials

Yan-Chang Lee (National Chung Cheng University, Taiwan); Wen-Hsin Hsieh (National Chung Cheng University, Taiwan)

The objective of our study was to develop an absorbent-force-driven microflow cytometer chip (AMCC) that used superabsorbent materials as the fluid-driving source to allow chip operation without external power and easy miniaturization. In our study, the fluid flow characteristics inside the AMCC, and the impact of the microstructure size on the flow velocity and hydrodynamic focusing width of AMCC were investigated. Results showed that superabsorbent materials allowed stable microchannel flow and hydrodynamic focusing and that
the flow rate and hydrodynamic focusing width of the AMCC could be controlled by varying the microchannel dimensions (the mean flow velocity was approximately 1.6 mm/s to 18.5 mm/s, and the hydrodynamic focusing width was approximately 3 μm to 20 μm). In addition, the fluorescent test results of AMCC were noted to be consistent with those of a large-scale flow cytometer (BD, FACSCalibur), thereby confirming the feasibility of using superabsorbent materials as the fluid-driving source in microfluidic chips. AMCC can effectively reduce the amount of test solution used, has the advantage of easy miniaturization, and provides a low-cost fluid actuation method that can be conveniently obtained, fabricated, and miniaturized.

17:14 Magnetotactic Bacteria as Dispatched Oxygen Sensors

Sylvain Martel (Polytechnique Montreal, Canada); Mahmood Mohammadi (Polytechnique Montreal, Canada); Dominic de Lanauze (Polytechnique Montreal, Canada); Ouajdi Felfoul (Polytechnique Montreal, Canada)

MC-1 Magnetotactic bacteria are considered as self-propelled oxygen sensors with overall sizes of only 1 to 2 μm across. Each cell contains a chain of magnetite nanoparticles that acts like a magnetic nano-compass. Magnetotaxis directional control can be applied from a weak magnetic field to force each cell towards specific areas where oxygen gradient is present. Once at the region under investigation, the directional magnetic field can be reduced to allow the cells to move towards regions of 0.5% oxygen level. A sufficiently high concentration of these cells allows us to visualize with the naked eyes, the low oxygen levels in planar and 3D fluidic environments.

17:32 Human Sensing Using Wearable Wireless Sensors for Smart Environments

Chika Sugimoto (Yokohama National University, Japan)
In this paper, the author proposes a prototype of smart system using wearable wireless sensors to realize smart environments. To provide appropriate personalized services, human information needs to be monitored, analyzed and fed back. We have developed a wearable sensing system which measures biological data and activity data in daily life using body area network technologies. To deal with human information, the author also proposes a state estimation model for evaluating thermal sensation based on hierarchal hidden Markov model. The model is learned from biological data and environmental data using neural network. The system could control appropriately the thermal environment to make each person feel comfortable under energy-saving conditions based on real-time personal conditions and environmental condition.

**S4D: Wireless Sensors Networks 2**
Chair: Nagender Kumar Suryadevara (Massey University, New Zealand)

**16:20 A Energy Efficient WSN System for Limited Power Source Environments**

Rodrigo Semente (Universidade Federal do Rio Grande do Norte, Brazil); Felipe Oliveira (Universidade Estadual do Rio Grande do Norte, Brazil); Alberto Lock (Universidade Federal da Paraíba, Brazil); Alexandre Silva (Universidade Federal do Rio Grande do Norte, Brazil); Andres Salazar (Federal University of Rio Grande do Norte, Brazil)

In this work, a Wireless Sensor Networks (WSN) is analyzed and implemented to control a instrumented process in environments with limited power source. Present propose is based on IEEE 802.15.4 standard, using Zigbee and Modbus protocols. A simplified and robust system architecture is presented, emphasizing the control subsystem of charge and discharge, using solar panels, as well as software optimized for task of network controlling and sensing, both characteristics which allow a reduced consumption of energy. These
characteristics were proved by energetic efficiency tests and a system study that will be automated to define a rate optimal operation.

16:38 An Ultra Low Energy 8-bit Charge Redistribution ADC for Wireless Sensors

Antonio J López-Martín (Public University of Navarra, Spain); Iñigo Cenoz Villanueva (UPNA, Spain)

A low-energy 8-bit charge-redistribution SAR ADC for wireless sensor nodes is proposed. The ADC employs a new capacitor switching procedure that allows a reduction of the average switching energy as compared to previous proposals. Simulation and measurement results of a test chip prototype operating at 100 kS/s are provided, showing a SFDR of 55.63 dB for a power consumption of 2.17 uW. The active area of the ADC is only 0.275 mm².

16:56 An Adaptive Approach to Information Discovery in Multi-Dimensional Wireless Sensor Networks

Menik Tissera (Deakin University, Australia); Robin Doss (Deakin University, Australia); Gang Li (Deakin University, Australia); Lynn M Batten (Deakin University, Australia)

Multidimensional WSNs are deployed in complex environments to sense and collect data relating to multiple attributes (multidimensional data). Such networks present unique challenges to data dissemination, data storage and in-network query processing (information discovery). In this paper, we investigate efficient strategies for information discovery in largescale multidimensional WSNs and propose the Adaptive Multi-Dimensional Multi-Resolution Architecture (A-MDMRA) that efficiently combines "push" and "pull" strategies for information discovery and adapts to variations in the frequencies of events and queries in the network to construct optimal routing structures. We present simulation results showing the optimal routing structure depends on the frequency of events and query occurrence in the network. It also balances push and pull operations.
in large scale networks enabling significant QoS improvements and energy savings.

17:14 Comparative Study of Routing Protocols for Opportunistic Networks

Majeed Alajeely (Deakin University, Australia); Asma’a Ahmad (Deakin University, Australia); Robin Doss (Deakin University, Australia)

Opportunistic networks or OppNets refer to a number of wireless nodes opportunistically communicating with each other in a form of "Store-Carry-Forward". This occurs when they come into contact with each other without proper network infrastructure. In OppNets there is no end-to-end connection between the source node and the destination node. OppNets grow from a single node (seed) to become large networks by inviting new nodes (helpers) to join the network. Due to these characteristics, OppNets are subject to real routing challenges. In this paper, we have presented an overview of the main available three families of OppNet routing protocols. Further, we have evaluated one protocol from each family (Epidemic, Direct Delivery and PRoPHET) in terms of complexity and scalability. Simulation results show that for small and medium complexity, the three protocols perform better than large complexity. As for scalability, simulation results show that Epidemic and PRoPHET perform better than Direct Delivery in terms of delivery rates and delays, but at a very high cost while Direct Delivery achieved lower delivery rates with a low cost.

17:32 Effect of Distributed Backoff mechanism to Simple Autonomous Active Period Selection Control in Cluster-tree type IEEE 802.15.4 WSNs with Cluster Mobility

Kazuo Mori (Mie University, Japan); Katsuhiro Naito (Mie University, Japan); Hideo Kobayashi (Mie University, Japan)
This paper aims to provide performance enhancement to cluster-tree type IEEE 802.15.4 WSNs under cluster mobility environments. The cluster mobility causes severe beacon collisions and greatly degrades the system performance. To enhance the system performance of WSNs with cluster mobility, the paper proposes a combination scheme of the simple autonomous active period selection control and the traffic adaptive distributed backoff mechanism, previously proposed in our recent work, and investigates an effect of the distributed backoff to the system performance. The results evaluated by computer simulation demonstrate the proposed scheme can improve the transmission performance and power efficiency in cluster-tree type WSNs under cluster mobility environments.
**Wednesday, December 4**

**09:00 - 10:20**

**S5: Keynote 2**

Chair: Subhas Mukhopadhyay (Massey University, New Zealand)

**09:00 – 9:45**

**Sensors for Non-invasive Diagnostics**

*Jagadeesh Kumar V (Indian Institute of Technology Madras, India)*

**09:45 -10:05**

*Technic (Industry Sponsor)*

**10:05 – 10:25**

*Micron Optics (Industry Sponsor)*

**10:40 - 12:10**

**S6A: Temperature, Humidity and Flow Sensors**

Chair: Jagadeesh Kumar V (Indian Institute of Technology Madras, India)

**10:40 Fluid Flow Rate Estimation using Acceleration Sensors**

*Laura Fabbiano (Polytechnic of Bari, Italy); Gaetano Vacca (Politecnico di Bari, Italy); Giuseppe Dinardo (Politecnico di Bari, Italy)*

The present paper describes a procedure improving the measurement of fluid flow rates in pipes through the measurement of vibrations. The authors show, via experimental tests for water system, that for a given pipe in terms of width, diameter and material, the first harmonic amplitude of the vibration signal transmitted from the flow to the pipe walls is linearly proportional to the flow rate at a given revolution of the pump. Then, accelerometer mini/micro-transducers can be used for non intrusive, low-cost and reliable flow rate measurements without load errors.

**10:58 Mach-Zehnder interferometer as a temperature sensor based on the nested fiber ring resonator**
Yun Dong Zhang (Harbin Institute of Technology, P.R. China); Changqiu Yu (Harbin Institute of Technology, P.R. China); Kaiyang Wang (Harbin Institute of Technology, P.R. China); Chi Xu (Harbin Institute of Technology, P.R. China); Haiping Wang (Ice Training Base in HeiLongJiang Province, P.R. China); Yuhua Zhang (Harbin Normal University, P.R. China)

An Mach-Zehnder (M-Z) interferometer coupled with the nested fiber ring resonator is theoretically demonstrated. The results show that the dispersion sensitivity of the interferometer is significantly enhanced by the strong dispersive response of the resonator. The sensitivity of the temperature sensor based on the nested fiber ring resonator coupled M-Z interferometer can achieve 320rad/°C, about ten times of that in traditional M-Z interferometer.

11:16 Development of polymer coated fibre Bragg gratings for relative humidity sensing

Adam Swanson (Massey University, New Zealand)

This paper looks at the development of a polyetherimide coated fibre Bragg grating based humidity sensor. Different fibre coating methods and coating thicknesses were trialled with a Bragg wavelength shift of 0.93pm/%RH achieved.

11:34 In-vitro measurement of pulp chamber temperature increase with light cured composite resins using fiber Bragg grating thermal sensor

Sharath Umesh (Indian Institute of Science, India); Aadarsh Koratagere (M S Ramaiah Dental College and Hospital, India); Adarsh Bhat (KLE Society's Institute of Dental Sciences and Hospital, India); Jayanth Ravi (M S Ramaiah Dental College and Hospital, India); Sundarrajan Asokan (IIsc, India)

Dental pulp is found to be vulnerable during cavity preparation and restoration procedures owing to the delicate pulp tissue characteristics. Aesthetic restorative dentistry relies on polymerization
of light-activated resin composites which increases the temperature of the pulp tissue. The potential damaging effect of temperature increase on pulpal tissue during restorative treatment has been a concern in dentistry. Polymerization of light composite resins results with increase of temperature caused by both the exothermic reaction process and the energy absorbed during irradiation. The purpose of this in vitro study is to measure the pulp chamber temperature increase induced during composite resin polymerization with various visible light-curing units using fiber Bragg grating thermal sensor (FBGTS). A 1 mm composite resin layer is applied to the proximal class II cavity prepared in an extracted molar tooth and light cured with different units which facilitates an increase in the pulp chamber temperature sensed by the FBGTS inserted into the pulp chamber. The FBGTS employed in the present work has been designed, developed and calibrated in the laboratory prior to the onset of the experiment. The results are expected to be an indicator towards the potential hazard caused by heat induced pulpal injuries while light curing of composite resins.

11:52 Noncontact Temperature Profiling of Rotating Cylinder by Laser-Ultrasonic Sensing

Ikuo Ihara (Nagaoka University of Technology, Japan); Akira Kosugi (Nagaoka University of Technology, Japan); Iwao Matsuya (Nagaoka University of Technology, Japan); Yasuhiro Ono (Nagaoka University of Technology, Japan)

There are growing demands for measuring surface and internal temperature profiles of rotating objects in the fields of engineering and manufacturing industries. In this work, a new noncontact method for measuring such temperature profiles of a heated rotating cylinder is presented. A laser-ultrasonic technique which provides noncontact ultrasonic measurements of heated objects is employed in the method. Surface temperature measurements for a heated cylinder using the laser-ultrasonic technique and a heat conduction analyses with a finite difference calculation are combined together for making a quantitative evaluation of the internal temperature profile in the radial
direction of the cylinder. To demonstrate the feasibility of the combined method, an experiment with a heated steel cylinder (100 mm dia.) rotating at 300 min-1 is carried out. A pulsed laser generator and a laser Doppler vibrometer are used for generating and detecting surface acoustic waves (SAWs) on the steel cylinder, respectively. Measured SAWs are used for determining both surface and internal temperatures of the cylinder. As a result, the estimated temperature distributions during heating almost agree with those measured by an infrared radiation camera. In addition, the influence of the rotating speed of the cylinder on the error in ultrasonically estimated surface temperatures is examined.

**S6B: Signal Analysis**
Chair: David Frakes (Arizona State University, USA)

**10:40 Circularly Moving Sensor for Use of Modulation Effect**

*Masako Kishida (University of Canterbury, New Zealand); Yusuke Hioka (University of Canterbury, New Zealand)*

A novel sensing architecture with a single sensor that allows estimation of the Direction Of Arrival (DOA) of a signal is proposed. The key idea is to move the sensor in a circular path to cause a phase modulation in the signal so that the observed signal has the DOA information in its message. The DOA can be estimated by demodulating the observed signal. The paper shows that the proposed method theoretically derives the DOA in an analytical form with continuous sampling. Simulation results of a more realistic discrete-time procedure illustrate the proposed architecture is able to provide a valid estimation from a sinusoidal signal with additive noise.

**10:58 Scale Factor in MEMS Gyroscopes - The Effect of Power Supply Voltage**

*Martin Vágner (Brno University of Technology, Czech Republic); Petr Beneš (Brno University of Technology & FEEC, Czech Republic)*
This paper discusses the behavior of MEMS gyroscopes during power supply fluctuations, which is a problem that has not been sufficiently analyzed to date. The focus is placed on the scale factor. In the opening section, the authors present the basic output configurations of the MEMS gyroscopes and propose their general models. The following part of the article has a practical character. Here, eight types of the above-defined gyroscopes are examined to demonstrate the influence of the applied supply voltage. Firstly, the measurement procedure is described, and subsequently the results of this experiment are presented. The outcome of the performed research consists in that the scale factor error is smaller than 1% if the power supply voltage fluctuates within the range of ±0.25 V around the nominal value.

11:16 Noise Analysis of a Capacitor-to-Voltage Converter With a Zoom-in Technique

Stoyan Nihtianov (Technical University - Delft, The Netherlands); Ali Heidary (Guilan University, Iran); Reza Taherkhani (Iran University of Science and Technology, Iran)

We report the noise analysis of a capacitor to voltage converter (CVC) with a zoom-in concept, used as a first stage in capacitive sensor interfaces for measuring very small capacitance variations. We will show that the zoom-in concept introduced in the first stage can not only relax the resolution requirement of the following stages, i.e. an analog-to-digital converter (ADC), but it can also increase the resolution of the capacitor to voltage converter itself. It will be also proven that, for a given measurement time, the resolution of the input stage of the CVC is independent of the load capacitor. This is true both with and without zoom-in technique. This finding can make the design of the complete system more flexible. We will show that such a system is very efficient for high resolution displacement measurement, based on a capacitive sensor system.

11:34 Wave Intensity Estimation Over Broad Wavelengths Based On Diffused Sensing
Kenta Niwa (NTT Media Intelligence Laboratories, Japan); Yusuke Hioka (University of Canterbury, New Zealand); Kazunori Kobayashi (NTT Media Intelligence Laboratories, Japan)

A novel sensing technique called diffused sensing which exploits homogeneous and isotropically reflected waves is applied for estimating wave intensity. By analyzing the observed signals with a sensor array, the intensity of the wave arriving from each source is estimated. However, it is difficult to estimate the wave intensity from a mixture of waves of various wavelengths. With diffused sensing, observation of waves is devised to decorrelate the transfer function between a sensor and the wave source to that of another sensor; this improves the performances of sensor arrays to distinguish multiple different waves. Numerical simulations showed that diffused sensing can facilitate estimation of the distribution of the wave intensity whose wavelength stretches over a broad range.

11:52 A Novel Signal Reconstruction Strategy of Multifunctional Self-validating Sensor

Qi Wang (Harbin Institute of Technology, P.R. China); Shen Zhengguang (Harbin Institute of Technology, P.R. China); Kai Song (Harbin Institute of Technology, P.R. China); Fengyu Zhu (Harbin Institute of Technology, P.R. China)

Aiming at the desired status self-validation of traditional multifunctional sensor, a novel multifunctional self-validating sensor functional model is employed to improve the measurement reliability. Detailed self-validating functions which consist of faults detection, isolation and recovery, validated uncertainty estimation and health levels evaluation of sensors are presented, especially the proposed multivariable relevance vector machine (MVRVM)-based signal reconstruction emphasized in this paper. Being different from traditional single measured physical signal, MVRVM has expanded into simultaneous reconstruction of multiple physical variables with one sparser model. Compared with previous one output with single model, the computational burden of this paper is much lower, which benefits the
on-line status validation of sensors. The working principle of MVRVM is emphasized for multiple measured signals reconstruction, which is very suitable for the final validated measurement values of multiple measured components. A real experimental system of multifunctional self-validating sensor was designed to produce the actual samples, and further verify the proposed methodology. Experimental results demonstrate that the proposed strategy could provide a good solution to the signal reconstruction of multifunctional self-validating sensors under both normal and off-normal situations.

S6C: Biosensors 3
Chair: Bryan Chin (Auburn University, USA)

10:40 Brain activity measurement in the occipital region of the head using a magneto-impedance sensor

Shingo Tajima (Nagoya University, Japan)

We have achieved pico-Tesla (10⁻⁸ Oe) resolution for micro magneto-impedance (MI) sensors by utilizing the ultra-low intrinsic noise of amorphous wire the pulse magneto-impedance effect. We previously reported a study on bio-magnetic measurement using a pico-Tesla resolution MI sensor without any magnetic shielding. In order to detect very weak magnetic fields such as bio-magnetic fields, we constructed an MI gradiometer to cancel out background uniform noise such as the geomagnetic field. In the present study, we measured brainwaves using an MI sensor, and the results showed that brain activity can be evaluated by the sensor. We compared our results with electroencephalogram (EEG) and magneto-encephalogram (MEG) data reported by previous studies, and considered the reliability of the data. The results suggest that the MI sensor is a convenient device for daily monitoring using MEG signals.

10:58 Using Wearable Near-field Radar Sensor for Non-contact Heartbeat Signal Detection

Hong-Dun Lin (Industrial Technology Research Institute, Taiwan)
Many of sensing techniques have been applied on basic physiological signal detection for clinical diagnosis and home healthcare. Most known maturely developed sensing methods (EEG/ECG/EMG/Temperature/BP etc. al.) replied on contact way to obtain desired physiological information for further data analysis. However, those methods might cause some inconvenient and uncomfortable problems, and not easy to be used for affective analysis in interactive performing. To improve this issue, a novel technology based on low power radar technology (Nanosecond Pulse Near-field Sensing, NPNS) with 300MHz radio-frequency was proposed to detect humans' pulse signal by the non-contact way for heartbeat signal extraction. In this paper, a NPNS based wearable sensor was also developed and applied on measuring the heartbeat signal from small artery at human head site. The proposed sensing technology is designed to continuously collect the humans' physiological signal, and validated in a preliminary experiment with ECG measurement. As a result, the accuracy of heart rate measurement can be over 95% with activity.

11:16 Higher throughput of optical detection of bacteria concentrated by negative dielectrophoresis

Ryoji Obara (Kyushu University, Japan); Ding Zhenhao (Kyushu University, Japan); Kenta Shinzato (Kyushu University, Japan); Michihiko Nakano (Kyushu University, Japan); Junya Suehiro (Kyushu University, Japan)

The authors have proposed a new method to concentrate bacteria flowing in a microchannel by using negative dielectrophoretic force generated by using a thin dielectric layer. In this study, it was demonstrated application of the bacteria concentration to improve throughput of optical detection of bacteria in microchannel.

