2016 Tenth International Conference on Sensing Technology

Nanjing, China | November 11 - 13, 2016

Programme & Abstracts Book

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Welcome Message

We would like to take this great opportunity to welcome you all to the 2016 Tenth International Conference on Sensing Technology, ICST 2016, held from November 11 – 13, 2016 at the Zhongshan Hotel in Nanjing, Jiangsu Province, China. The conference has been jointly organized by Southeast University, China and Massey University, New Zealand. This is the tenth conference of the series; the first two (2005, 2007) of which were held at Massey University, New Zealand, Palmerston North campus, the third (2008) one was held at National Cheng-Kung University, Tainan, Taiwan, the fourth (2010) one was held at the University of Salento, Lecce, Italy. Then the fifth (2011) one was held at Massey University, New Zealand, Palmerston North campus and the sixth (2012) was held at Kolkata, India. The seventh (2013) one was held at the Wellington campus of the Massey University, New Zealand and the eighth (2014) one was held at Liverpool John Moore University, Liverpool, United Kingdom and the ninth one was held at Auckland University, Auckland, New Zealand during December 2015. We would like to congratulate all the authors and share this happiness with you all. All total 131 papers will be presented over three days in three parallel oral sessions and poster format.

The applications of Sensing Technology ranging from medical diagnostic to industrial manufacturing and to defense, national security, prevention of natural disaster and terrorism. The proper detection of events by high performance sensors and appropriate analysis of sensor signals can lead to early warning of phenomena like the bridge collapse at Mississippi river and many other countries and help to prevent deaths from these types of catastrophic accidents. There is a need for interaction between researchers across technologically advanced and developing countries working on design, fabrication and development of different sensors. We sincerely hope ICST 2016 provides a forum for that.

On behalf of the organizer we would like to extend our sincere thanks to many organizations and individuals. Firstly we would like to thank all the authors as they are the key people for any conference to succeed. 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 and for lending their help, support, time and effort to make this conference a great success. Our special thanks to our keynote speakers and invited speakers for their time and support.

The conference has received technical sponsorship from IEEE Instrumentation and Measurement Society along with IEEE IMS Nanjing/Shanghai/Wuhan Joint Section Chapter, IEEE IMS Xian/Chengdu Joint Section Chapter and Jiangsu.
Instrument and Control Society. We thank all the societies for extending the support.

We believe that the conference 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 Nanjing and enjoy your time while you are in China.

S. C. Mukhopadhyay, A. Song, R. Yan, K.P.Jayasundera and G. Y. Tian
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Sanjay Kimbahune, Tata Consultancy Services Ltd. India
Keynote Speaker

From Sensors to Sensor Informatics

Prof. Robert X. Gao

Abstract

Recent advancement in data science has opened up new opportunities to complement advanced sensing technologies for more effective and efficient extraction of information embedded in raw sensor data to enable intelligence operation and control of machines and processes, leading to the low-cost production of high quality products. Actionable information generated by data analytics has the potential to increase the accuracy and reliability in predictive modeling of equipment failure rates and remaining useful life, consequently improving the robustness in preventative maintenance scheduling.

This keynote highlights research that integrates process-embedded sensing methods with advanced computational algorithms to improve the observability in manufacturing process monitoring and product quality control, using polymer injection molding as an example. The design, characterization, and realization of a multivariate sensor with acoustic wireless data transmission capability are introduced, which outperforms commercial sensors in predicting the quality attributes of injection molded parts, due to integration of advanced computational method. The presentation demonstrates the significance of integrating sensing physics with data analytics for advancing the science base for manufacturing.

Author’s Short Biography

Robert X. Gao is the Cady Staley Professor of Engineering and Department Chair of Mechanical and Aerospace Engineering at the Case Western Reserve University in Cleveland, Ohio, USA. Since receiving his Ph.D. from the Technical University of Berlin, Germany in 1991, he has been working on physics-based sensing methodology, multi-resolution signal processing, and energy-efficient sensor networks for improving the observability of systems and processes. Together with his students, he has published over 350 refereed papers and 2 books. He holds 9 patents, and is a
recipient of multiple honors and awards, including the IEEE Instrumentation and Measurement Society’s Technical Award (2013), NSF CAREER award (1996), and multiple Best Paper awards.

Prof. Gao is an elected Fellow of the IEEE, ASME, SME, and CIRP, a Distinguished Lecturer of the IEEE Instrumentation and Measurement Society, and a Corresponding Member of the Connecticut Academy of Science and Engineering. He was a Distinguished Lecturer of the IEEE Electron Devices Society, and served as an Associate Editor for four IEEE and ASME journals. Presently he serves as a Guest Editor for the Special Issue on Data Science-Enhanced Manufacturing of the ASME Journal of Manufacturing Science and Engineering.
**Keynote Speaker**

**Thin-film Coated Optical Fibre Sensors**

Prof. Ignacio R. Matias

**Abstract**

During the last decades, much research has been done in the field of fiber optic sensing technology and more concretely in thin films coated optical fiber sensors. The deposition of thin-films on optical fibre substrates has permitted, during the last decade, widening the traditional domains of application of optical fibre sensors (e.g., gyroscopes, strain and temperature) to other research fields. These thin films could be built up onto diverse types of fibers and optical architectures. And this is possible thanks to modern deposition techniques, which permit coating the optical fibre with materials, whose properties change as a function of a biological or chemical species. Most of the times, those materials enable the introduction of losses to the propagation of light in the optical waveguide. And those losses get modulated as a function of the target parameter. One particular type of thin films coated optical fiber sensors are those based on Lossy Mode Resonances (LMR), developed by the first time in our laboratories.