11:34 Wirelessly Powered Microfluidic Sensor and Actuator Systems
Microfluidic systems, which handle fluids in very small quantities, are becoming increasingly popular in bio-medical applications. This research aims to develop a wireless power supply module which can drive microfluidic sensor and actuator systems using inductive power transfer (IPT) with super capacitor storage. The main challenge is to source a variety of microvalves which have different power requirements ranging from micro-watts to couple of watts. An IPT solution is proposed where the primary side is external to the microfluidic system while the secondary coil will be housed within the microvalve, which is very challenging as miniaturization is vital. Supercapacitors are used as a backup to source high power requirements of the system.

11:52 Apnea Sensing Using Photoplethysmography

Gaurav Gaurav (IIT Madras, India); Mohanasankar Sivaprakasam (IIT Madras, India); Jagadeesh Kumar V (Indian Institute of Technology Madras, India)

Apnea is a very common phenomenon. While in adults apnea may just disturb the sleep, for neonates apnea can be life threatening. This paper describes a technique of detecting apnea using photoplethysmography (PPG). The proposed technique is easily applicable for monitoring neonates on a long-term basis for apnea detection since PPG is a non invasive technique. In the proposed method, the respiratory signal that is inscribed in a typical PPG is extracted using wavelet decomposition. The onset of apnea is then detected using the power spectrum of the extracted respiratory signal. The apnea detection algorithm was tested on 16 subjects and the maximum time taken for detection of onset of apnea is found to be less than 10 s (except for an outlier of 15 s), which is clinically acceptable.
Farming is a major industry in New Zealand and the welfare of the farmed animals should be of high importance. A system is required to estimate the pain felt by animals in various procedures such as docking and castration. To do this the system will be used in research to identify the applied force levels which cause pain. It can also be used to estimate the effectiveness of pain control drugs for animals and establish required doses. This paper presents a new pain sensing system based on the use of stepping motor for applying force and flexiforce sensor for measuring the applied force. The new sensing system is successfully built and tested.

In this paper, we propose a triple-axis MEMS-based thermal accelerometer and analyze its sensitivity and response. Thermal accelerometers detect acceleration by measuring the deflection of a heat plume in a microchamber. Usually, the heat plume is created by a heater on the top of a microcavity. By the use of computational fluid dynamics, the measurement ability of the sensor was analyzed for different positions of the heater. The results showed that the conventional designs where the heater located at the cavity center could measure only two components of acceleration vector, since the large cross-sensitivity between vertical and horizontal measurements cannot be avoided. In contrast, in our novel design, the heater formed a wide loop rounding the cavity center so that the mutual effects of these measurements were significantly reduced. For instance, the cross sensitivities were less than 5% for acceleration up to 10g.
applied to any directions. Furthermore, with the new position of the heater a frequency bandwidth at 3 dB of 70 Hz was obtained with applying a sinusoidal acceleration.

11:16 Reducing the Probe Ball Diameters of 3D Silicon-Based Microprobes for Dimensional Metrology

Nelson Ferreira (Technische Universität Braunschweig & Institut für Mikrotechnik, Germany); Alexander Brennecke (Technische Universität Braunschweig, Germany); Thomas Krah (Physikalisch-Technische Bundesanstalt, Germany); David Metz (Technische Universität Braunschweig, Germany); Karin Kniel (Physikalisch-Technische Bundesanstalt, Germany); Frank Härtig (Physikalisch-Technische Bundesanstalt, Germany); Andreas Dietzel (Technische Universität Braunschweig, Germany); Stephanus Büttgenbach (Technische Universität Braunschweig, Germany)

Micro probing systems based on silicon force sensors allow accurate force and displacement measurements in the range of several μN or μm. Due to the high sensitive diffused piezoresistors and an appropriate electrical circuitry, these probing systems enable tactile measurement without leaving scratches on the probed surfaces. To probe microstructures on workpieces, probes with probe balls as small as possible are sought. Mostly, commercial microprobes have probe balls with diameters of 120 µm or larger. In this work, microprobes with probe ball diameters down to 50 µm are presented and characterized in detail. In order to verify the performance of these new microprobes, measurements have been carried out to characterize both their mechanical behavior and their sensitivity. These properties have been extensively analyzed for different sensor designs and probe ball diameters. For instance, microprobes with probe ball diameters of 50 µm have a stiffness of about 0.637 mN/µm in X-Y and about 20.023 mN/µm in Z directions of the probe. The sensitivity amounts to 1.174 mV/V/µm and 20.478 mV/V/µm in X-Y and Z directions, respectively. The results presented encourage a new generation of microprobes to be used in dimensional metrology.
11:34 **An experimental study of the fluids mechanism and effects of liquid for capacitive pressure sensor**

**Mohd Norzaidi Mat Nawi (Universiti Sains Malaysia & Underwater Robotic Research Group, Malaysia); Asrulnizam Abd Manaf (Universiti Sains Malaysia, Malaysia); Mohd Rizal Arshad (Universiti Sains Malaysia, Malaysia); Mohamad Faizal Abd Rahman (Universiti Sains Malaysia & Universiti Teknologi Mara Malaysia, Malaysia)**

This paper demonstrate the experiment for the capacitive pressure sensor for the fluid mechanism and effects of liquid to the sensor performance. We proposed the sensor using one side electrode with implementation electrical double layer capacitor. The sensor consists of membrane and microchannel where it is fabricated using PDMS material. This sensor was able to measure the pressure below than 7 kPa. When the pressure was applied to the membrane, it gives the deflection and liquid inside microchannel will moved oppose the membrane. The liquid movement gives the capacitance change to the sensor where it depends on the types of liquid used. The comparison was made between the experiments and analytical for the liquid displacement inside microchannel. In order to study the effect of liquid to the capacitance change, the methanol, ethanol and silicon oil were chosen. When related to the capacitance, the important factor is for liquid is dielectric constant. It is proved that the methanol which is has a higher dielectric give high performance compare to the ethanol and silicon oil. Given the sensor sensitivity for the methanol and ethanol are 0.98 pF/kPa and 0.55 pF/kPa, respectively.

11:52 **Magnetic tactile sensing method with Hall element for artificial finger**

**Jun-ichiro Yuji (Kumamoto National College of Technology, Japan)**

This paper describes a magnetic tactile sensor with Indium antimonide (InSb) Hall elements for multifunctional sensing devices to detect the normal contact force and the temperature. This sensor consists of two Hall elements and a magnet that are embedded in a silicone rubber.
The temperature characteristic of InSb Hall elements depends on the bias circuit to generate the Hall voltage. Two output Hall voltages driven by two kinds of bias circuits were measured in the normal contact force range from 0 to 50N, the temperature range from -10 to 50℃. The inverse response surface to identify the normal contact force and the temperature was formulated using the experimental results. It was possible to detect the contact force and the temperature by obtaining two kinds of Hall voltages.

12:10 - 14:00
S7: Combined Lunch and Short Oral 1
Chairs: Michael J. Haji-Sheikh (Northern Illinois University, USA), Ian G Platt (Lincoln Ventures Ltd, New Zealand)

An add-drop ring resonator interferometer sensor with high sensitivity

Yun Dong Zhang (Harbin Institute of Technology, P.R. China); Xiaoqi Liu (Harbin Institute of Technology, P.R. China); Kaiyang Wang (Harbin Institute of Technology, P.R. China); Xuenan Zhang (Harbin Institute of Technology, P.R. China)

We propose an add-drop ring resonator interferometer with high sensitivity. We theoretically demonstrate this add-drop ring resonator configuration with a compact size enables the simultaneously producing fast light and slow light. We also theoretically calculate the sensitivity of the add-drop ring resonator interferometer as a sensing system. The sensitivity of our configuration can achieve , which is enhanced by compared to that of the traditional single-bus ring (SBR) resonator which is . This proposed structure enables highly sensitive, compact and stable sensors.

RF Capacitive Piezoelectric Displacement Extraction

Mahmoud Alahmad (UAEU, UAE)

The piezoelectric materials exhibit strong interaction between their mechanical and electrical properties that could be translates into
innovative components and architectures. This paper reports for the extraction of a piezoelectric thin film displacement when subject to voltage stress using interdigitated capacitance measurements. An interdigital structure incorporating 0.75 µm thin film lead zirconate titanate has been constructed. With bias applied between the fingers, the spacing between them will expand, therefore reducing the total capacitance. Both capacitor theory and piezoelectric material analysis are used to extract the film displacement from the measured capacitance variation.

Glucose Detection Using an Electro-Optical Fluidic Device Based on Pulse Width Modulation

Jing-Yau Tang (National Cheng Kung University, Taiwan); Ming-Kun Chen (National Cheng Kung University, Taiwan); Min Haw Wang (Chinese Culture University, Taiwan); Ling-Sheng Jang (National Cheng Kung University, Taiwan)

This paper presents a near-infrared (NIR) electro-optical fluidic device with pulse width modulation (PWM) for flow injection glucose analysis. The device contains two emitter light emitting-diodes (LEDs), two photodiodes, and a poly (methyl methacrylate (PMMA) micro-fluidic. The pulsed LEDs have wavelengths of 1450 nm and 1650 nm (in the NIR spectrum range). Five concentrations of glucose solution can be detected by the proposed device. The LED was pulsed of different PWM and pulse frequency affect the amount of light received light voltage response for glucose detection. The optical fluid device is a cost-effective, simple structure without fibers and lenses for various glucose detection applications.

Recent evolution of smart force transducers -

Dan Mihai Stefanescu (Romanian Measurement Society, Romania)

The paper presents measurement principles, technological aspects and typical performances of several types of smart force transducers (vibrating wire, resistive and optical), as well as integrating a classical
strain gauge force transducer into a medical application using virtual instrumentation.

Detection of Snail Tracks on Photovoltaic Modules using a Combination of Raman and Fluorescence Spectroscopy

Martin De Biasio (Carinthian Tech Research AG, Austria); Raimund Leitner (CTR AG, Austria); Christina Hirschl (Carinthian Tech Research AG, Austria)

Snail tracks are discolorations of the silver fingers on solar cells. We present a measurement system that can detect snail tracks. Their origin is unknown, but they are thought to be linked to micro cracks in the solar cell. Regions with micro cracks on a photovoltaic module were identified using electroluminescence measurements. Based on the electroluminescence data the faulty regions were mapped with a system that uses a combination of Raman and fluorescence spectroscopy. Our results show that our measurement system is a powerful tool for detecting snail tracks.

MobiDriveScore - A System for Mobile Sensor Based Driving Analysis

Chirabrata Bhaumik (Tata Consultancy Services & TCS Innovation Labs, India); Tapas Chakravarty (Tata Consultancy Services, India); Avik Ghose (Tata Consultancy Services, India); Arijit Chowdhury (Tata Consultancy Services, India)

Assessment of driving behavior and estimation of risk therein is an important use case for telematics and vehicular networking technology domain, which has gained interest in the fleet management and consumer verticals, but above all with the car insurance firms. These firms have started incorporating the results of such analysis to provide their customers with "pay as you drive" insurance plans, which decide the initial premium based on the driver's past history of crashes and violations. Then the parties enter into an evaluation period of about two months (say), at the end of which premium is recalculated based on analysis of accelerometer, GPS and on-board diagnostic (OBD II)
data. However, the consumer has no way of knowing how the evaluation is going due to lack of access to insurance device data. One major criterion of such evaluation is based on the detection and aggregation of high-risk maneuvers by the driver, which typically constitutes of hard bump, sharp cornering, hard stop and speed limit violations. In this paper we propose MobiDriveScore, a novel method for routine ventures using which the consumer can assess his/her own driving pattern. Thus the consumer can consciously reduce the risk associated with his/her driving by using MobiDriveScore. For MobiDriveScore, detection of maneuvers is done using accelerometer and GPS sensors only, which are integral part of modern day smartphones. MobiDriveScore captures sensor signals and detects events with a confidence score. The scores are then aggregated either locally (short term) or on a server (long term) to provide risk indexes for a driver. For such classification of driving pattern, MobiDriveScore supplies a "severity" index to each maneuver. Subsequently the anomalous region is deciphered using histogram plots. The aggregated anomaly for each trip is normalized with respect to severity index and a risk score is calculated. Detailed analysis of each trip is provided, which will help the driver to conclude whether the risk is due to bad road conditions or rogue traffic. Thus using MobiDriveScore, the user can choose an alternate route or choose to travel a little early to improve upon the premium rates and stay safe. It will also help aggressive drivers to become more passive. Experiments have been conducted and the initial results of MobiDriveScore are found to be encouraging.

**Compressed Sensing for Wireless Pulse Wave Signal Acquisition**

Kan Luo (Southeast University, P.R. China); Jianfeng Wu (Southeast University, P.R. China); Jianqing Li (Southeast University, P.R. China); Hua Yang (Southeast University, P.R. China); Zhipeng Cai (Southeast University, P.R. China)

Wireless-enable pulse wave (PW) biosensor is generally used for pervasive and non-invasive health care monitoring. However, the energy efficiency of the present devices still needs to be improved due
to the high energy consumption during wireless communication. In this paper, a compressed sensing (CS) scheme for wireless PW signal acquisition is proposed. With the CS-based scheme, airtime over energy-hungry wireless links can be reduced and energy efficiency of the wireless biosensor can be improved. PW signal is sparse under the discrete cosine transform (DCT) basis. Therefore, the CS-based scheme can efficiently compress and recover the signal by the 1-bit sparse quasi-Toeplitz measurement matrix and the basis pursuit de-noising (BPDN) model. The efficiency improvement of node was evidenced by the practical experiments on a MICAz node. By using the proposed scheme, the average percentage root-mean-square difference (PRD) of 4.23%, energy saving of 35.15% and node prolonging of 54.20% can be achieved.

Measurement of Wireless Power Transfer

Andi Sudjana Putra (National University of Singapore, Singapore); Sriharsha Bhat (National University of Singapore & National University of Singapore, Singapore); Vinithra Raveendran (National University of Singapore, Singapore)

Wireless power transfer offers the potential to redefine the usage of electricity. The advancement of near field magnetic resonance technology makes wireless power transfer viable nowadays. This paper presents our current development of wireless power transfer technology and focuses on the power measurement aspect of such technology. The continuous nature of the wireless power transfer requires certain arrangement of measurement, which will be discussed in this paper. We have applied this technology in a model for the future transportation application.

Develop a reading tracking function on e-book reading system by using sensing and cloudized storage technologies

Chia-Hung Lai (National Cheng Kung University, Taiwan); Lu-Chun Pan (National Cheng Kung University, Taiwan); Chia-Cheng Hsu (National Cheng Kung University, Taiwan); Yen-Ning Su (National Cheng Kung University, Taiwan);
Reading is an important task to enrich students' knowledge and to enhance students' ability and skills of learning and thinking. Moreover, reading is the well-known brain exercise which helps the brain to improve concentration, promotes empathy, and helps the brain to effectively construct links between neurons. If a person can often keep reading habits, reading is the best exercise to prevent loss of cognitive function in old age. With the advanced development of the Internet and the popularity of electron carriers, electronic books (e-books) have been as computer-aided tools to help students learn in the classroom teaching activities. Sensing and clouding storage technologies are used as tools to assist teachers in teaching students to understand the learning status and learning achievement. In general, reading mainly is divided into two phases, learning to read, and reading to learn. In order to understand the learning status of students, teachers observe the learning behavior of students and analyze their learning ability and skills to adjust the teaching strategies and teaching progresses for adaptive learning in classrooms. In order to help teachers effectively observe students' learning, this study proposed a cloudized e-book reading rate tracking system (CERRTS) with an e-book learning environment and the proposed system includes the sensing technology of touch screen and the cloudized technology of storage. In order to verify the function of the proposed system, the study used a camera to record the learning status of students and to compare the reading rate of the system records and the reading rate of the camera recording. The results show that there is not significantly different between the system and the video. Moreover, the proposed system provided a friendly computer-assisted tool that helps instructors understand the learning status of students.
Antonio J López-Martín (Public University of Navarra, Spain); Alfonso Carlosena (Public University of Navarra, Spain)

An overview of the field of contactless potentiometers in the automotive sector is presented. First, the main automotive systems that require the use of these devices are described. Then, the different sensors that can be employed to implement them are reviewed. Finally, a contactless potentiometer developed by the authors for automotive applications is described as a case study. It is based on a GMR Wheatstone bridge, is digitally configurable, and achieves maximum errors within +/-0.5% in an angular range of more than 100º.

Coupled add-drop ring resonator for highly sensitive sensing

Yun Dong Zhang (Harbin Institute of Technology, P.R. China); Xiaoqi Liu (Harbin Institute of Technology, P.R. China); Xuanan Zhang (Harbin Institute of Technology, P.R. China); Ping Yuan (Harbin Institute of Technology, P.R. China)

We propose a coupled add-drop ring resonator configuration for highly sensitive sensing. We theoretically examine the asymmetric Fano lineshapes of the two output ports of the proposed structure. The sharpness and the asymmetricity of the Fano resonance are linked to the high sensitivity. We theoretically calculate the sensitivity of the proposed coupled add-drop ring resonator as a sensor. The sensitivities of the two ports of our configuration can achieve (drop port) and (through port) respectively. The performance of the proposed structure is enhanced by almost 20 times than that of the single ring resonator based add-drop interferometer by introducing the upper ring resonator. This proposed configuration enables highly sensitive, compact and stable sensors.

Temperature resilient measurement of refractive index for liquids

Vijaya Kumar Narayanan (Government Engineering College, Thiruvananthapuram, India)
The measurement of refractive index of liquids is of great importance as it is its prime optical property. There are several methods of refractive index measurement for liquids. But the accuracy of measurement is influenced by temperature fluctuations. In this paper, a method is proposed for the implementation of an accurate, portable and temperature resilient, fiber based refractometer for liquids. The analog front end of the refractometer alone is a cost effective adulteration detector. It can be calibrated to measure the amount of adulteration or absolute refractive index of liquids. The temperature resilience in measurement is achieved using an instrumentation amplifier with high Common Mode Rejection Ratio (CMRR). This refractometer is implemented both using glass and plastic fibers.

**Detection of norovirus and rotavirus by dielectrophoretic impedance measurement**

Michihiko Nakano (Kyushu University, Japan); Ryoji Obara (Kyushu University, Japan); Ding Zhenhao (Kyushu University, Japan); Junya Suehiro (Kyushu University, Japan)

Aim of this paper is to demonstrate virus detection by dielectrophoretic impedance measurement (DEPIM). DEPIM consists of two processes of dielectrophoretic trapping of target particles and measuring impedance change with increasing the number of trapped particles. DEPIM has been used to detect bacteria suspended in aqueous solution. In this study, norovirus and rotavirus, which cause gastroenteritis in human, were used as the target viruses. As the results, 50 ng/ml of norovirus and 10 ng/ml of rotavirus were detected within 100 s.

**Direct Integration of Field Effect Transistors as Electro Mechanical Transducer for Stress**

Sven Haas (Chemnitz University of Technology & Center for Microtechnologies, Germany); Michael Schramm (TU Chemnitz, Germany); Danny Reuter (Chemnitz University of Technology, Germany); Kay-Uwe Loebel (TU Chemnitz, Germany); Andreas Bertz
The detection of motion with an active electrical device like a transistor allows to shrink the transducer to a few micrometers and to integrate them into a CMOS-process. A promising method for that is using the piezoresistive effect in the channel of a transistor. We have investigated the fundamental behavior of strain sensitive transistors with respect to different transistor parameters. Therefore the transistors have been simulated by using a modified BSIM3.3 model. The simulations showed an increase of the drain current between 3.5 % and 5.8 % for a 60 MPa stress and an acceptable shift of threshold voltage and almost no increase of leakage current. For metrological characterization pressure sensitive silicon membranes have been fabricated as strain inducing elements. First measurements with elongated membranes confirmed the simulation results.

**Sensing and actuating applications of potassium sodium niobate**

Asha Dahiya (University of Delhi & NSIT, India); Om Thakur (NSIT, Delhi University & Faculty of Technology, India)

Many ceramics have been studied due to their importance in the fabrication of multilayer ceramic capacitors and actuators. Potassium Sodium Niobate (K0.5Na0.5NbO3) is one of the most promising candidate of lead free piezoelectric ceramics used in sensors and actuators. K0.5Na0.5NbO3 (KNN) was successfully synthesized by solid state reaction method. X-ray diffraction studies (XRD) confirmed the single phase structure. Capacitance of the sample sintered at 11000C as a function of temperature and frequency was measured. The variation of electrically induced strain with the applied electric field has also been studied.

**Graphene pattern by gravure printing for wireless strain sensor**

Lei Huang (Shanghai Normal University, P.R. China)
The paper shows the gravure printing technology is used as deposition method to pattern a graphene film on flexible polyimide substrates for a wireless strain sensor (WSS). According to the inductive coupling between the reader antenna and the graphene pattern (GP), a change in the GP characteristic can be detected wirelessly by a corresponding change in the complex impedance of the reader antenna. The WSS overcomes the inadequacy of the existing conventional sensors limited monitoring locations. And the WSS also exhibits a high sensitivity of 51% under a load of 100 N.

CHLAC based Vision Sensing Method for Bicycle Rider Detection to Avoid Confusing Similar Shape Pedestrian

Yuki Ishii (Tokyo University of Science, Japan); Hiroshi Hisahara (Tokyo University of Science, Japan); Masahito Ota (Tokyo University of Science, Japan); Takeki Ogitsu (Tokyo University of Science, Japan); Hiroshi Takemura (Noda Tus, Japan); Hiroshi Mizoguchi (Tokyo University of Science, Japan)

This paper proposes robust bicycle rider detection method from video sequence. The proposed method does not confuse rider with similar shape pedestrian such as bicycle pusher. There are a large number of accidents happened while riding a bicycle. To prevent these accidents, bicycle rider detector is required for traffic monitoring camera system. Thus, many researches have been done in this filed. However, previous works make no mention of discriminating bicycle rider from pusher, to say nothing of bicycle rider detection. In order to realize the detection method to avoid confusing such similar shape pedestrian, the authors utilize CHLAC (Cubic Higher-order Local Auto-Correlation). The proposed method can detect human automatically and also recognize bicycle rider. In an experiment using video sequence, bicycle rider detection rate can be achieved 80.23%. Experimental results prove effectiveness of the proposed method.

Quantum Tunneling Composite (QTC) based tactile sensor array for dynamic pressure distribution measurement

81
Asitha L. Kulasekera (University of Moratuwa, Sri Lanka); Ranjith Amarasinghe (University of Moratuwa, Sri Lanka); Peshala Priyadarshana (University of Moratuwa, Sri Lanka)

This paper presents the design and simulation of a quantum tunneling composite (QTC) based tactile sensor array for use in pressure distribution measurement. QTC exhibits a rapid reduction in resistance with applied force making it suited for use in force sensing applications. Properties of QTC are exploited to design a tactile sensor array capable of measuring a dynamic pressure distribution over the sensor area. QTC acts a complete conductor after a certain stage reducing its effectiveness as a force sensor beyond that stage. QTC also takes considerable time to return to its original state after deformation due to force. These drawbacks found in QTC, limits its use to only that of a simple low cost switch. The proposed design for the tactile sensor array overcomes these drawbacks found in QTC material by incorporating a novel sensor array structure which enables an extended range of operation and allows rapid return to its unloaded state. This design allows for the use of QTC as a simple, cheap force sensor. The design can be further optimized to match the characteristics of the proposed sensor with the force range of a given application. A collection of such tactile elements is used to create a dynamic force sensing array. The design and simulation of the sensor array structure is described. This sensor array can be connected via a data acquisition system to a computer, which converts the data into a color contour map using LabView and MATLAB to measure and display the force distribution in real-time.

**Low Temperature Low ppm Acetone Detection by Pd/TiO2/p-Si Metal-Insulator-Semiconductor Devices**

Arnab Hazra (Bengal Engineering and Science University, India); Basanta Bhowmik (Bengal Engineering and Science University, India); Koushik Dutta (Bengal Engineering and Science University, India); Partha Bhattacharyya (Bengal Engineering and Science University, Shibpur, India)
In this present investigation nanocrystalline TiO2 based sensor was developed for low ppm level (10-100) acetone detection. TiO2 thin film (Thickness: 1 µm) was prepared by sol-gel technique and deposited on the p-Si substrate (5 Ωcm, (100)) by dip coating method. Film was annealed at 450ºC for 3 hours in air environment. XRD and FESEM study confirmed the (101) anatase growth with ~6-9 nm particle size. Pd electrode was deposited on the TiO2 sensing layer to prepare the Pd/TiO2/p-Si Metal-Insulator-Semiconductor (MIS) device structure. A detailed acetone sensor study was performed for this MIS device in the temperature range of 100 to 200ºC. Sensor showed a repeatable sensing performance with a appreciably fast response time of 7.7 s at 100ºC towards 10 ppm acetone with corresponding recovery of 13 s at 200ºC in 10 ppm acetone. Response magnitude was increased from 3.2% to 6.4% with increasing the acetone concentration from 10 to 100 ppm at 200ºC.

**Feedback Control of Outer Rotor Spherical Actuator Using Adaptive Neuro-Fuzzy Inference System**

*Junghyun Chu (Osaka University, Japan); Noboru Niguchi (Osaka University, Japan); Katsuhiro Hirata (Graduate School of Engineering, Osaka University, Japan)*

Importance of actuators increased in the field of automatic devices and a number of related researches are proceeding currently. Many researchers are studying multi-DOF mechanism actuators which focus on a simple structure, higher torque and precise control. Among these researches, spherical actuator structures can satisfy with requirements of multi-DOF mechanism. In order to achieve a high accuracy of the control performance, a number of control methods have been developed. In this paper, we propose a feedback control using adaptive neuro-fuzzy inference system (ANFIS) for an outer rotor spherical actuator. In order to verify the ANFIS, experiments using the outer rotor spherical actuator are implemented on dSPACE controller with MATLAB/Simulink.
**Common-path Heterodyne Interferometric and Magnetic Sensitivity-enhanced Surface Plasmon Resonance Carbon Monoxide gas sensor**

Kai-Pian Huang (Department of Mechatronics Engineering National Changhua University of Education, Taiwan); Shen Chih-Hsiung (National Changhua University of Education, Taiwan); Jing-Heng Chen (Feng Chia University, Taiwan)

Combining magnetic catalysis effect, surface plasmon resonance phenomena, and common-path heterodyne interferometry, a highly sensitive and highly stable carbon monoxide sensing technique was proposed in this paper. Magnetic catalysis material SnO2-Fe3O4 was prepared and was spin coated on the gold film of SPR prism. The SPR apparatus can provide a highly sensitive ability to carbon monoxide. Carbon monoxide gas at different concentrations was measured under different strengths of applied magnetic fields. The experimental results reveal that the system has a best resolution of 0.0507 ppm applied 24 Gauss magnetic field in normal direction. Due to the introduction of common-path heterodyne interferometer, the system is stable against environment vibrations.

**A Review of Sensor Technology for In-field Phosphate monitoring**

Sheetal Mapare (Massey University, New Zealand); Pak Yu (Massey University, New Zealand); Abhimanyu Sarkar (AgResearch, Grasslands Research Centre, New Zealand); Subhas Mukhopadhyay (Massey University, New Zealand)

With the increasing awareness of fertilizer effects on environmental and soil quality, soil tests are being conducted. In-field phosphate sensors have been a topic of research since the early 1980s. It provides a user friendly alternatives to more time consuming and costly laboratory analyses. Phosphate sensors can be used in agricultural and site-specific crop management to optimize application of fertilizers and minimize contamination of rainfall runoff. The main limitation in the development of phosphate sensors is selectivity.
Another drawback in the development of phosphate sensors is their repeated uses. Further research is needed to address these problems and make in-field phosphate sensors more widely available.

**Highly Sensitive Magnetic-Catalytic Gas Sensor**

Shen Chih-Hsiung (National Changhua University of Education, Taiwan); Shu-Jung Chen (National Changhua University of Education, Taiwan)

Magnetic-catalyzed SnO2 with Fe3O4 of CMOS MEMS gas sensor is proposed and it's based on the magnetic-catalytic sensing mechanism to increase sensitivity. Beyond the conventional power dissipation of heating to maintain a certain working temperature, a new approach for gas sensor with magnetic-catalytic mechanism works at the ambient temperature without the consideration of active heating. The design and fabrication is realized by the standard 0.35μm CMOS process to fabricate a gas sensor with mesh stacked electrodes. For the preparation of magnetic sensing material, a prepared solution of sol-gel SnO2 is mixed at SnO2:Fe3O4 = 3:1, which was deposited onto mesh stacked electrodes. When the CO gas sensor is introduced, the sample is tested and verified inside a CO gas chamber with a magnetic field generator of solenoid coil. We also build a magnetic-catalytic gas reaction behavior description based on Gibbs free energy and the Eyring equation. A careful investigation of measurement results, at horizontal magnetic field, the sensitivity of proposed CO gas sensor reaches 1.73%/ppm under the 12 Gauss which shows widely applicable for an ultra-low power chemical microsensor with high sensitivity.

**Design and Analysis of a GMR Eddy Current probe for NDT**

Rodrigo W Porto (UFRGS, Brazil); Valner Brusamarello (UFRGS, Brazil); Ricardo de Azambuja (Plymouth University, United Kingdom); Osmar Frison Jr. (UCS, Brazil)
Defect detection in metallic plates represents an important issue in metal industry, because its potential use in quality control process. Eddy current testing is one of the most extensively used nondestructive techniques for inspecting electrically conductive materials. The purpose of this paper is to present an eddy current testing system for surface defect detection in conducting materials using a giant magnetoresistive (GMR) sensor. A solenoid is used to produce an alternate magnetic field and generate eddy currents in the material under test. The GMR sensor was mounted inside the coil and the arrangement was adapted in the axis of a vertical machining center. In order to validating the measurement device, defects were induced by cracks machined in workpieces made of aluminum. Thus, the parts were scanned with the sensor prototype and a method to estimate the width and depth of the induced defects was proposed after analyzing the output voltage signal.

Error in mathematical modelling and enhancement of sensing performance of electrostrictive capacitive sensors

Om Thakur (NSIT, Delhi University & Faculty of Technology, India); Nidhi Agrawal (Netaji Subhas Institute of Technology, University of Delhi, India)

Dielectric material sandwiched between two electrodes in an electrostrictive capacitor sensor plays a very important role in performance of the sensor. The dielectric material to be selected is required to possess good electromechanical properties like high strain, high permittivity etc. Researchers have simplified the standard equation for calculation of electrically induced strain in dielectric material of the sensor. This paper analyzes the effect of this simplification of equation on six different materials. In case of one simplified equation, error has been found in the range of underestimation from 96% to 3273% and in case of other equation, range of error is from underestimation of 36% to overestimation of 1842%. For enhancing properties like permittivity of the dielectric material used in the sensor, nano fillers are incorporated into the dielectric material. In this paper study has been done on two filler
materials, TiO2 and ZnO and it is found that TiO2 filler increases permittivity more in comparison to ZnO for same level of concentration.

**Practicable Camera Modeling Technique Applying Fuzzy Modeling for 3D Sensing Based on Stereo Vision**

*Toshihiko Watanabe (Osaka Electro-Communication University, Japan); Yuichi Saito (DACS, Japan)*

Recently, the 3D sensing technique using multiple cameras has been applied to various areas such as visualization, motion capturing, and so on. However, improvement of the camera model calibration is indispensible for more precise measurement. In this study, we propose a practicable fuzzy modeling approach for 3D sensing utilizing the configuration of the stereo vision. A distance between a sensing target and the camera is used for structuring the fuzzy model for cameras considering optical projection characteristics. In our approach, the weighted least mean square error method is successfully applied considering fuzzy partition to formulate the fuzzy model. Then iterative calculations for solving the inverse problem of the camera fuzzy model are performed to attain measured coordinates. Through sensing experiments of stereo vision measurement based on the proposed approach, we showed the performance of the model was drastically improved compared with the conventional modeling approach.

**Sensors for Evaluation of Thermodynamical Model of pMA**

*Lukas Kopecny (Brno University of Technology, Czech Republic); Ludek Zalud (Brno University of Technology, Czech Republic)*

In this paper a mathematical model of Pneumatic Muscle Actuator (pMA) is developed and verified. The focus is put on thermodynamical behavior of pMA during charging and discharging process. Problems with selection of temperature sensor are discussed and evaluation of a mathematical model is done.
14:00 - 15:30
S8: Invited Session 2
Chair: Krishanthi Jayasundera, Massey University, New Zealand

14:00 – 14:30
Edge Mining: Making sense of sensor data
James Brusey, Coventry University, UK

14:30 – 15:00
A miniaturised silicon biosensor system for the detection of triglycerides and urea
Enakshi Bhattacharyya, Indian Institute of Technology Madras, India

15:00 – 15:30
Metal oxide nanostructures for gas sensing and optoelectronic applications
John Kennedy, GNS Science, New Zealand
15:50 - 17:20
S9A: Gas and Chemical Sensors 3
Chair: Veronica Sberveglieri, (University of Modena and Reggio Emilia, Italy) and Elena Gaura, (Coventry University, UK)

15:50 SERS from ZnO Nanorod Arrays and its Application for detecting N719

Wensheng Shi (Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, P.R. China)

The surface-enhanced Raman scattering (SERS) from ZnO nanorod arrays (ZnONRs) was investigated. It was found that the realization of the efficient photoinduced charge transfer between the ZnONRs and the attached probe molecules is a critical prerequisite for the SERS. The SERS of the dye (Bu4N)2[Ru(dcbpyH)2-(NCS)2] with 10-7 M concentration can be observed from the ZnO nanostructures.

16:08 Gas-Phase Biosensor with High Sensitive & Selective for Formaldehyde Vapor

Kohji Mitsubayashi (Tokyo Medical and Dental University, Japan)

An optical fiber gas-phase biosensor (bio-sniffer) for assessment of indoor formaldehyde was fabricated and tested. The bio-sniffer measures formaldehyde vapor as fluorescence of reduced nicotinamide adenine dinucleotide (NADH), which is the product of formaldehyde dehydrogenase (FALDH) reaction. Usually, an enzyme loses its specific activity in the gas phase. This makes biochemical gas monitoring difficult. We used a micro flow-cell with a FALDH immobilized membrane to prevent the FALDH from deactivation. An ultraviolet light emitting diode (UV-LED) with peak emission of 335nm was employed as an excitation light source. Emission of the UV-LED was introduced to the optode through an optical fiber and fluorescence of NADH was picked up coaxially at the optode. In order to improve the sensitivity, a photomultiplier tube was utilized as a photodetector. Consequently, continuous formaldehyde monitoring
with biochemical method was successfully conducted with high sensitivity and high selectivity. A real-sample test was also carried out with the bio-sniffer. According to the results, it is expected to be useful in fast and convenient monitoring of indoor formaldehyde.

16:26 **In2O3:Ga-based Ceramics: Advantages and Shortcoming for Application in One-electrode Gas Sensors**

Beongki Cho (Gwangju Institute of Science and Technology, Korea); Songhee Han (Mokpo National Maritime University, Korea)

The influence of doping by gallium (0-10 wt.%) on gas-sensing characteristics of In2O3-based gas sensors has been studied. In2O3-based ceramic was prepared by sol-gel technology. Ozone, CO, CH4 and H2 were used as tested gases. The addition of Ga into the In2O3 matrix was found to be effective in increasing sensor response to ozone and improvement of sensor response selectivity. It was assumed that this improvement was connected with optimization of In2O3 ceramics structure.

16:44 **ISFET with Built-in Gold Electrode and Readout Circuit with Frequency-Adjustable Pulse Output**

Ruey-Lue Wang (National Kaohsiung Normal University, Taiwan); Hsin-Hao Liao (National Chip Implementation Center, Taiwan); Hann-Huei Tsai (National Chip Implementation Center, Taiwan); Ying-Zong Juang (Chip Implementation Center, National Applied Research Laboratories, Taiwan); Chien-Cheng Fu (National Kaohsiung Normal University, Taiwan); Chi Yu (National Kaohsiung Normal University, Taiwan)

In this paper, an ISFET with a built-in gold reference electrode and an integrated readout circuit with frequency-adjustable pulse output is presented. The CMOS chip is based on the TSMC 0.35um process with post-process gold metallization. The sensing membrane is surrounded with two gold rings, which can be used as a reference electrode or an enzyme-immobilizing material for pH-value or
biomolecule-concentration detection. The ISFET is one of the input differential transistor pair of an operational amplifier in its readout circuit, which mainly consists of a voltage-to-current converter and a current-controlled oscillator. The output pulse frequency is linearly proportional to the effective gate voltage of the ISFET, which is immersed in the analyzed solution with a stably biasing reference electrode. A current-offset structure is added into the oscillator to shift the transfer characteristic line of the output frequency versus the effective input voltage, which usually varies due to process variation. The transfer characteristics of the pulse frequency versus pH value are measured by an external Ag/AgCl reference electrode and an on-chip gold reference electrode, respectively. The built-in gold reference electrode brings about a larger sensitivity. The measured output transfer characteristics show the sensitivity of more than 2kHz/pH with linearity of 99% at least.

17:02 **Electronic nose for the early detection of different types of indigenous mold contamination in green coffee**

Veronica Sberveglieri (University of Modena and Reggio Emilia, Italy); Elisabetta Comini (University of Brescia, Italy); Dario Zappa (University of Brescia, Italy); Estefania Nunez Carmona (University of Modena and Reggio Emilia, Italy); Andrea Pulvirenti (University of Modena and Reggio Emilia, Italy)

In the last few years Electronic Noses (ENs) has revealed like a very effective and fast tool for monitoring, of microbiological spoilage and food quality control. The European regulations talk about the maximum concentration of mycotoxins permitted in green coffee beans. The aim of this study was the essay of the ability of EN for the early detection of mold contaminations from Aspergillus spp., in cooperation with classical microbiological and chemical techniques like Gas Chromatography coupled with Mass Spectroscopy with SPME technique. In general the selection of the raw material is controlled by visual selection, shape color and size. Often this process in not enough to avoid the entrance in the food chains of contaminated products. EN is able to early detect the qualitative and
quantitative differences between contaminate an uncontaminated samples. The achieved results vividly recommend the use of EN like a quality control tool in industry laboratories.

**S9B: Novel Applications 2**

Chair: Joe-Air Jiang (National Taiwan University, Taiwan)

**15:50 Novel Application of Ultrasonic Sensors and Kinect Sensors to Identify People and Measure Their Location - Realization of "Human SUGOROKU", A Large Scale Board Game in which People Play as Pieces**

Tomohiro Nakayama (Tokyo University of Science, Japan); Takayuki Adachi (Tokyo University of Science, Japan); Takeki Ogitsu (Tokyo University of Science, Japan); Hiroshi Takemura (Noda Tus, Japan); Hiroshi Mizoguchi (Tokyo University of Science, Japan); Fusako Kusunoki (Tama Art University, Japan); Masanori Sugimoto (Hokkaido University, Japan); Etsuji Yamaguchi (Kobe University, Japan); Shigenori Inagaki (Kobe University, Japan); Yoshiaki Takeda (Kobe University, Japan)

The authors are developing a novel learning support system "Human SUGOROKU" by integration of ultrasonic sensors and Kinect sensors. The system is a relocatable large scale digital board game that human-players as its piece move on squares. To realize the system, we measure players locations and gestures identifying players, by integrating output information from both sensors. This paper explains overview of the system and proposes a method to reduce installation time. That length of installation time is one of the most serious problems when we relocate the system. Most part of the time is spent to unify sensors' coordinate systems. Usually, as each sensor has own coordinate system, we can't use sensors' output directly without unifying their coordinate systems. In order to unify sensors' coordinate systems, we need accurate positioning of the sensors, but accurate positioning manually is difficult and takes much time. The proposed method is a positioning-free convenient unifying method for different kinds of multiple sensors by using dedicated instrument. We conduct
an experiment to evaluate the proposed method, and confirm that the method can reduce installation time for the system.

16:08 Microfluidic-based Capacitive Sensor for Underwater Acoustic Application

Mohamad Faizal Abd Rahman (Universiti Sains Malaysia & Universiti Teknologi Mara Malaysia, Malaysia); Asrulnizam Abd Manaf (Universiti Sains Malaysia, Malaysia); Mohd Rizal Arshad (Universiti Sains Malaysia, Malaysia); Mohd Norzaidi Mat Nawi (Universiti Sains Malaysia & Underwater Robotic Research Group, Malaysia)

This work proposes a new concept of underwater acoustic capacitive sensor that operates based on the microfluidic mechanism. The main structures consist of a membrane, microchannel and coplanar detecting electrodes. The new sensor device is proposed to avoid the process complexity and facilities limitation during fabrication of the existing acoustic capacitive sensor meant for underwater application. The device is realised through a simple softlitography technique to produce the main detecting structure (membrane) and the detection region (microchannel). The final testing shows the ability of the device to detect an acoustic signal transmitted by an underwater projector at resonance frequency of 200 kHz. The linearity test of the coplanar electrodes configuration also yields the detection sensitivity of 0.021 pF/mm, operated at specific geometry. The result thus indicates that the proposed structure is able to become an alternative sensing device to the existing underwater acoustic sensor for low frequency underwater application.

16:26 Low Cost Contour Check of Loading Units using PMD Sensors

Christian Prasse (Fraunhofer Institute for Material Flow and Logistics, Germany); Jonas Stenzel (Fraunhofer Institute for Material Flow and Logistics, Germany); Bartholomäus Rudak (TU Dortmund, Germany); Frank Weichert (TU Dortmund, University of Technology, Germany); Heinrich Mueller (TU Dortmund, University of Technology, Germany);
Michael ten Hompel (TU Dortmund, University of Technology & Fraunhofer-Institut Materialflow and Logistics, Germany)

In this paper, a novel approach for the detection of parcel loading positions on a pallet is presented. This approach realizes a substantial change in comparison to traditional system design of contour detection in de-palletizing processes. Complex 3D-vision systems, costly laser scanners or throughput decreasing local sensor solutions integrated in grippers are substituted by a low-cost Photonic Mixing Device (PMD) camera. By combining PMD technology and a predetermined model of loading situations, stored during the assembly of the pallet, this approach can compensate for the drawbacks of each respective system. An essential part of the approach are computer-graphics methods specific to the given problem to both detect the deviation between the nominal and the actual loading position and if necessary an automated correction of the packaging scheme. From an economic point of view this approach can decrease the costs of mandatory contour checking in automated de-palletizing processes.

16:44 RFID assisted Flexible Manufacturing System

Dinesh Herath (University of Moratuwa, Sri Lanka); Sahan Vindika (University of Moratuwa, Sri Lanka); Chanuka Prasanna (University of Moratuwa, Sri Lanka); Ranjith Amarasinghe (University of Moratuwa, Sri Lanka); Dzung Viet Dao (Griffith School of Engineering, Australia); George Mann (Memorial University of Newfoundland, Canada)

A novel Flexible Manufacturing System (FMS) with customer-order based production is introduced using web-services technology and a real-time updatable inventory database to enhance operational efficiency of the manufacturing environment. The proposed FMS consists of intelligent control systems integrated with RFID technology, a smart conveyor system, robot arms and sorting mechanisms and a real-time updatable inventory database with application software. This study demonstrates the significance and benefits of a customer-order based production using smart conveyor
system with the integration of RFID technology for product identification and handling, specifically in the manufacturing industry.

17:02 Developing a low-cost general-purpose device for the Internet of Things

Adriana Wilde (University of Southampton, United Kingdom); Richard Oliver (University of Southampton, United Kingdom); Ed Zaluska (University of Southampton, United Kingdom)

The Internet of Things is the concept of Internet-enabling physical objects. This paper describes a device to allow an object to be Internet-enabled using wired-Ethernet, in a power-efficient and low-cost fashion. This paper discusses a port of the Contiki operating system for use with the LM3S6965 processor. We hereby demonstrate that it is possible to run the Contiki operating system on a modern, Ethernet-enabled microcontroller and that such a low-cost device is suitable for both further research and inclusion in consumer products.

S9C: Sensor Interfacing

Chairs: Adriana Wilde (University of Southampton, United Kingdom) and James Brusey (Coventry University, UK)

15:50 Multi-sensor Information Processing and Fusion Module

Jiebing Yan (Xi’an Jiaotong University, P.R. China); Xiaoxin Wang (Xi’an Jiaotong University, P.R. China); Hongli Hu (Xi’an Jiaotong University, P.R. China); Hongmei Wang (Xi’an Jiaotong University, P.R. China)

In order to satisfy the character of multi-sensor system which has a large amount of data and strict requirement of real time response, a module based on FPGA & DSP is designed for multi-sensor information processing and fusion after considering that FPGA (EP2C8T144C8N) has high-speed, complex logic control ability and floating-point DSP (TMS320C6713B) has high-speed, complex data...
processing capability. FPGA controls interface and timing of the sensor signal acquisition, pre-processes data and transfers the data to DSP in parallel, which can simplify the peripheral circuit and ensure the real-time performance of the system; Data processing is realized in DSP, and DSP is used as main control chip to manage the system operation and communicate with the host computer. The system combines the best advantages of FPGA and DSP, and its structure is suitable for modular design and has strong versatility. Finally the system is applied to solid phase concentration measurement of the multiphase flow. The experimental results show that the method has great advantages over traditional methods in computing precision and speed.

**16:08 A Resistive Potentiometric Type Transducer with Contactless Slide**

*Supriya V Thathachary (Indian Institute of Technology, Madras, India); Boby George (Indian Institute of Technology Madras, India); Jagadeesh Kumar V (Indian Institute of Technology Madras, India)*

Though conventional potentiometric type resistive transducers are simple to construct and use, they are not popular owing only to the fact that a sliding contact needs to be employed. In this paper, a potentiometric type resistive displacement transducer that uses a contact-less slide is presented. A dedicated signal conditioning circuit proposed here operates on the output of a slide that moves, without having a physical contact, on the resistive element and provides an output voltage directly proportional to the quantity being sensed (displacement or velocity). Since the output of the circuit is dependent only on a dc reference voltage and the measurand, an acceptable level of accuracy can be obtained with ease. Results of simulation studies and experimentation establish the efficacy of the proposed scheme.

**16:26 Energy-Efficient Inertial Sensor Fusion on Heterogeneous FPGA-Fabric / RISC System on Chip**
Energy efficiency is a major design goal for mobile and wearable devices. These kind of devices most often comprise System-on-Chip processor cores and further custom hardware accelerators. A novel heterogeneous hardware architecture introduced by Xilinx and Altera consists of a programmable FPGA like structure and a common RISC processor core. For system designers this commercial architecture enables enhanced flexibility in partitioning of algorithmic tasks. The hardware demonstrator for auditory feedback of movements (sonification) captured by multiple inertial measurement units proposed in this paper bases on a heterogeneous Xilinx Zynq System on Chip processing core and a custom hardware accelerator. Energy efficiency is enhanced by utilizing the hardware accelerator for orientation estimation based on a Kalman filter algorithm. The evaluation furthermore explores the usability of High Level Synthesis tools based on a fixed-point software implementation. Moreover, the area and power consumption of a later hardware accelerator ASIC implementation based on a 40 nm TSMC library.

16:44 A Simple Signal Conditioning Scheme for Inductive Sensors

Piyush Kumar (Indian Institute of Technology Madras, India); Boby George (Indian Institute of Technology Madras, India); Jagadeesh Kumar V (Indian Institute of Technology Madras, India)

Signal conditioning of inductive sensors so as to obtain an output proportional to just the change in the inductance alone is fraught with problems. The large value of self inductance that is present in a sensor coil and the change in the inductance being a small fraction of this large inductance coupled with the winding resistance of the sensor coil make signal conditioning of such inductive sensors a challenge. This paper presents a simple analog front-end suitable for signal conditioning of inductive sensors. The proposed signal
A conditioning circuit provides an output linearly related to the change in inductance due to the measurand alone, masking the large value of self (offset) inductance present in inductive sensors as well as the appreciable winding resistance. A prototype of the proposed signal conditioning circuit was developed and tested in the laboratory. Test results validate the efficacy of the technique presented herein.

17:02 A Direct-Digital Converter for Resistive Sensor Elements in Bridge Configuration

Ramanathan Ponnalagu (IIT Madras, India); Boby George (Indian Institute of Technology Madras, India); Jagadeesh Kumar V (Indian Institute of Technology Madras, India)

A dual slope direct digital converter (DDC) suitable for resistive sensor elements already connected in the form of a Wheatstone bridge is presented here. The proposed DDC accepts the whole bridge as an integral part of a dual slope analog to digital converter and provides a digital value proportional to the input quantity being sensed by the four resistive sensing elements of the bridge. Simulation studies establish the efficacy of the proposed DDC. Maximum error observed in the simulation study was < 0.25 %. To demonstrate the practicability of the proposed DDC, experiments were conducted on a prototype DDC. The error in the output of the prototype was found to be < 0.5 %.

S9D: Healthcare Applications 1

Chair: Shubhajit Roy Chowdhury (Centre for VLSI and Embedded Systems Technology, IIIT Hyderabad, India)

15:50 Design and Development of a Feedback Mechanism and Approach for Patient-Instrument Stabilization during Office-based Medical Procedures

Kok Kiong Tan (National University of Singapore, Singapore); Wenyu Liang (National University of Singapore, Singapore); Tong-Heng Lee (National University of Singapore, Singapore); Chee Hoe Choy
This paper presents the design, development and application results of a feedback mechanism for general patient-instrument stabilization, though illustrated more specifically for an office-based ear procedure in the paper. It serves a twofold objective. First, it characterizes the head movement patterns in different positions with respect to space and time which serves as the specifications for an overall stabilization strategy and the design of a realistic head movement simulator. Secondly, it is used as a feedback mechanism to engage patients to jointly achieve patient-instrument stabilization while distracting them from the procedure on hand. At the core of the development is the iNEMO, an integrated IMU MEMS module, mounted on the patient's head. Signal processing and sensor fusion algorithms converts the transducer data into the roll, pitch and yaw of the head movements which are used for analysis and control purposes. With such a feedback mechanism, the experiment results show that patients can maintain a desired head orientation within a very tight threshold. Other applications of such a device and approach will be also highlighted in the paper.

16:08 Implementing Sensor-Actor Networks with the Elastic Network Model for Laparoscopic Training

Christopher C Chiu (University of Technology, Sydney, Australia); Zenon D Chaczko (University of Technology, Sydney & SoCC, Australia); Lulwah Alqarni (University of Technology, Sydney, Australia); Amna Almarwani (University of Technology Sydney, Australia)

Sensor-Actor Networks (SANETS) is adaptable for surgical simulation contexts, to illustrate how the Elastic Network Model can be used for laparoscopic end-effector navigation through vital organs and other obstacles. The active modeling of agents as interactive components of a unified laparoscopic simulator seeks to emulate the medical environment as a virtual representation in the coordinated SANET
16:26 Investigation of Bone Resonance during Femoral Reaming in Hip Replacement Surgery

Paul O Donoghue (Institute of Technology Tralee, Ireland); Bob Jackson (ITTralee, Ireland); Daniel Riordan (Institute of Technology, Tralee, Ireland); Joseph Walsh (Institute of Technology, Tralee, Ireland); Ali Abdulkarim (Kerry General Hospital, Ireland); John Rice (Kerry General Hospital, Ireland)

This paper documents current investigations which are attempting to find a suitable audio pattern to identify the moment when a prosthetic hip-joint replacement has been correctly inserted into the thigh bone. Research Questions: We have two objectives: firstly, is there any distinctive pattern of sound frequency or resonation associated with proper femoral rasping? Secondly, can we predict the point where fracture of the femur during the rasping process occurs using the analysis of the sound frequency changes? Initial research into this project has noted that by placing a bone conduction microphone close to the knee of the patient, the resonances of the thigh bone can be detected as the joint is reamed into place. A distinct increase in the pitch of the resonance can be noted as the joint reaches its correct position. It is proposed that by collecting and analysing a suitably large database of audio recordings of the rasping process, that a prediction model for when the joint is optimally reamed into position can be created. It must be noted that, as each femur will be of different size/density, each rasping process will yield different results. Therefore analysis will have to be undertaken to create a model which will prove reliable for all cases.

16:44 Thick Film Flow Sensor for Respirator Applications
A new approach to monitoring respiration activity for first responders is proposed. This approach emphasizes low cost and portability. Current commercial methods cost upwards of $100 and aren't reusable or portable. The design goal was to achieve a portable stand alone unit that measures and displays both breaths per minute as well as inhalation/exhalation using simple low cost commercial components. The prototype device is portable and battery operated as well as accurate. This approach has benefits in the field for emergency medical technicians as well as other medical professionals.

17:02 TailGait: A Light-Weight Wearable Gait Analysis System

Jirapong Manit (King Mongkut's University of Technology Thonburi, Thailand); Prakarnkiat Youngkong (King Mongkut's University of Technology Thonburi, Thailand)

Gait parameters such as step and stride lengths, step and stride times, and time spent in single and double support are important factors for physicians to diagnose and/or monitor patients. Tropically, assessing these spatial and temporal parameters accurately require an expensive equipment, which cannot be afforded by most general hospitals in developing countries. This paper presents a light-weight and easy-to-use gait analysing system called TailGait, which allows users to be able to measure these essential gait parameters. A concept of measuring the displacement of trunk as the stepping distance has been proposed, instead of using inertia measurement sensors which cannot avoid the integration error. TailGait has been compared with Computer Dyno Graphy (GDC), a commercial gait analysis system. The result shows that temporal and spatial parameters can be collected precisely by the TailGait and there is a possibility to apply this system for clinical tests in the future.
09:00 Novel Bent-Tapered Mode Converting Multimode Optical Fiber Sensor based on Evanescent Wave Absorption

Nirmal Punjabi (Indian Institute of Technology Bombay, India); Jitendra Satija (IIT Bombay, India); Soumyo Mukherji (Indian Institute of Technology Bombay, India)

In this study, design and fabrication of a novel bent-tapered optical fiber sensor for enhanced Evanescent Wave Absorption (EWA) based sensing application is demonstrated. A combination of bending and tapering acts as a mode converter, which results in high penetration depth of evanescent field. In addition, tapered region of the probe increases the coupling efficiency at the detector end by V-number matching and thus helps in improving the signal to noise ratio significantly. Effect of taper ratios (ranging from 0.17 to 1) was investigated to optimize for the maximum sensitivity using fluorescein isothiocyanate (FITC) dye as an analyte. Taper ratio of 0.37 showed the highest sensitivity, and was found to be 2.4-fold better compared to untapered bent probe of similar length. The larger penetration depth coupled with higher sensitivity will be beneficial for sensing application involving larger analytes e.g. bacteria & virus.

09:18 Towards Building a Miniaturized Shape Sensor - Building process of a Shape Sensor for Use in Single Port Surgery

Hendrikje Pauer (Karlsruhe Institut for Technology (KIT) & IPR, Germany); Christoph Ledermann (Karlsruhe Institute of Technology & Institute for Process Control and Robotics, Germany); Oliver Weede (Karlsruhe Insitute of Technology (KIT), Germany); Heinz Wörm (Karlsruhe Institute of Technology (KIT), Germany)
Required in robot assisted Single Port Surgery, 3D shape sensing of flexible snakelike instruments using fiber Bragg gratings is a current research topic of several working groups. Though some theoretical results are achieved, a practical implementation that can be applied for instruments in SPS has not yet been particularly described. The specific instruments own special technical properties as e.g. they allow very small bending radii. In this paper, approaches for the building process of a shape sensor, that meet the special technical requirements of the instruments are followed and evaluated. The theoretical foundations and calculation methods are adapted to the built shape sensor. The overall goal is to develop a building process for a miniaturized shape sensor that can be integrated into medical instruments. A first macro sized shape sensor is successfully produced. The miniaturization caused serious difficulty. In this paper experiences with the fiber handling and occurring production problems are particularly described. In summary, the realization of a shape sensor has proven already to be technically feasible but for miniaturization it has to be done further research concerning the used material and the practical fiber handling.

09:36 **Highly Accurate Refractive Index Sensor Based on Fourier-Transformed Phase Acquisition in Fiber-Optic Interferometer**

*Young Ho Kim (Gwangju Institute of Science and Technology, Korea); Kwan Seob Park (Gwangju Institute of Science and Technology, Korea); Byeong Ha Lee (Gwangju Institute of Science and Technology, Korea); Seok Lee (Korea Institute of Science and Technology, Korea); Deok Ha Woo (Korea Institute of Science and Technology, Korea); Young-Tak Chough (Gwangju University, Korea)*

High precision refractive index (RI) measurement was achieved by utilizing the phase term of a Fourier-transformed interference signal. With a fiber-optic Fabry-Perot RI sensor, it was verified that the proposed method had high resolving performance in RI determination compared with the conventional wavelength tracing method. Even with a tiny variation in liquid RI, the Fourier-transformed phase shift showed high accuracy as much as 0.99995 of R square value.
09:54 Tapered Plastic Optical Fiber Sensor for Detection of Ethanol Concentration in H2O

Hasnida Saad (Universiti Teknologi MARA, Malaysia, Malaysia); Mohd. Kamil Abd. Rahman (Universiti Teknologi MARA Malaysia, Malaysia); Mohd Tarmizi Ali Ali (Universiti Teknologi Mara, Malaysia)

This paper presents the preparation and characteristics of an intensity-based tapered plastic optical fibre (POF) coated with a mixture of poly-vinyl alcohol (PVA) and SiO2 for sensing ethanol concentration in H2O. The 1.0 mm-diameter POF was tapered to a diameter of about 730 µm using tensile tester with thermostatic chamber and the total tapered length was 5.0 cm. The tapered section was coated with a sensing element comprising of a mixture of PVA polymer and SiO2 with a ratio of 9.0v%:1.0v%. A thin layer of protective coating was applied on this sensing element after it was thermally cured at 80°C. More light was guided into the core of the POF at sensing area with increasing concentration of ethanol. This effect is depicted from linear increase of light intensity within 630 nm to 644 nm wavelength region. The POF ethanol sensor has shown to exhibits repeatable results for measurement of 2.0% to 10.0% and 0.2% to 1.0% concentration of ethanol in water with the sensor sensitivity measured up to 35.67 per wt% of ethanol concentration.

10:12 Feasibility Evaluation of Multi-point Sensing for Hetero-core Spliced Optical Fiber Sensor Using Internet-based Protocol

Lee See Goh (Soka University Japan & Graduate School of Engineering, Japan); Kazuhiro Watanabe (Soka University Japan, Japan); Norihiko Shinomiya (Soka University, Japan)

This paper describes a feasibility evaluation of multi-point sensing for hetero-core spliced (HC) optical fiber sensor network by using the internet-based protocol. This sensor is able to serve as a medium for data communications and as a sensor in the same fiber line simultaneously. In our previous study, we have successfully developed an optical fiber sensor network integrating data
communications and sensing function using the (HC) optical fiber sensor [1]. In order to extend the application of sensor network and remotely manage it, a network management method is required. We proposed and constructed an internet-based remote data acquisition sensor network by using one of the standard operation and maintenance protocols for the internet - Simple Network Management Protocol [2]. This study aims to distinguish the status of fiber optics sensors for the management of the sensor network. The sensor network has been verified and the results demonstrated that the data communications is successfully performed in the systems while distinguishing status of HC optical fiber sensors.

**S10B: Magnetic Sensors 1**

| Chair: Ian M Woodhead (Lincoln, New Zealand) |

**09:00 Prototype Instrument for Sheet Resistance Measurement by Pulse Voltage Excitation**

_Hideo Saotome (Chiba University, Japan); Hiroaki Kaneko (Chiba University, Japan)_

A novel contactless method for measurement of the sheet resistance of a semiconductor wafer, that utilizes pulse voltage excitation, has been proposed by one of the authors. This novel method was applied and a prototype instrument was developed that can measure sheet resistance under 5 milli-Ohms/sq, which is the same as the smallest value for the conventional contactless method.

**09:18 Development of Multi Core Magneto-Impedance Sensor for Stable pico-Tesla Resolution**

_Tsuyoshi Uchiyama (Nagoya University, Japan)_

Noise from amorphous wire magneto impedance elements in CMOS pulse sensor circuit is investigated. We clarify the average current bias effect for low noise magneto impedance sensor operation. In order to raise signal to noise ratio (SNR), single core head and multi
core head are used and compared. We have showed that the noise floor of four core head magneto impedance sensor is lower than 1 pT/Hz\(^{1/2}\) for the frequency range from 20 Hz to 500 Hz. The results would be a useful to design high SNR magneto-impedance sensor based on amorphous wire in combination with CMOS pulse circuit.

09:36 Design of liquid detection sensor with low-frequency electromagnetic field

K. Tashiro (Shinshu University, Japan); Hiroyuki Wakiwaka (Shinshu University, Japan); Takeshi Mori (Shinshu University, Japan); Ryo Nakano (Shinshu University, Japan); Noor Harun (Universiti Kuala Lumpur, Malaysia); Misron Norhisam (Universiti Putra Malaysia, Malaysia)

This paper presents the design of liquid detection sensor with low frequency electromagnetic field. The purpose of this sensor is to detect a change in the conductivity or permittivity of the liquid. If the evaluation frequency is less than 100 kHz, skin effects would be negligible. Our proposed sensor consists of two cylindrical sensors, a solenoid coil and a cylindrical capacitor. When they have an ideal shape, estimation methods for inductance and capacitance have been already proposed. However, we should make it clear that there are problems in practical application. First of all, we fabricated several coils and capacitors, and confirm the validity of the estimation methods. From experimental results, it was found that we should take into account estimation error and existence of the parasitic element. We also present a liquid detection demonstration with fabricated sensors based on differences in conductivity and permittivity.

09:54 Nondestructive Evaluation of Hardness using AC Permeability and Impedance Analysis

Hiroaki Kikuchi (Iwate University, Japan)

The equivalent circuit for the relation between the impedance of the coil wound around the magnetic yoke and the permeability of the
material was analyzed for a quantitative estimation of an initial permeability of materials from the impedance measurement of the magnetic yoke, and for optimum design of a magnetic yoke and a condition of an impedance measurement. Additionally, a potential of NDE for hardness on deformed low carbon steel using the impedance measurement were confirmed experimentally.

10:12 Self-Sensing Active Magnetic Bearing Using 2-Level PWM Current Ripple Demodulation

Wolfgang Gruber (Johannes Kepler University Linz & Institute for Electrical Drives and Power Electronics, Austria); Manuel Pichler (Johannes Kepler University Linz, Austria); Michael Rothböck (Johannes Kepler University Linz, Austria); Wolfgang Amrhein (ACCM GmbH, Austria)

This paper deals with the implementation of a position estimation method for a small radial active magnetic bearing. Thus, the rotor position is not measured with a sensor but demodulated from the phase current ripple, excited by the 2-level pulse width modulated phase voltages. The mathematical description of the phase currents is given and the demodulation procedure for obtaining the rotor position is outlined. Stable levitation of the rotor is achieved by this method without the need of any physical position sensor. Measurements regarding the estimated sensor signal quality and its dynamic behavior are conducted. Possible future improvements are discussed.

S10C: Mechanical Sensors 2
Chair: Dan Mihai Stefanescu (Romanian Measurement Society, Romania)

09:00 Analysis and compensation of MEMS gyroscope drift

Zhanlin Diao (BMTI, P.R. China)

Compared with traditional rate sensors, the Micro Electro Mechanical System (MEMS) gyroscope is smaller, lighter, cheaper and lower in power consumption. Thus, it has been widely used in consumer
electronics, automation electronics and inertial navigation systems. However, because of the limitations of contemporary technology, the MEMS gyroscope usually has structure defect which will result in large drift. In this paper, we will report a method for analysis and compensation of MEMS gyroscope drift. Firstly, the gyro error characters are analyzed with the help of Allan variance. After that, Auto-regressive (AR) model and auto-regressive moving-average (ARMA) model of gyroscope random drift are built. Besides, Kalman filter will be designed to decrease the random error of gyro. Test result shows that the variance of KF output is no more than 30% of the original signal variance. In conclusion, the combination of Allan variance, time series analysis and Kalman filter induce an excellent compensation effect of MEMS gyroscope drift.

09:18 Intentionally imperfect sensors for measuring mechanical parameters

Norbert Schwesinger (Technische Universität München, Germany)

while modern sensors benefit from increasing precision by permanently shrinking dimensions, we have focused on the opposite way of thinking and developing. Although, coming from the MEMs branch we developed sensors with millimeter sized dimensions for the detection of mechanical parameters. Main key of our investigations is the intentionally imperfectness of the sensors. From this point of view, we have considered the question: Would it be possible to generate electrical sensor signals allowing for a high quality determination regarding mechanical loads? Change of capacitance by external mechanical forces is the basic measuring principle used in our development. The sensors consist of PDMS membranes filled with randomly distributed spheres of steel. Above the membrane, an interdigitated electrode structure is positioned. Just slight moves of the spheres by external mechanical forces change the field distribution and therefore the capacitance. Differences between common known sensors and our developments are in the complexity of fabrication technology and precision. In our investigations, we found that it is possible to detect accelerations or slops even if the sensing systems
consists of randomly distributed functional elements. Moreover, the sensitivity of the sensors was comparable with extreme sensitive devices available on the market.

09:36 Microcrystalline silicon gauges for the measure of very high deformation with less than one mm resolution

Yannick Kervran (University of Rennes 1, France); Sabri Janfaoui (University of Rennes 1, France); Olivier De Sagazan (University Rennes 1, France); Samuel Crand (University of Rennes 1, France); Nathalie Coulon (University of Rennes 1, France); Jean-Philippe Gauthier (University of Rennes 1, France); Tayeb Mohammed-Brahim (University Rennes 1, France)

Microcrystalline silicon films are used as piezoresistive material to fabricate very small resistor and transistor gauges of deformation. Very small gauges were fabricated allowing then the possibility to detect the variation of the shape of any surface with high spatial resolution. Resistor gauges with 5 µm x 125 µm smallest size showed a gauge factor of 30 even when applying high strain of 0.42%. The small size demonstrates the high spatial resolution. Field effect thin film transistor (TFT) gauges showed a gauge factor of 85 under the same high strain. This value is close to that of single crystalline silicon gauges that are not flexible and then cannot support very high deformations. The longer technological process of the TFT gauges reserves their use to the measurement of low deformations when high resolution is required.

09:54 Novel High-resolution Sidewall Imaging using Standard Atomic Force Microscopy Equipment

Florian Krohs (University of Oldenburg & Div. Microrobotics and Control Engineering, Germany); Sergej Fatikow (University of Oldenburg, Germany)

The Atomic Force Microscope (AFM) represents an essential measuring instrument in various disciplines covering life science,
biology, material science, semiconductor industries, and micro- and nanotechnology. It has revolutionized surface analysis by providing high-resolution visualization of structures at micro-, nano-, and atomic scales. Several different operation modes evolved over time providing means to characterize the morphological, chemical, electrical and mechanical properties of surfaces and nanostructures. However, conventional AFM technology is limited as it is a 2.5D image acquisition technique thus only giving a "view from above". In semiconductor and nanomanufacturing industries the measurement of linewidths, critical dimensions (CD), and sidewall angle/roughness on the wafer level is one of the most fundamental dimensional nanometrology needs. As technology progresses the critical dimension size and tolerance decreases. Especially, characterizing the sidewall roughness of nanostructured photonic components is one of the key challenges and plays an important role in optimizing the efficiency of nanooptical devices such as waveguides. The main source for loss in waveguides is the sidewall roughness which results in diffuse scattering. Standard pyramidal AFM probes are unable to correctly scan these structures. Firstly, the pyramidal tip of the AFM probe cannot scan high aspect ratio structures in a correct way leading to a distorted AFM image and to incorrect trench width and height. Secondly, the sidewall roughness and angle of the structure cannot be measured at all since the AFM probe is not able to contact the sidewall structure. To overcome these problems, we suggest a novel method for performing sidewall measurements that is based on utilization of standard AFM equipment in combination with customized FIB-milled AFM tips and a control loop incorporating the torsion of the cantilever as feedback to control the lateral position of the AFM tip.

10:12 Coordinate measurement on wafer level - from single sensors to sensor arrays

Thomas Krah (Physikalisch-Technische Bundesanstalt, Germany); Achim Wedmann (Physikalisch-Technische Bundesanstalt, Germany); Karin Kniel (Physikalisch-Technische Bundesanstalt, Germany); Frank Härtig (Physikalisch-Technische Bundesanstalt, Germany); Nelson
Systems fabricated in microtechnological processes are increasingly employed in industrial products. For that purpose, it is necessary to have a method at hand to measure them, just as macroscopic components and systems too, for reasons of quality assurance. Whereas there already exist a multitude of different systems based on diverse measurement principles for the measurement of single Microsystems, a cost-effective measurement of a large number of Microsystems on wafer level is currently realizable with optical measurement systems only, a fact that owes less to a technical advantage than to a faster measurement rate. This article portrays arrays fit for a parallelized tactile measurement of geometric dimensions and mechanical qualities of Microsystems on a wafer to overcome the disadvantage of extended measuring times and to use the advantage of being able to measure a wide scope of structures and being able to perform traceable measurements. Moreover, this article introduces innovative tactile elements for various measuring tasks and structures to be measured.

S10D: Healthcare Applications 2
Chair: Soami Daya Krishnananda (Dayalbagh Educational Institute & Microwave Physics Lab, India)

09:00 Wearable Textile Sensor Sock For Gait Analysis

Oren Tirosh (Victoria University & Motion3D, Australia); Rezaul Begg (Victoria University, Australia); Elyse Passmore (Victoria University, Australia); Nili Knopp-Steinberg (Zinman College of Physical Education and Sport Sciences at the Wingate Institute, Australia)

The ability to measure foot plantar pressure and gait characteristics during a prolonged period of daily life activities has many important applications in people with gait disorders. This paper presents the
development of a wearable textile sensor sock incorporating these measurements, offering the potential to detect major events during the stance phase of the gait cycle. The sensors are constructed from conductive thread and are connected to a data logger with a Secure Digital card to allow prolonged recording. Validation of the temporal parameters measured with the textile sensor sock compared to F-scan insole (Tekscan, Inc.) showed 1.6% and 3.8% differences in stride and stance duration, respectively. Test-retest reliability study showed highly repeatable measurements (r = 0.96) in 3 days apart. These results demonstrate the potential for using textile-based sensor sock in future applications providing active gait assistance to people with gait disorders.

09:18 Assessment of Local Muscle Fatigue by NIRS

Yoshiki Muramatsu (Tokyo University of Science, Japan); Hiroshi Kobayashi (Tokyo University of Science, Japan)

Assessment of a muscular fatigue level and the grade of recovery from muscle fatigue are required at various scenes such as medical treatment, welfare, the work place, etc. Frequency transition of EMG is generally utilized for it though, it is impossible to apply it in case of isotonic contraction and also influenced by condition and environment. Thus there are no apparatus and method which measure fatigue noninvasively and simply. In this study, we propose to apply near-infrared spectroscopy (NIRS) which can measure the amount of oxygenated hemoglobin and deoxygenated one for fatigue estimation, and attempt to evaluate the level of local muscle fatigue.

09:36 Non Invasive Estimation of Blood Glucose using Near Infra red Spectroscopy and Double Regression Analysis

Swathi Ramasahayam (IIIT-H, India); Sri Haindavi Koppuravuri (IIITH, India); Bharat Kavala (IIT Guwahati, India); Shubhajit Roy Chowdhury (Centre for VLSI and Embedded Systems Technology, IIIT Hyderabad, India)
This paper presents a unique technique for non-invasive estimation of blood glucose concentration using near infra red spectroscopy. The spectroscopy has been performed at the second overtone of glucose which falls in the near infra red region. The near infra red spectroscopy has been performed using transmission photoplethysmography (PPG). The analog front end system has been implemented to get the PPG signal at the near infra red wavelengths of 1070nm, 950nm, 935nm. The PPG signal that has been obtained is processed and double regression analysis is carried out with the artificial neural network for estimating the glucose levels. The root mean square error of the prediction was 5.84mg/dL.

**09:54 Ambient Assisted Living Framework for Elderly Wellness Determination through Wireless Sensor Scalar Data**

Nagender Kumar Suryadevara (Massey University, New Zealand); Chia-Pang Chen (National Taiwan University, Taiwan); Subhas Mukhopadhyay (Massey University, New Zealand); Ramesh Kumar Rayudu (Victoria University of Wellington, New Zealand)

In this paper, we have presented an integrated framework for healthcare management of Ambient Assisted Living for quantitative assessment of wellness related to an elderly in terms of their daily activities performance. The importance of the middleware in the integrated platform, its elements and services for the effective healthcare monitoring of an elderly is revealed. The emphasis of the middleware description is to provide the details of the technological intricacies related to the smart home monitoring system. The assimilated technologies in the middleware of the home monitoring system have led to an effective wellness determination of an elderly living alone in their own home.

**10:12 A GMR Sensor based Guiding Tool for Location of Metal Shrapnel during Surgery**
In this paper, a Giant Magneto Resistance (GMR) sensor based online tool for removing shrapnel during surgery is presented. This tool is intended to guide doctors, while performing surgery to remove metal shrapnel from victims of bomb blasts, gun fire, land mines etc. Presently doctors rely on imaging systems to locate shrapnel in the victim's body before surgery. Effectiveness of surgery and recovery solely depends on the doctors' skill to trace the shrapnel. Therefore, in some cases, the shrapnel, in spite of being visible in the images, may become untraceable during surgery. So in such cases, a sensing tool that can guide the doctor to the location of the shrapnel will be very effective. An inductive proximity sensor can serve this purpose, but its output can be affected by its lead inductance or other circuit parameters. Therefore in order to overcome such effects, a GMR based sensing tool is proposed here. The details and experimental results obtained from this tool are presented in this paper. The tool can detect shrapnel materials such as steel, copper, brass and Aluminium.

10:50 - 12:20
S11A: Optical Sensors 2
Chair: Joseph Walsh (Institute of Technology, Tralee, Ireland)

10:50 New detectors and detector architectures for high resolution optical sensor systems
Andreas Eckardt (DLR German Aerospace Center & Institute of Optical Sensor Systems, Germany); Ralf Reulke (Humboldt-Universität zu Berlin, Germany)

The Institute of Optical Sensor Systems (OS) as member of the Robotics and Mechatronics Cluster of the German Aerospace Center (DLR) has more than 30 years experiences with high-resolution imaging technology. The technology changes in the development of
detectors, as well as the significant change of the manufacturing accuracy in combination with the engineering research define the next generation of spaceborne sensor systems focusing on Earth observation and remote sensing. The combination of large TDI lines, intelligent synchronization control, fast-readable sensors and new focal-plane concepts open the door to new remote-sensing instruments. This class of instruments is feasible for high-resolution sensor systems regarding geometry and radiometry and their data products like 3D virtual reality. Systemic approaches are essential for such designs of complex sensor systems for dedicated tasks. The system theory of the instrument inside a simulated environment is the beginning of the optimization process for the optical, mechanical and electrical designs. Single modules and the entire system have to be calibrated and verified. Suitable procedures must be defined on component, module and system level for the assembly test and verification process. This kind of development strategy allows the hardware-in-the-loop design. The paper gives an overview about the current developments at DLR OS in the field of innovative sensor systems design for spatial and spectral high resolution remote sensing instruments.

11:08 Design and Test of Prototype Attitude Control System as Telescope Stabilizer with Fiber Optic Gyroscopes

Yongxiao Li (Peking University & China Unicom, P.R. China); Yunfeng Zhang (Peking University, P.R. China); Zinan Wang (Peking University, P.R. China); Zhengbin Li (Peking University, P.R. China); Ming Liu (Peking University, P.R. China); Liangfu Ni (Peking University, P.R. China); Chenglong Liu (Peking University, P.R. China)

This paper describes the design details and the features of the prototype attitude control system with depolarized interferometric fiber optic gyroscopes (IFOG). The optical section of the IFOG is constructed by a 2 kilometer long single mode fiber (SMF) loop. The electrical signal of IFOG is sampled by the PXI5922 digitizer. The actuator of our attitude control system is constituted by the 2 axes
controllable optical turntable with the four-phase stepper motor drive by the ATmega168 microcontroller. The electronic section of the prototype attitude control system is fully controlled and synchronized by the computer through LabVIEW program. The preliminary test results demonstrate that averaged sensitivity of the all depolarized IFOG is 0.02deg/hr and the static state maintaining stability of this prototype system is 0.002 degree under the laboratory environment. The system achieved the objective of compensation of earth spinning hence could be applied as to the stabilization of telescope.

11:26 Nitrogen dioxide sensor based on optical fiber coated with a porous silica matrix incorporating lutetium bisphthalocyanine

Marc Debliquy (University of Mons, Belgium); Driss Lahem (Materia Nova, Belgium); Antonio Bueno Martinez (Universite de Mons, Belgium); Christophe Caucheteur (Faculté Polytechnique de Mons (F.P.Ms), Belgium); Marcel Bouvet (Universite de Bourgogne, France); Patrice Mégret (University of Mons (UMONS) & Faculté Polytechnique, Belgium); Marie-Georges Olivier (Universite de Mons, Belgium)

In this work, we present the results of a sensor exploiting a coating consisting of lutetium bisphthalocyanine (LuPc2) dispersed in a porous silica matrix deposited by a sol-gel process. LuPc2 shows a gasochromic effect in the telecommunication wavelengths range. The absorption spectrum in this range strongly decreases in contact with NO2. The sensor consists then in a coating deposited on a single-mode silica fiber tip in order to form a Fabry-Pérot cavity. An amplitude change in the reflected spectrum is observed after contact with 1 ppm NO2 thus showing its sensitivity to that gas.

11:44 Lithium Niobate (LiNbO3) Optical Retarders Used as Electric Field Sensors

Celso Gutierrez-Martínez (Instituto Nacional de Astrofísica, Optica y Electrónica (INAOE), Mexico)
Electric field sensing using LiNbO3 polarization interferometers, acting as optical retarders, has been demonstrated in previous works. A polarization interferometer is implemented by an birefringent optical waveguide, which is constructed on a Z-cut-y propagating LiNbO3 crystal. However polarization interferometers are quite sensitive to optical polarization, which results in DC-drift of the sensed signal at the output. To minimize the DC-drift of the electric field sensing, unbalanced LiNbO3 Mach-Zehnder interferometers can also be used. Such a device is inherently polarization insensitive when constructed on an x-cut z-propagating LiNbO3 crystal. Either the polarization or the unbalanced interferometers introduces optical delays, which can be modulated by the sensed electric field. At the output of the optical retarders the variations of the electric field are imprinted on the optical delay variations. To recuperate the electric field information, optical demodulation is achieved by introducing a second optical delay, which is matched to the sensor's optical delay. In this paper a description of the two types of optical retarders, when used as electric field sensors is presented.

12:02 Improving sensing properties of the long-period gratings by reactive ion etching

Mateusz Smietana (Warsaw University of Technology, Poland); Marcin Koba (Université du Québec en Outaouais, Poland); Saurabh Tripathi (University du Quebec en Outaouais, Canada); Predrag Mikulic (Université du Québec en Outaouais, Canada); Wojtek J. Bock (Université du Québec en Outaouais, Canada)

This work presents an application of reactive ion etching (RIE) for effective sensitivity tuning of the long-period gratings (LPGs). The technique allows for an efficient and well controlled etching of the fiber cladding and for achieving dispersion turning point of higher order cladding modes, where LPGs show the highest sensitivity to a number of influences. The effect of the etching on spectral properties of the LPGs is discussed. We correlated the decrease in fiber radius with the shift of the LPG resonance wavelength. The advantage of this
approach is a capability for very repeatable post-processing of the LPGs with a remarkable precision.

**S11B: Image, Vision and Range 2**
Chair: Goutam Chattopadhyay (CalTech, JPL, USA)

**10:50 Soil Backscatter Measurement with Impulse (Ultra-Wideband) Radar**

*Adrian Tan (Lincoln Agritech Limited & Lincoln University, New Zealand); Sean Richards (Lincoln Agritech Limited, New Zealand); Ian G Platt (Lincoln Ventures Ltd, New Zealand); Ian M Woodhead (Lincoln, New Zealand)*

We are developing a method that allows remote soil moisture measurement from electromagnetic sensors that are mounted on irrigators. To do that, techniques from the impulse (ultra-wideband) radar are applied, which enables the measurement of soil reflection at resolutions smaller than the antenna beamwidths of the radar. We derive a relationship between the radar's parameter (i.e. pulse-width, antenna parameters, radar location and sensing angle with respect to ground level) and the soil surface resolution that the radar is capable of achieving. In addition, we also propose a method to calculate the radar backscatter coefficient of the ground from the signals that are received by the radar. Using the proposed method, radar measurements are performed on wet pasture to measure the radar backscatter coefficients at different grazing angles. Measured results show that radar backscatter coefficients can be reliably measured at the angles up to 60 degrees from nadir. This paper presents the progress in our ongoing work to develop a small and practical remote soil moisture measurement for smart irrigation.

**11:08 Compton Camera Imaging**

*Shiro Ikeda (The Institute of Statistical Mathematics, Japan); Hirokazu Odaka (Japan Aerospace Exploration Agency, Japan); Makoto*
The goal of the Compton camera imaging is to visualize the gamma-ray intensity map. Here, we focus on the case where the gamma-ray sources are sufficiently far from the camera and propose a new reconstruction method for the Compton camera imaging. The method is called the bin-mode estimation (BME). The assumption is valid for astronomy applications. The method can be implemented easily, and numerical simulations show the proposed method provides sharp reconstructions.

11:26 Unsupervised Saliency Detection and A-Contrario based Segmentation for Satellite Images

Junbo Zhao (Wuhan University, P.R. China); Shuoshuo Chen (Wuhan University, P.R. China); Diyang Zhao (University of Macau, P.R. China); Hailun Zhu (Wuhan University, P.R. China); Xiaoxiao Chen (Wuhan University, P.R. China)

In recent years, salient region detection techniques are widely used in image segmentation. The traditional image segmentation techniques primarily depend on human to label or mark the target areas interactively, which is far insufficient for real-time image processing. Therefore, in this paper we propose a new method of unsupervised saliency detection based segmentation, for high-resolution satellite images, which requires no manual interaction and prior knowledge of their content. Our proposed model of saliency at the considered pixel is a weighted average of dissimilarities between the pixel involved patch and the other patches. Moreover, we evaluated global and multi-scale contrast differences in order to extend the saliency calculation window to the entire image. To acquire an appropriate threshold for the remote sensing images segmentation, we apply a probabilistic a-contrario framework based on perception principle to
measure the meaningfulness of such saliencies. According to the experimental results, our method is feasible and practicable for satellite image segmentation.

11:44 Image Quality and Image Resolution

*Ralf Reulke (Humboldt-Universität zu Berlin, Germany)*

13 years after the introduction of the first digital airborne mapping camera in the ISPRS conference 2000 in Amsterdam, several digital cameras with more than 100 MPixel per image are available. They are now well established in the market and have replaced the analogue mapping cameras. A general improvement in image quality accompanied the digital camera development. The signal-to-noise ratio and the dynamic range are significantly better than with the analogue cameras. In addition, digital cameras can be spectrally and radiometrically calibrated. The use of these cameras required a rethinking in many places. In the recent years, some activities took place that should lead to a better understanding of the cameras and the data produced by these cameras. Several projects, like the projects of the German Society for Photogrammetry, Remote Sensing and Geoinformation (DGPF) or EuroSDR (European Spatial Data Research), were conducted to test and compare the performance of the different cameras. This paper will give an overview of standard and alternative approaches in image quality criteria's, the derivation and the use of this parameters.

12:02 Optics and Radar Image Fusion

*Ralf Reulke (Humboldt-Universität zu Berlin, Germany)*

Optical and Radar images cover two distinct aspects in the satellite image analysis. Optical images giving more semantic information derived e.g. from multispectral data, while the radar being more versatile due to independence on cloudy and night scenes. Due to the different detection methods can expect that the fusion of these
different data types can lead to improvements in the overall information from the observed scene. We define, that the information content (IC) of a set of (multispectral) images can be optimally derived from the data, if spatial and spectral resolution is adequate to the task that has to be solved. Furthermore the information is masked by typical sensor smear and noise. Thus the information, which can be derived from remote sensing imagery, depends on the system performance or image quality (IQ). By the additional use of radar data (e.g. for classification), often no significant improvement in the result is visible. Thus, we expect a drastic improvement of IC in the fused image, if the IQ of the two sets is comparable. This can be also analyzed in terms of image quality (IQ) for the fused data. The main purpose of this contribution is to achieve a number representing IQ, as e.g. the National Image Interpretability Rating Scale (NIIRS). The chosen fusion algorithm was the Principal Component Analysis (PCA) applied and validate on different area sets in Germany.

S11C: Environmental Monitoring 1
Chair: Takehito Azuma (Utsuminiya University, Japan)

10:50 Low-Cost Sensor Array Design Optimization Based on Planar Electromagnetic Sensor Design for Detecting Nitrate and Sulphate

Mohd Amri Bin Md Yunus (Faculty of Electrical Engineering & Universiti Teknologi Malaysia, Malaysia)

In recent years, the tremendous development of agriculture sector has been driven by the growing human population. Therefore, the crop productions need to be increased to fulfill the food demands. In order to do it, the amount of fertilizer used, might have been more than required and unabsorbed fertilizer by plants usually washed into water sources like rivers, ponds, and wells. Hence, the water will be polluted and unsafe to consume. Therefore, it is important to determine the contamination level in natural water resources. This paper discusses the development of a low-cost sensor array based on planar
electromagnetic sensors to determine the contamination levels of two common fertilizer components which are nitrate and sulphate in water sources. Three types of sensor array, were suggested: parallel, star, and delta. The modeling and simulation of all type of sensor array were carried out using COMSOL Multiphysics 4.2 software to calculate the sensors' impedance value. The contamination state was simulated by altering the electrical properties values of the environment domain of the model to represent water contamination. The simulations results show that all types of sensor array are sensitive to conductivity, $\sigma$ and permittivity, $\varepsilon$. Furthermore, a set of experiments was conducted to determine the relationship between the sensor's impedance and the waters' nitrate and sulphate contamination. The performance of the system was observed where the sensors were tested with the additional of distilled water with different concentrations of amount of potassium nitrate and potassium sulphate. The sensitivity of the developed sensors was evaluated where the best sensor was selected. Based on the outcomes of the experiments, the star sensor array placement has the highest sensitivity and can be used to measure the water content in the water.

11:08 Detection of Microorganisms in Water and different Food Matrix by Electronic Nose

Estefania Nunez Carmona (University of Modena and Reggio Emilia, Italy); Veronica Sberveglieri (University of Modena and Reggio Emilia, Italy); Andrea Pulvirenti (University of Modena and Reggio Emilia, Italy)

Alimentary matrix from as simples as water to other more complex like vegetables and dairy products pass very restrictive controls to evaluate the quality of the products. In the case of the water the early detection of the pollution is important to preserve the consumer's health. Regarding more complex matrixes, microorganisms play an important role being part of important managing process, like for example, fermentation developed by Lactic Acid Bacteria (LAB) in bread. Electronic Noses (ENs) has show to be a very effective and fast tool for monitoring microbiological spoilage and food quality
control. The capacity of this instrument can also be used for the selection of the most appropriate species or strains for a determinate purpose. The aim of this study was essay the ability of EN for the detection of bacterial presence in water and other foodstuff in cooperation with classical microbiological and chemical techniques like Gas Chromatography Mass Spectrometry with SPME (GC-MS-SPME). The achieved results notably advocate the use of EN in industry laboratories like a very important tool in quality control.

11:26 UAV-based measurement of vegetation indices for environmental monitoring

Thomas Arnold (Carinthian Tech Research AG & University of Klagenfurt, Austria); Martin De Biasio (Carinthian Tech Research AG, Austria); Andreas Fritz (Carinthian Tech Research AG, Austria); Raimund Leitner (CTR AG, Austria)

This paper presents an airborne multi-spectral imaging sensor which is able to simultaneously capture three visible and three near infrared channels. The first prototype was integrated in a Schiebel CAMCOPTER® S-100 VTOL (Vertical Take-Off and Landing) UAV (Unmanned Aerial Vehicle) for in-flight tests. A miniaturized version of the initial multi-spectral imaging system was developed to fit into a more compact UAV. The imaging system captures six bands with a minimal spatial resolution of approx. 10cm x 10cm (depending on altitude). Results show that the system is able to resist the high vibration level during flight and that the actively stabilized camera gimbal compensates for rapid roll/tilt movements of the UAV. After image registration the acquired images are stitched together for land cover mapping and flight path validation. Moreover the system is able to distinguish between different types of vegetation and soil.

11:44 Basic Research on an Environmental Monitoring System for Assaying Cesium and Barium Using Laser-Induced Breakdown Spectroscopy

Satoshi Ikezawa (Waseda University, Japan)
This paper reports a new method for real-time in-situ elemental analysis of measured radioactive elements that are strictly legally constrained to move the measuring samples for safety reasons. In this method, the applicable range of conventional laser-induced breakdown spectroscopy (LIBS), which has been used only to determine the elemental composition, is expanded in order to obtain an estimate of the isotope ratio by measuring the variation due to temporal change in the atomic disintegration products in small enclosed spaces. It is noted that this method takes full advantage of LIBS such that any pretreatment of the measured sample is not required. In this study, a confirmatory test for the LIBS measurement of cesium and barium based on the results for the disintegration of cesium is demonstrated as part of a preliminary survey for developing a monitoring system for actual radioactive materials.

12:02 Improving leak detection sensing in pipelines: A multidimensional approach with FDM

Aime’ Lay-Ekuakille (University of Salento, Italy); Giuseppe Griffo (University of Salento, Italy); Patrizia Vergallo (University of Salento, Italy)

The problem of detecting leakages in pipelines has been assuming a crucial importance for saving water from bad usage and exploitation. FDM (Filter Diagonalization Method) is a promising method used in nuclear magnetic resonance for decaying issues. We propose a comparison between a one-dimensional FDM and a multidimensional one. This comparison points out interesting aspects related to the leak width and noise contained in the signal and that are hidden in 1 D FDM.

S11D: Network Protocols
Chair: Ibrahim Al-Bahadly (Massey University, New Zealand)

10:50 μMobile IPv6 in Wireless Sensor Networks
In the new era of Internet of Things, wireless sensor networks (WSNs) can provide a new way of communication between the Virtual and the Real World. However, mobility has become more and more important in flat WSNs allowing them to expand to new concepts and extending their applicability. Meanwhile, it is also crucial to control losses and support quality of service in these mobile environments. In fact, this is very important for monitoring people’s health conditions in hospitals, in military scenarios and in dangerous industrial environments. However, so that an end-user application can take advantage of a mobility scenario, a low level mobile protocol should be implemented in a transparent way for applications. This article presents the implementation details and some evaluation studies of two mobility models for WSNs: one based on the well-known MIPv6 and another one based on our previous work in draft-silva-6lowpan-mipv6.

11:08 Storage Node based Routing Protocol for Wireless Sensor Networks

Shah Ahsanul Haque (University of South Australia, Australia); Syed Mahfuzul Aziz (University of South Australia, Australia)

Efficient routing is a key concern for the execution of high performance query processing in Wireless Sensor Networks (WSN). Existing routing protocols lack the efficiency in terms of energy consumption, accuracy and timing response. Data storage and processing constraints in sensor nodes also hinder the efficient and timely response in various applications, especially in healthcare, where, many vital data are collected from the patients using wireless devices. These data can be crucial for saving the patient’s life. Thus, an efficient, accurate and fast routing protocol is of utmost importance in healthcare. Present routing protocols in hierarchical network
protocols, the cluster heads are selected from general sensor nodes, however the storage and processing constraints perceive in the usual wireless biomedical sensors as the processing requires more energy consumption and the storage capacity is limited. In this paper we propose a novel routing protocol by utilizing Storage nodes. We evaluate and prove the feasibility of the proposed protocol through extensive simulations. Simulation results show that the protocol is more energy efficient, faster and data resilient compared to other techniques.


Che-Shen Cheng (National Taipei University of Technology, Taiwan); Chwan-Lu Tseng (National Taipei University of Technology, Taiwan); Joe-Air Jiang (National Taiwan University, Taiwan); Yi-Jhang Lin (National Taiwan University, Taiwan)

Many applications of wireless sensor networks (WSNs) - including medical healthcare, military surveillance and security systems - must meet the requirement of 100% coverage, but the issue of coverage is not addressed by studies on routing protocols. Thus, this work proposes an adaptive coverage-preserving routing protocol (ACPRP) to deal with coverage. ACPRP can also reduce the possibility that a node with less overlapped coverage is selected as a relay node. Furthermore, the Particle Swarm Optimization (PSO) algorithm is used to find optimal weight parameters which are fed into the cluster head selection mechanism and the hierarchy routing selection mechanism proposed by this work. The best transmission route between nodes is calculated based on remaining energy, coverage and transmission distance of each node. In terms of coverage, the simulation results show that the ACPRP is able to provide up to 134%~151% additional service time with 100% coverage, compared to the existing LEACH-Coverage-U protocol and the LEACH protocol, and generate up to 13.4% additional service time with 100% coverage, compared to the ECHR protocol. Therefore, the simulation
results demonstrate that the ACPRP is able to provide a better service time for 100% coverage.

11:44 The Study of 6LoWPAN with SCTP Multi-homing in Smart Grid

Yang-Wen Chen (National Chi Nan University, Taiwan); Arak Sae Yuan (National Chi Nan University, Taiwan); Kuan-Ta Lu (National Chi Nan University, Taiwan); Quincy Wu (National Chi Nan University, Taiwan)

With the evolution of communication technology, wireless networks have become widely adopted in many modern applications. The communication in a Smart Grid system relies on a large number of low-power sensors, which stimulates vigorous development of related researches. Stream Control Transmission Protocol (SCTP) is a new transport-layer protocol. It combines the advantages of both TCP and UDP, and provides new features such as multi-homing and multi-streaming. SCTP can provide high-performance transmission in both wired and wireless networks. This paper applied SCTP in a wireless sensor network, and studied how it can improve network reliability.

12:02 An Infrastructure for Integrating Heterogeneous Embedded 6LoWPAN Networks for Internet of Things Applications

Samuel Catapang (The University of Auckland, New Zealand); Zachary Roberts (The University of Auckland, New Zealand); Kevin I-Kai Wang (The University of Auckland, New Zealand); Zoran Salcic (The University of Auckland, New Zealand)

The recent trend of ubiquitous computing and the Internet of Things demands everyday objects to be IP addressable and Internet accessible. This brings forward the challenges of converting or mapping formerly isolated wireless sensor networks (WSNs) to be IP compatible. 6LoWPAN is one of the first protocols which provide IP compatibility to low data rate WSNs. While 6LoWPAN is efficient for WSNs, there are other limitations such as different physical layers and radio interfaces which will break the information flow between
heterogeneous IP-compatible networks and the Internet. In this paper, an integrated hardware/software solution is presented to bridge two heterogeneous 6LoWPAN networks. It is motivated by the necessity of merging a body area network and an environment control network in typical health monitoring applications of an intelligent environment. The unification is achieved through use of a physical I2C connection, making a single hybrid router with the capability to route packets across both networks. The commonalities between two 6LoWPAN implementations allow highly efficient packet translation between two network stacks. Internet connectivity was added through use of an edge router, and allows each node to be addressed and accessed directly from anywhere on the Internet.

12:20 - 14:00
S12: Combined Lunch and Short Oral 2
Chairs: Michael J. Haji-Sheikh (Northern Illinois University, USA), Ian G Platt (Lincoln Ventures Ltd, New Zealand)

An Ultralow-Noise Ag/AgCl Electric Field Sensor with Good Stability for Marine EM Applications

Zhendong Wang (China University of Geosciences, P.R. China); Ming Deng (China University of Geosciences, P.R. China); Kai Chen (China University of Geosciences, P.R. China); Meng Wang (China University of Geosciences, P.R. China)

This paper presents an ultralow-noise level of Ag/AgCl electric field sensor for detecting seafloor electric field signals. During the anodization process, we used a constant current and a constant potential for achieving the ultralow-noise level and for improving the stability and repeatability of the Ag/AgCl electric field sensor, respectively. We took advantage of newly developed materials to generate high-quality Ag/AgCl electric field sensors. Typical measured noise level is 0.6 nV/rt(Hz) at 1 Hz. The source resistance between pairs of Ag/AgCl electric field sensors is approximately 5 Ω, almost independent of frequency between 0.1 Hz and 10 Hz. The offset potential is typically below 0.1 mV with a drift of less than 5 μV/day.
and less than 10 μV/°C. This Ag/AgCl electric field sensor has promise for improving the accuracy of marine electric field measurements.

**Design and Characterization of a PCB based Capacitive Shear Force Sensor for Robotic Gripper Application**

*Sheng-Jui Chen (Industrial Technology Research Institute, Taiwan); Jian-Lin Huang (Industrial Technology Research Institute, Taiwan)*

The shear force sensor is one of the key elements in future robotic industries; it is of great importance in applications where robotic arms are required to delicately interact with objects to be handled. This paper presents the development of a capacitive shear force capable of sensing shear forces in two degrees of freedom. The fabrication of the sensor is based on the PCB fabrication process, a well-known and mature technology. We adopt the capacitance sensing scheme for its high sensitivity and easy implementation. For sensor characterization, we used a force gauge and an optical interferometer to measure sensor's parameters including its sensitivity and resolution. The dimension of our prototype shear force sensor including the metal housing is 26 mm x 13 mm x 58 mm suitable for the integration with commercial robotic grippers. For sensor performance, we achieved a shear force sensitivity of 126 fF/N and a resolution of smaller than 5 mN.

**Gasoline-diesel mixtures quantifying using terahertz time-domain waveform**

*Yinan Li (Tianjin University & Tianjin University, P.R. China); Jian Li (Tianjin University, P.R. China); Zhen Tian (Tianjin University, P.R. China); Nan Zhou (Tianjin University, P.R. China); Lijun Sun (North Automatic Control Technology Institute, P.R. China); Shijiu Jin (Tianjin University, P.R. China); Zhoumo Zeng (Tianjin University, P.R. China)*

Refined oil mixtures can be quantified using terahertz absorption coefficient spectra and dualistic linear regression fitting. When this
method was used to quantify mixtures of -10# diesel and 97# gasoline, the volume fraction of 97# gasoline was well fitted. However, the absolute error between the real and fitted -10# diesel content was large (17.5%). To solve this problem, the present research addresses the possibility of developing a method that would allow direct, simple, and accurate determination of the -10# diesel content in gasoline-diesel mixtures, using a terahertz time-domain pulse coupled to a multi-parameter combined analysis. The multi-parameter represents the time delay and amplitude of the first transmission dip and peak in the time-domain pulse. The relationship between these four parameters and the -10# diesel content in gasoline-diesel mixtures was thoroughly investigated and four distinct calibration models for quantifying gasoline-diesel mixtures were built, using least square fitting. To enable the development of an informative and accurate calibration model, the four individual models were given proper weights and combined. The weight was determined by the cosine-optimal-method, which aimed to determine the most proper weight under the condition of the cosine of the angle between the fitted content vector and the real content vector that reaches the maximum. This method allows the determination of -10# diesel content in gasoline-diesel mixtures with a low absolute error (2.6%), resulting in predictions that are more accurate and precise than those obtained by the terahertz absorption coefficient spectra and dualistic linear regression fitting.

**ZigBee Based Wireless Sensor Networks and Their Use in Medical and Health Care**

**Zhongwei Zhang (University of Southern Queensland, Australia); Xiaohua Hu (Haikou Normal University, P.R. China)**

Better medical and health care have been always expected despite the ever growing cost of providing such care services to hospitals and nursing homes. Pervasive sensing and wireless networking technology pose a great potential to the provisions of quality medical or health care with lower but reasonable cost. One of breakthrough or achievements is wireless sensor networks technology, in particular,
medical wireless sensor networks. Medical Wireless sensor networks (WSNs) include Wireless Body Area Networks (WBANs), and Wireless Personal Area Networks (WPANs). In virtue of low communication range and low data transmission rate, Wireless Personal Area Networks (WPANs) have a promising prospect of being deployed in Medical and Hearth care domains. In this paper, it is to deliberate how and how good to use a modified OPNET-ZB model to implement a WPANs that would be deployed in the domain of medicine and health care. We also present a performance comparison of two different categories of Opnet-ZB model based WPANs. Based on the OPNET-ZB model, we simulate two categories of WPANs and study the feasibility of the WPANs deployment in two scenarios.

**Application of Image Processing to Laser Reflective Pattern for Multi-layer Auto-focusing System**

*Wei-Yen Hsu (National Chung Cheng University, Taiwan); Chien-Sheng Liu (National Chung Cheng University, Taiwan)*

It is very important for laser auto-focusing systems in the applications of precise machining. The reflective laser area which is a semi-circular pattern is usually used to estimate the degree of defocusing. As work piece surface may be different in reflective properties and not always smooth, the reflective pattern is usually not a perfect semi-circle. In this study, a novel image processing algorithm is proposed to overcome this fault. Comparing with the conventional method based on the bias of gravity center, the results indicate that the proposed method can not only reconstruct the desired semi-circle back but also calculate the defocusing distance individually. After we use microscope and obtain images and perform the binary-valued image processing, we can clearly discriminate the border and structure of semicircle images and reduce the complexity of the processing of product images. The purpose of binary-valued processing is to discriminate the objects and background of images, so as to obtain the information of objects. We observe the changes of eccentric distance among images with the increases of the focal distance of microscope to determine the accuracy of microscope. The experiment results have
shown the superiority of the sharpness measurement scheme we proposed.

**Design of Automatic Force Application System and Outlier Detection for Force Sensor**

Chi He (Changchun University of Science and Technology, P.R. China); Guangling Dong (China Baicheng Ordnance Test Center, P.R. China); Qiang Li (China Baicheng Ordnance Test Center, P.R. China); Hongqiang Wei (China Baicheng Ordnance Test Center, P.R. China); Jihua Zhang (China Baicheng Ordnance Test Center, P.R. China); Jian Lu (China Baicheng Ordnance Test Center, P.R. China)

The function of fire control system on armored vehicle and the importance of test and evaluation (T&E) for weapon system were described. Composition and working principle of automatic force application system were introduced. With specific problems appeared in use of force sensor, outlier detection of measured data and its generating reason were analyzed with 3σ and Romanovski criteria. In which, the measured data was gathered from precision calibration test of force application and measurement parameters. Calculation results indicate the rationality and feasibility of the proposed outlier detection method for force sensor.

**Second and Subsequent Fragments Headers Compression Scheme for IPv6 Header in 6LoWPAN Network**

Samer Adnan Awwad (University Putra Malaysia, Malaysia); Chee Kyun Ng (Universiti Putra Malaysia, Malaysia); Nor K. Noordin (Universiti Putra Malaysia, Malaysia); Borhanuddin B Mohd. Ali (Universiti Putra Malaysia, Malaysia); Fazirulhisyam Hashim (Universiti Putra Malaysia, Malaysia)

Wireless Embedded Internet aims for efficient connectivity for embedded devices to the internet. This requires the embedded devices to run IPv6 protocol. The 6LoWPAN was introduced to enable IPv6 internet connectivity for WPAN. Enabling IPv6 in wireless, small
size, low power, low rate, limited memory and limited computation capabilities devices, with a limited frame size, is not directly applicable. The relatively huge header size of upper layers protocols (e.g. TCP, UDP and IPv6), in addition to IEEE 802.15.4 header, will deplete the frame payload to approximately 33 bytes. Some protocols had been designed to compress the headers to provide more space for the data payload. In this paper, we present a header compression scheme for 6LoWPAN network. The scheme exploits the correlation between the first and the subsequent fragments' headers and the redundant headers that is transmitted within the first fragment will not be carried again within the second and the subsequent fragments. Second and Subsequent Fragments Headers Compressor Scheme (S&SFHC) can work as a standalone technique or can be integrated with other compassion techniques. However, in this paper, we assess the standalone scheme where the scheme is not integrated with other compression scheme. The performance of the S&SFHC is evaluated based on packet delivery ratio, total charged consumed throughput and average delay. It achieved 20%, 6%, 26% and 6% in terms of packet delivery ratio, total charged consumed, throughput and average delay compared to LOWPAN_IPHC.

**Visible Light Photocatalytic Activity of TiO2/MWNTs Nanocomposite Prepared Using Modified Microwave Technique**

**Firas Alosfur (Universiti Kebangsaan Malaysia (UKM), Malaysia)**

A facile method for in-situ dressing of multi-walled carbon nanotubes (MWNTs) with TiO2 nanoparticles was achieved using modified microwave technique. TiO2/MWCNT nanocatalyst was formed using titanium (IV) isopropanoxide as the precursor in the presence of MWCNTs and constantly irradiated for 5 min. FE-SEM micrographs suggested that TiO2 nanoparticles were well attached on the outer sidewall of MWCNTs. XRD measurement revealed that the TiO2 exist in anatase form with the calculated crystallite size of approximately 5 nm. XPS results show that TiO2 contacts closely with MWCNTs via Ti-O-C bonds. The photocatalytic activity of the nanocomposite was evaluated based the degradation of methylene blue under visible light
irradiation. The results showed that 1 mg of TiO2/MWCNTs hybrid nanocatalyst efficiently degraded the dye.

**A low power environmental wireless radiation monitoring system by using 920MHz frequency band**

*Yoshinori Matsumoto (Keio University, Japan)*

Wireless radiation monitoring system has been developed by sensor network and one board type radiation module. The one board type radiation module is based on Pocket Geiger type5 by Radiation-watch.org. The power consumption of the module was reduced to 2mW for a solar cell driving. The module is designed to connect a Grove terminal of Arduino microprocessors. The radiation dose rate was transmitted by wireless modules (Xbee, RF bee etc.), and collected by the application program. The communication distance of the module was around 40-160m in a straight line distance. Because a lower power radiation detector is required for the environmental measurement around the Fukushima nuclear plant, a custom detection ASIC has been designed by 0.6µm CMOS process. The power consumption of the detector circuit was 1.5mW. New viewer software has been designed for the radiation time-series log file associated with GPS position data.

**Wavelet Singular Entropy-based Feature Extraction From a Temperature Modulated Gas Sensor**

*Kai Song (Harbin Institute of Technology, P.R. China); Qi Wang (Harbin Institute of Technology, P.R. China); Bing Wang (No. 49 Institute, China Electronics Technology Group Corporation, P.R. China); Hongquan Zhang (No. 49 Institute, China Electronics Technology Group Corporation, P.R. China)*

This paper demonstrates that a single thermally-modulated semiconductor gas sensor can discriminate and measure concentrations between two different explosive gases (CH4 and H2) and their mixtures. This method uses a novel feature extraction
method, which is based on the wavelet singular entropy (WSE). From the time-frequency domain and energy spectrum perspective, wavelet decomposition coefficients and WSE are extracted as the features from the dynamic response of a single SnO2-based sensor in a rectangular temperature mode. Also, distance criterion as the feature evaluation criteria is employed to determine the optimal wavelet function, decomposition level and wavelet coefficients. Experimental results show that, compared with fast Fourier transform (FFT) and discrete wavelet transform (DWT), the WSE technique is more effective in terms of feature extraction and is highly tolerant to the presence of serious additive noise in the sensor response.

A Comprehensive Sensor Taxonomy and Semantic Knowledge Representation—Energy Meter Use Case

Ranjan Dasgupta (Tata Consultancy Services Ltd, India); Sounak Dey (TCS, India)

The increasing use of sensors and their observations in applications like environmental monitoring, security and surveillance, health care, infrastructure, meteorology and others not only generate huge amount of sensor data but also increase complexity of integration of heterogeneous sensor devices, their data formats and procedures of measurements. Therefore ways to manage sensors, sensing devices and systems and thereby handling generation of large volume of sensor data is becoming very important. Formal definition of sensor data encodings and web services to store and access them given by Sensor Web Enablement (SWE) initiative of Open Geospatial Consortium (OGC) provides syntactic interoperability but collecting, reasoning, querying on sensors and their observations require sensor semantic compatibility. It allows users to work with domain concepts, their relations and restrictions, which is an abstraction above the technical nitty-gritty of diverse sensor data format and their integration. The paper describes various sensor concepts and their relationships extending IEEE SUMO upper level ontology and OntoSensor, including SensorML and classifies sensor information into five major sensor knowledge representation (1) hierarchy (2) data
(3) function (4) data exchange and (5) domain specific along with code snippets of semantic services generated by mapping between conceptual relationships with structural relationships described in object oriented languages like C++ or Java.

**A Feasibility Study of Utilizing Tribo-Acoustics for Mobile User Interface**

*Leong Yeng Weng (Kanazawa University & Universiti Tenaga Nasional, Japan); Hiroaki Seki (Kanazawa University, Japan); Yoshitsugu Kamiya (Kanazawa University, Japan); Masatoshi Hikizu (Kanazawa University, Japan)*

This paper proposes the feasibility of using triboacoustically emitted signals (TES) generated between finger (covered or uncovered) and tracing surfaces (with or without mechanoreceptors) as an input method for mobile users. This is achieved by localizing upon the acoustic signals generated during the net motion between 2 surfaces in contact. This property allows it to be highly versatile in many real life scenarios. The design of the system opportunistically utilizes the microphone's frequency limitations to define its fundamental frequency of 25kHz and the uniqueness of each signal captured to separate the microphones pairs at the 8th subharmonic distance of separation. The system was proven to be feasible and versatile as test results show it could recreate triboacoustically traced shapes when coupled with different types of surface materials. Results show that the acoustical localization system is able to recreate shapes of a tracing event similar to that produced by the visually localized system but at lower precision and accuracy.

**GPS-Guided Modular Design Mobile Robot Platform for Agricultural Applications**

*Liqiong Tang (Massey University, New Zealand); Samuel J O Corpe (Researcher, New Zealand); Phillip Abplanalp (Researcher, New Zealand)*
This paper outlines the development of a modular mobile robot platform that is designed to provide agricultural industries with improved capabilities around managing land and the plants/animals that are held on it. The system was designed to operate within a range of environmental conditions, as well as the idea of a modular system that could provide a range of capabilities while remaining small enough to minimize the impact on the land through soil compacting. A primary component of this robot is the navigation system, with an augmented GPS implemented to provide the local positioning for the robot. A range of on board sensors is required to provide the robot with an accurate description of its operating environment, as well as to prevent collisions with objects. To test the underlying navigation capabilities of this system, a prototype was developed using a Navman GPS module. The results of this testing indicated that the system was capable of recording a travelled path within a field and then re-navigating that path within the specified accuracies of the GPS module. Future prototype development will aid in proving the capabilities of the system, with the possibility for significant improvements within agricultural industries.

**Bio-Robotic System Using Bio-metric Signals**

*Christopher Scott (Researcher, New Zealand); Liqiong Tang (Massey University, New Zealand); Gourab Sen Gupta (Massey University, New Zealand)*

Using bio-metric signals such as muscle and neuron signals through intelligent control systems to mimic human behavior, recovery human organ function and rehabilitation in health care or remove human beings from hard or dangerous working condition has being an active research area especially in recent decades. This research attempts to develop a cost effective bio-driving robotic system for hand amputees more precisely for wrist disarticulation. The system aims to use the EMG signals from amputee's arm to realize a few commonly used finger and hand movements. So far the research is able to obtain the desired EMG signals through a specific data acquisition and signal processing procedure. A specially designed finger unit has been
designed and the test model is able to function as expected. Further research is still in process. It is hoped that the entire system will be able to be driven by the amputees using their EMG signals and realized the selected finger and hand functions that they use in their everyday life.

**Determination of Critical Span in Real Time using Proper Orthogonal Decomposition**

Jie-Jyun Wan (National Taiwan University, Taiwan); Chia-Pang Chen (National Taiwan University, Taiwan); Cheng-Long Chuang (Intel Labs, Intel Corporation & Intel-NTU Connected Context Computing Center, National Taiwan University, Taiwan); Po-Hsiung Chang (Central Weather Bureau, Taiwan); Hsin-I Ku (Central Weather Bureau, Taiwan); Hsin-Kai Wang (Central Weather Bureau, Taiwan); Wen Chi Huang (National Taipei University of Education, Taiwan); Joe-Air Jiang (National Taiwan University, Taiwan)

In a power delivery system, excessive loads may lead to high temperature of power transmission lines. The extent of aging is proportional to the severity of the thermal overload. How to evaluate aging is an important issue for electric power systems. A critical span refers to a span where the highest conductor temperature occurs in transmission lines and thereby limits how much power can be delivered. In order to monitor real-time temperature of an overhead transmission network, this paper develops a method to simulate a dynamic model for conductor temperature distribution of transmission lines. Proper orthogonal decomposition (POD) is a widely used technique to simulate a spatio-temporal model. For high-dimensional data, POD is an efficient method to reduce the complexity of modeling. Furthermore, an extension of POD - the gappy POD - is used in this study to determine the critical spans so as to reconstruct the conductor temperature distributions of all spans. The simulation results show that the proposed method provides an efficient way of estimating transmission conductor temperature with high accuracy. The average mean square error is less than 10^-4. Through building a transmission conductor temperature model, the critical span of
transmission lines are determined so that effective management and scheduling in real time for power delivery systems can be achieved.

An enhanced network management system for 6LoWPAN-based wireless sensor network

Hsiang-Ting Fang (National Chi Nan University, Taiwan); Ya-Ling Wang (National Chi Nan University, Taiwan); Yang-Wen Chen (National Chi Nan University, Taiwan); Quincy Wu (National Chi Nan University, Taiwan)

Wireless sensor networks (WSNs) have become widely used because of their low cost and low power consumption. With the IPv6 Low-power Wireless Personal Area Network (6LoWPAN) standard proposed by Internet Engineering Task Force (IETF), WSNs can be seamlessly integrated with Internet devices running IPv6. With 6LoWPAN, it will be easy to manage a lot of sensors via the Internet by many existing network management tools. This paper illustrates the design and implementation of an enhanced network management system for 6LoWPAN-based WSNs. Through the simple network management protocol (SNMP) and an Event-Driven mechanism, the system can help users to manage a large number of sensors efficiently.

KIKIWAKE System for Promoting Interest in Sound Source Separation Technique - Novel Application of Microphone Array and Signal Processing -

Tomoki Taguchi (Tokyo University of Science, Japan); Masafumi Goseki (Tokyo University of Science, Japan); Ryohei Egusa (Kobe University, Japan); Miki Namatame (Tsukuba University of Technology, Japan); Masanori Sugimoto (Hokkaido University, Japan); Fusako Kusunoki (Tama Art University, Japan); Etsuji Yamaguchi (Kobe University, Japan); Shigenori Inagaki (Kobe University, Japan); Yoshiaki Takeda (Kobe University, Japan); Hiroshi Mizoguchi (Tokyo University of Science, Japan)
In recent years, the Microphone array signal processing has been actively studied in the field of engineering. In consideration of our hope that children’s interest in this technology will lead to the future development of science and technology, we have developed the KIKIWAKE system with microphone array and conducted Prince Shotoku game to promote children's interest.

**Gain uniformity of trapezoidal triple-GEM detectors**

Yasser Maghrbi (Texas A&M University, Qatar)

The Triple Gas Electron Multiplier (Triple-GEM) became recently one of the most popular gaseous ionization detectors used in high energy physics. Together with the experimental tests, the Monte Carlo simulation is a very important tool for the understanding of the properties of the triple-GEMs. The electron gain has to be stable and uniform enough across the detector. In this paper it is proposed to study the gain and its uniformity in a triple-GEM detector of a trapezoidal shape. It also reports on the uncertainty which can occur during the construction or the operation processes and can result in a gain variation.

**Development of Upgradable Mobile Platform for Smart Applications**

Prabudda Geekiyanage (University of Moratuwa, Sri Lanka); Tharanga Jayarathne (University of Moratuwa, Sri Lanka); Isuru Jayasinghe (University of Moratuwa, Sri Lanka); Ranjith Amarasinghe (University of Moratuwa, Sri Lanka)

The research related to this paper is focused on developing a low cost autonomous robotic platform for domestic use which can be upgraded to perform multiple tasks. As the first step of it, we present here a testing prototype focusing on navigation and localization. Here the construction of the prototype is discussed where an overview of the platform is given. The driving mechanism and navigation and localization methodology is explained in details with the algorithms
used. Finally the paper presents the test results generated through the testing platform including the map generated by the robot.

**Stability analysis of load frequency control systems with real-time pricing and external signals**

*Takehito Azuma (Utsunomiya University, Japan); Tatsuhiko Watanabe (Utsunomiya University, Japan)*

This paper discusses stability of a load frequency control system with real-time pricing. The load frequency control system considered in this paper also depends on an external signal. The external signal corresponds to the predicted electrical load in spot pricing and is called as load-predicted signal. The load frequency control system with the external signal can be derived as an uncertain linear system. Since the uncertain linear system is described as an extended uncertain linear system which consists of monomials about the state, stability of the extended system is analyzed based on sum of squares. From the result of stability analysis, the admissible stability margin is obtained for the load-predicted signal. The efficacy of the load frequency control system with real-time pricing and load-predicted signal is demonstrated in a numerical example.

**Wireless Underground Sensor Network Design for Irrigation Control: Simulation of RFID Deployment**

*Vinod Parameswaran (University of Southern Queensland, Australia); Hong Zhou (University of Southern Queensland, Australia); Zhongwei Zhang (University of Southern Queensland, Australia)*

Wireless Underground Sensor Networks (WUSN) using Electro-Magnetic (EM) wave communication has to address the challenges posed by the underground environment. An alternative to EM wave communication for WUSN is Magnetic Induction (MI). This research aims to study the possibility of using MI communication for WUSN designed for irrigation control in horticulture. As a case study, a typical Pecan farm in Australia has been considered. The case study would
focus on the application of accurate soil moisture reporting and regulation for the farm, under all climatic conditions. This application addresses the issue of water-shortage confronting irrigation in Australia. This paper presents the results obtained from simulation of RFID deployment as part of WUSN design, and is a sequel to an earlier published work as part of an ongoing project.

**Multi-Source Information Fusion for Drowsy Driving Detection Based on Wireless Sensor Networks**

*Wei Liang (Changshu Institute of Technology, P.R. China); Subhas Mukhopadhyay (Massey University, New Zealand); Razali Jidin (Universiti Tenaga Nasional, Malaysia); Chia-Pang Chen (National Taiwan University, Taiwan)*

Drowsy driving is a major cause of road accidents. This paper analyses the drivers' behavior in the state of fatigue driving and introduces the latest developments of drowsy driving detection technology. In this study we also propose a drowsy driving detection based on the driver's physiological signals such as eye activity measures, the inclination of the driver's head, sagging posture, heart beat rate, skin electric potential, and electroencephalographic (EEG) activities, as well as response characteristics, decline in gripping force on the steering wheel and lane keeping characteristics. By developing a hierarchical model that is able to collect the sensing data, analyze the driving behavior and the reactions to the driver, it can provide a safe and a comfortable driving environment. Combining different indications of drowsiness and processing the contextual information to predict whether a driver is drowsy, the system not only issues a warning for the driver, but also provides the drowsy driving information to transportation control center and other vehicles if necessary.

**Distributed Access Scheme for Body Area Networks**

*Haoru Su (University of Science and Technology Beijing, P.R. China); Zhiliang Wang (University of Science and Technology Beijing, P.R. China)*
Sensor networks are being researched and deployed in a wide range of applications in healthcare. A number of tiny wireless sensors strategically placed on or in the human body create a wireless body area network (WBAN) that can monitor various vital signs and provide real-time feedback to medical personnel. In this paper, we present the architecture of an ambulatory e-health system including a cluster-tree structured WBAN. In this WBAN, to achieve synchronization, the BAN coordinator and cluster heads (CHs) send beacon frames periodically. It is necessary to schedule the different beacon frames to avoid beacon collisions. We propose a Distributed Access Scheme (DAS) to solve the beacon collision problem. In Distributed Access Scheme, the CHs select their own contention-free time slot (CFTS) of the beacon-only period for sending its beacon frame to nodes in its cluster.

An Experimental Study of Temperature Effect on Material Parameters of PZT Ceramic Ring Used in Knock Sensors

Stanislav Klusáček (Brno University of Technology & CEITEC - Central European Institute of Technology, Czech Republic); Jiří Fialka (Brno University of Technology, Czech Republic); Petr Beneš (Brno University of Technology & FEEC, Czech Republic); Zdeněk Havránek (Brno University of Technology, Czech Republic)

This article describes the experimental research of a ring of PZT ceramics used in knock sensors. The main aim of the paper is to investigate the temperature effects related to the parameters of piezoelectric materials and to characterize the influence and changes exerted by these parameters on the properties of knock sensors. The purpose of the research is to facilitate the fault diagnosis of an active piezoelectric element, thus enabling the self-diagnostics of a sensor in normal engine operation. Such self-diagnostics is necessary to prevent engine damage and can be performed via online health monitoring of knock sensors. The properties of the material forming the active element based on PZT ceramics are significantly affected by temperature changes. In the paper, the temperature deviations are compared with the impedance and phase characteristics in the
working temperature range of the engine and also related to different types of sensor damage. Based on the material defects (cracks, fissures, fractures) and changes in the material coefficients connected with the frequency characteristics, we can assess the degree of the damage in the examined sensors and evaluate the quality of the inside piezoelement. The results of the realized experimental comparison are shown within the paper. A series of experiments was conducted on a knock sensor, in which we used piezoelectric elements with a differing number of cracks. The experiments demonstrate that the proposed methods can be used for the above-mentioned purpose and are applicable to eliminate any possible damage of an automotive engine caused by vibrations.

**ZnO nanostructures synthesized by arc discharge for optical coating and sensor applications**

Fang Fang (GNS Science, New Zealand); John Kennedy (GNS Science, New Zealand); John Futter (GNS Science, New Zealand); Jerome Leveneur (GNS Science, New Zealand)

Zinc oxide (ZnO) is an important member of semiconductors with a wide direct band gap of 3.37 eV. ZnO nanostructures exhibit interesting properties including high catalytic efficiency and strong adsorption ability. The attention on ZnO nanostructures has been focused on the application in sensing because of its unique properties. The arc discharge method has been successfully applied to obtain ZnO nanostructures. Different arc discharge parameters were chosen to tune the morphology of the as-synthesized structures. Samples were characterized by using scanning electron microscopy (SEM), transmission electron microscopy (TEM) and near infrared diffuse reflectance spectroscopy. A large quantity of high purity ZnO nanorod structures were obtained. Different morphologies and size distributions were obtained by changing partial pressure of arc discharge. Diffuse reflectance of the ZnO nanostructures synthesized by arc discharge method were successfully measured. Up to 60 % of near infrared reflection (NIR) was achieved for ZnO nanostructured synthesized by arc discharge method in the NIR range (800 - 950
The developed ZnO nanostructures will be of immense use in optical sensors. This work highlights the potential use of ZnO nanostructures synthesized by the arc discharge method in optical and bio sensing.

**Individual Nanoparticle Zeta Potential Measurements using Tunable Resistive Pulse Sensing**

Eva Weatherall (Victoria University of Wellington, New Zealand); Geoff Willmott (Callaghan Innovation, New Zealand); Ben Glossop (Izon Science, New Zealand)

Tunable resistive pulse sensing has been used to measure the zeta potential of two sets of 200 nm diameter polystyrene nanoparticles in 0.1 M KCl electrolyte. Data were analysed using two methods, both of which yield particle-by-particle zeta potential values based on electrophoretic mobility. Five pore specimens were used, and in most cases data clearly indicate that one particle set had a higher (less negative) zeta potential than the calibrated zeta potential of the other particle set (-35 mV). Three tungsten needles were used to fabricate the pores, and comparable results were obtained for pores made by the same needle. Measurements were carried out with varying potential applied, and a reliable working range of 0.3 to 0.6 V was observed. Measurement of zeta potentials on individual nanoparticles is important for colloidal applications such as foods, cosmetics, mineral extraction and biomedical technologies.

**Geographical monitoring of Electrical Energy Quality determination: the problems of the sensors**

Maurizio Caciotta ("Roma Tre" University, Italy); Fabio Leccese ("Roma Tre" University, Italy); Sabino Giarnetti ("Roma Tre" University, Italy); Stefano Di Pasquale ("Roma Tre" University, Italy)

Is taken into account the problem at the right price to pay for electricity, according to its quality. It refers to the bond between the definition of perceived quality and the one linked to the technical
parameters. The problems of sensor systems, especially regarding their synchronization linked to their distribution on a geographic basis, is considered. We have the solutions for centralized control of their time course.

14:00 - 15:20
S13A: Built Environment
Chair: Stoyan Nihtianov (Technical University - Delft, The Netherlands)

14:00  **Modeling for gas flow measurement consumed by a boiler. Towards a low-cost sensor for energy efficiency**

_Baya Hadid (University of Poitiers & Ecole Nationale Supérieure d'Ingénieurs de Poitiers, France); Régis Ouvrard (University of Poitiers, France); Laurent Le Brusquet (Supelec, France); Thierry Poinot (University of Poitiers, France); Erik Etien (University of Poitiers, France); Frédéric Sicard (EDF R&D, France)_

This paper deals with the modeling of the gas flow supplied to a boiler in order to implement a soft sensor. This study is a part of ANR CHIC project which has an aim to minimize the measuring chain cost in the energy efficiency improvement programs. This implementation requires the estimation of a mathematical model that expresses the flow rate from the control signal of the solenoid valve and the gas pressure and temperature measurements. Two types of models are studied: LPV (Linear Parameter Varying) model with pressure and temperature as scheduling variables and a non-parametric model based on Gaussian processes.

14:18  **Detection of Street Lighting Bulbs Information to Minimize Commercial Losses**

_Guilherme Marcio Soares (Federal University of Juiz de Fora, Brazil); Henrique Braga (Federal University of Juiz de Fora, Brazil); Alcindo G. B. Almeida (Federal University of Juiz de Fora, Brazil); Estêvão Teixeira (Federal University of Juiz de Fora, Brazil); Raphael Mendes (Federal University of Juiz de Fora, Brazil); Missael Machado (Federal_
This paper introduces a computational methodology developed to extract information about public lighting points. The objective is to give electricity companies exact information about the actual luminaries and bulbs installed on the lighting poles, thus minimizing commercial losses. The developed electronic system, that incorporates hardware and software elements, is discussed, as well as a theoretical background concerning spectrum signature detection and the computational intelligence employed to classify lamp classes and wattages. First experimental results obtained from the devised system are presented.

**14:36 Conductor Damage Inspection System for Overhead Power Cables**

Kevin J Stevens (Quest Integrity NZL Ltd, New Zealand); Keith Lichti (Quest Integrity NZL Ltd, USA); Ian Minchington (Quest Integrity NZL Ltd, New Zealand)

Corrosion and reliability of overhead power lines is a significant industrial problem. The design, development and testing of a Conductor Damage Inspection System (CDIS) is described. The system can measure bulges due to corrosion and internal defects within cables, is remotely operated and can be operated on a live line.

**14:54 Implementation of Transducer Electronic Data Sheet for Zigbee Wireless Sensors in Smart Building**

Harikrishnan Vijayadharan Suseelakumari (Centre for Development of Advanced Computing, India); Sabarimuthu Irene (Ubiquitous
Emerging sensor era in building automation and control recommends the need of interoperable wireless sensors in future homes. The rapid development in smart sensor manufacturing from multitude of sensor manufacturers has also led to the incompatibilities among various devices in wireless sensor network. IEEE 1451 defines a set of open, common, network-independent communication interfaces for connecting transducers (sensors or actuators). Sensing devices come with different calibration, output data units, data-packet structure, number of sensors in devices, buffering techniques, throughput time etc. Interoperability challenge among the devices can be addressed by usage of common reliable globally accepted standard like IEEE 1451. This paper explains implementation of IEEE 1451 standard for ZigBee motes with Activity recognition sensor, PIR sensor, Accelerometer sensor and Temperature sensor.

S13B: Magnetic Sensors 2
Chair: Keith Jones (Callaghan Innovation & Measurement Standards Laboratory, New Zealand)

14:00 A New Eddy Current Sensor Composed of Three Circumferential Gradient Winding Coils

Peng Xu (Nanjing University of Aeronautics and Astronautics, P.R. China); Jun Huang (Nanjing University of Aeronautics and Astronautics, P.R. China)

This paper proposes a new eddy current testing sensor composed of three planar fan-shaped circumferential gradient winding spiral coils. We study the crack detection principle by using the ECT sensor. The experiment of crack detection is set up and a series of samples machined with a slot at different size are detected by using the ECT sensor. Finally the quantitative estimations of crack width, depth and extension direction are studied, which prove the method is feasible and reliable.
14:18 Effect of annealing on magnetic properties and Giant magnetoimpedance effect of amorphous microwires

Ahmed Talaat (Basque Country University, UPV/EHU, Spain); Valentina Zhukova (Basque Country University, UPV/EHU, Spain); Mihail Ipatov (Basque Country University, UPV/EHU, Spain); Juan Blanco (Basque Country University, UPV/EHU, Spain); Arcady Zhukov (Basque Country University, UPV/EHU & Ikerbasque, Science Foundation, Spain)

We studied Giant magnetoimpedance (GMI) effect and magnetic properties of amorphous Fe-Co rich as-prepared and annealed microwires. We measured the GMI magnetic field and frequency dependences, hysteresis loops and domain walls (DWs) dynamics of composite microwires produced by the Taylor-Ulitovski technique. We observed that these properties can be tailored either controlling magnetoelastic anisotropy of as-prepared CoFeBSiC microwires or controlling their magnetic anisotropy by heat treatment. High GMI effect has been observed in as-prepared Co-rich microwires. High DW velocity and rectangular hysteresis loops we observed in heat treated Co-rich microwires. We observe increasing of the DW velocity under stress in some annealed samples.

14:36 Effect of nanocrystallization on Giant magnetoimpedance effect of microwires

Ahmed Talaat (Basque Country University, UPV/EHU, Spain); Valentina Zhukova (Basque Country University, UPV/EHU, Spain); Mihail Ipatov (Basque Country University, UPV/EHU, Spain); Lorena Gonzalez-Legarreta (Universidad de Oviedo, Spain); Blanca Hernando (Universidad de Oviedo, Spain); Arcady Zhukov (Basque Country University, UPV/EHU & Ikerbasque, Science Foundation, Spain)

We studied GMI effect and magnetic properties of Finemet-type FeCuNbSiB microwires. We observed that GMI magnetic field and frequency dependences and magnetic softness of composite
microwires produced by the Taylor-Ulitovski technique can be tailored either controlling magnetoelastic anisotropy of as-prepared FeCuNbSiB microwires or controlling their structure by heat treatment or changing the fabrication conditions. High GMI effect has been observed in as-prepared Fe-rich and heat treated microwires with nanocrystalline structure.

14:54 **Soft Magnetic Amorphous Ribbons with High Frequency Magnetoimpedance for Sensors**

Ahmed Talaat (Basque Country University, UPV/EHU, Spain); Mihail Ipatov (Basque Country University, UPV/EHU, Spain); Valentina Zhukova (Basque Country University, UPV/EHU, Spain); Lorena Gonzalez-Legarreta (Universidad de Oviedo, Spain); Victor Prida (University of Oviedo, Spain); Blanca Hernando (Universidad de Oviedo, Spain); Julian Gonzalez (Basque Country University, Spain); Arcady Zhukov (Basque Country University, UPV/EHU & Ikerbasque, Science Foundation, Spain)

Magnetoimpedance (MI) response of near-zero magnetostriction Co-based amorphous ribbons in as-cast (with different wide dimension) and exhibiting a macroscopic uniaxial magnetic anisotropy induced by stress-annealing (300 MPa at 340, 360, and 400 °C during 1 h) is investigated in a frequency range from 10 MHz up to 1000 MHz. Comparison among MI effect of as-cast state and stress-annealed ribbons is discussed. It is remarkable that more spectacular and defined MI effect is observed in the stress-annealed ribbons owing to the presence of a macroscopic uniaxial transverse magnetic anisotropy developed with the stress annealing which enhances the transverse component of the magnetic susceptibility. The influence of a preceding stress relief before the stress-annealing process on the MI effect is also analyzed.
14:00 Effects of Environmental Conditions on Photovoltaic Module Measurements

Patrizia Vergallo (University of Salento, Italy); Aime' Lay-Ekuakille (University of Salento, Italy); Claudio De Capua (University of Reggio Calabria, Italy); Rosario Morello (University Mediterranea of Reggio Calabria, Italy)

This work illustrates the study on two commercially available photovoltaic modules: a copper indium diselenide (CIS) module and a cadmium telluride (CdTe) one, under real operating conditions in order to investigate on the effects of environmental conditions on their energy production.

14:18 Measurement of Ultrafine Exhaust Particles Using Light Scattering

Harald Axmann (AVL DiTEST Fahrzeugdiagnose GmbH, Austria); Alexander Bergmann (AVL List GmbH, Austria); Bernd Eichberger (Graz University of Technology, Austria)

A new device based on light scattering for measuring the particle concentration in the exhaust of diesel engines is presented. The paper outlines the theory of light scattering, followed by a description of essential parts of the scattering measurement setup. Finally, the issues of correlation to known measures and the calibration for low concentrations are discussed.

14:36 Planar Electromagnetic Wave Sensor for Instantaneous Assessment of Pesticides in Water

Olga Korostynska (Liverpool John Moores University, United Kingdom); Ismini Nakouti (Liverpool John Moores University, United Kingdom); Alex Mason (Liverpool John Moores University, United Kingdom); Ahmed I Al-Shamma'a (Liverpool John Moores University, United Kingdom)

This paper reports on the development of a novel electromagnetic wave sensor for real-time monitoring of presence and concentration of
pesticides in water. In particular, the change in the electromagnetic wave signal in microwave frequency range is used as an indicator of water quality. The sensing element was designed on a FR4 substrate and the planar interdigitated pattern was printed on top of the sensor from Au material to avoid any chemical reaction between the solution tested and the sensor itself. The performance of the developed system was tested on two commercially available pesticides and the results confirmed the viability of using microwaves for real-time water purity monitoring as the corresponding spectra for these pesticides were unique and clearly depicted a shift in the resonant frequencies of the sensor when it was placed in contact with water samples.

14:54 Using Motion Sensor for Landslide Monitoring

Kuo-Lung Wang (National Chi Nan University, Taiwan); Yo-Ming Hsieh (National Taiwan University of Science and Technology, Taiwan)

Owing to plate collision effect, mountain area in Taiwan is about 70% of this island. Landslide hazard is a serious issue since typhoon and earthquake attacks Taiwan every year. Slope land community is more common than before owing to over development from residence requirement. A community with dip slope was selected in this project to perform landslide displacement monitoring. Numerical analysis for sensor alignment location was executed to help decision. Two triaxial acceleration sensors were mounted to the ground surface to calculate tilt of ground surface. Thus the displacement can be derived base on slip surface assumption. Small displacement was found during a typhoon event in July, 2013.

S13D: Dielectric Measurement

Chair: K. Tashiro (Shinshu University, Japan)

14:00 Microwave Sensing of pM Concentration of Insulin in Buffer solution using WGM-DR
Ritika Verma (Dayalbagh Educational Institute, India); Soami Daya Krishnananda (Dayalbagh Educational Institute & Microwave Physics Lab, India)

In this paper we describe a Whispering gallery mode (WGE800) dielectric resonator method with a cheap polycarbonate sample holding disk for sensing variation in picomolar (pM) concentration of Insulin in hepes buffer solution. For investigation of pM concentration Insulin solution mainly three different volumes i.e. 0.4, 0.8 and 6.4 microliter volume of sample solutions loaded on SHD and analyzed. Obtained results shows that calculated loss tangent of solution is sensitive to variation in pM concentration of Insulin with no shift in frequency. Moreover, small response time, low sample volume and its ability to sense losses in pM concentration of Insulin in liquid medium makes this method ideal insulin biosensor for medical diagnostic purpose.

14:18 Development of a Predictive Water-Holding Capacity Method in Postmortem Longissimus Dorsi Muscle

Badr M Abdullah (Liverpool John Moores University, United Kingdom); Alex Mason (Liverpool John Moores University, United Kingdom); Jeff Cullen (Liverpool John Moores University, United Kingdom); Ahmed I Al-Shamma'a (Liverpool John Moores University, United Kingdom)

To accelerate measurement of the water-holding capacity (WHC) of meat, a predictive method based on the use of electromagnetic microwave spectroscopy is investigated. A system is developed to estimate WHC from postmortem muscle. The proposed method is compared with the widely used EZ-Driploss method. WHC is normally estimated by measuring drip loss of the early postmortem muscle over a long period of time. Unlike current methods which are time-consuming, this method estimates the drip loss within 30 minutes. Drip loss of longissimus dorsi muscle is measured using the developed method and the EZ-Driploss method. Results indicate that there is a strong correlation between reflection and transmission
signatures of the meat samples and their corresponding drip loss measured using the EZ-Driploss method.

14:36 Moisture Content Estimation of Wet Sand from Free-Space Microwave Techniques

Sean Richards (Lincoln Agritech Limited, New Zealand); Adrian Tan (Lincoln Agritech Limited & Lincoln University, New Zealand); Ian G Platt (Lincoln Ventures Ltd, New Zealand); Ian M Woodhead (Lincoln, New Zealand)

Dielectric models are used with permittivity measurements of material for translation from permittivity to moisture content. A dielectric model for pure sand was developed based on fundamental physical properties such as the permittivity and geometry of the host material particles, and the frequency dependent processes that determine the permittivity of water. The measurement of sand using the short-circuited reflection method is discussed as is the processing of the measured data to extract permittivity values. Measured data in the 1 - 6 GHz frequency range for sand with a volumetric moisture content of 6.35 and 11.47% and thickness of 100 and 200mm is compared with the dielectric model.

14:54 Utilisation of an Embedded Resonant Structure to Differentiate Lipomyces Yeast Cultures based upon Lipid Content and Cell Concentration

Richard Blakey (Liverpool John Moores University, United Kingdom); Alex Mason (Liverpool John Moores University, United Kingdom); Ahmed I Al-Shamma'a (Liverpool John Moores University, United Kingdom); Carole Rolph (University of Central Lancashire, United Kingdom); Gary Bond (University of Central Lancashire, United Kingdom)

This article proposes a method for differentiation of biological samples based upon the dielectric characteristics of the sample. Lipid accumulation within cells is significant as it serves as a marker
pertaining to the metabolism and oncologic state of the cell and organism. This is accomplished through dielectric characterisation of the sample utilising circuit board based resonant structures. This paper presents a preliminary experiment using lipid accumulating yeast cultures to model lipid droplets in mammalian cells. The experiment indicated that lipid positive and negative cultures can be differentiated based upon the dielectric characteristics of the sample.