In any case, the possibility of depositing sensitive nano-films with thicknesses under the wavelength of the interrogating optical light source, make necessary to re-invent many of the classical photonic sensors and devices. New phenomena and properties are appearing. As in many other fields, there is a lot of work left to do in this one.

**Author's Short Biography**

**Ignacio R. Matias** received the M.S. degree in Electrical and Electronic Engineering and the Ph.D. degree in optical fiber sensors from the Polytechnic University of Madrid, Spain, in 1992 and 1996, respectively. He became Lecturer at the Public University of Navarra (UPNA), Spain, in 1996, where presently is a Full Professor of the Electrical and Electronic Engineering Department and the Director of the Research Institute of Smart Cities, UPNA, Pamplona, Spain. He has co-authored 6 books and 17 book chapters. Taking into account only international publications, he has published
177 papers in high impact journals and about 208 communications in prestigious international conferences, 15 of them as keynoted or invited. He has participated in 77 Research Projects, has 14 patents, 6 copyrights, and he is also founder-partner of 5 spin-offs companies.

Prof. Matias has received several scientific and research awards. Just to mention one, he was awarded by the IEEE Sensors Council Meritorious Service Award of the year 2013. He is Editor of 3 International Journals: IEEE Sensors Journal, Hindawi Journal of Sensors and the International Journal on Smart Sensing and Intelligent Systems. He has collaborated in the organizations of numerous scientific events, has supervised 12 doctoral thesis and has occupied several academic positions.
Abstract

It is of significant interest to develop a noninvasive, accurate and biocompatible temperature measurement methods for the study of bio-medical application. It belongs to one of the most challenge in the field of bio-thermo-physical. Magnetic nanothermometry (MNTM) and magnetic heat using magnetic nanoparticles (MNPs) has a unique property that allows non-invasive temperature probing and in vivo thermal manipulation.

In the past five years, our group reported different approaches for remote temperature measurement by using the MNPs. The majority of the reported methods used the first-order Langevin function to describe static magnetic properties of MNPs. The MNTM using Langevin function and finite terms of Taylor expansion of Langevin function to model the magnetization and the inverse susceptibility of MNPs in dc magnetic field was proposed to measure temperature by our group.

The experiments performed in MPMS SQUID VSM (QUANTUM Design, USA) were time-consuming with an accuracy of 0.57 K in the temperature range from 310 to 350 K. Under the calibration of Bloch’s Law, maximum temperature estimation error of 0.022 K with a standard deviation of 0.017 K was achieved using the experiment data obtained in SQUID. In weak sinusoidal magnetic field, a real-time MNTM with maximum temperature estimation error of 0.67 K and standard deviation of 0.29 K in 1 s measurement was achieved, whereas the experiments shown the maximum temperature estimation error was 0.48 K with a standard deviation of 0.19 K in sinusoidal ac plus dc magnetic fields.

In order to improve the resolution and responding time of temperature measurement, triangle wave magnetic field was used to in real-time MNTM. We employ time-varying MNP-based sample, induced by low frequency (f = 25 Hz) triangular-wave magnetic field, to achieve the approach of real-time recording of magnetization curve. We found that by employing the magnetization curve of a magnetic fluid sample containing magnetite nanoparticles of about 30 nm in diameter the accuracy of the temperature probing is about 0.32 K (0.1% relative accuracy), with response time of 1 s.

A model based on Brownian relaxation time was constructed to temperature
measurement by using the AC susceptibility of magnetic nanoparticles (30 nm average diameter). The new approach for remote MNTM was achieved with measured AC susceptibility by the designed system and the proposed model. Our experimental results show that our MNTM allows temperature errors lower than 0.3 K with standard deviations lower than 0.1 K in the temperature range from 310 to 320 K.

Whereas in the application of laser heating, our experiments showed that the MNP DC magnetization temperature-measurement system can detect a 14.4 ns laser pulse at least.

**Author’s Short Biography**

**Wenzhong Liu** joined the Huazhong University of Science and Technology (HUST) in 2000, and became a full professor in 2011. Currently he is Chair of the Department of Measurement Science and Instruments, HUST.

Dr. Liu earned his B.S., M.S. degrees and Ph. D. from HUST’s Department of Control Science and Engineering in 1997, 2000 and 2004 respectively. At HUST he teaches Sensor and Transducer, and Digital Signal Processing. He specializes in weak signal detecting, focusing on issues related to characterization of magnetic nanoparticles (MNP), temperature pulse detection and temperature imaging using MNP. His current research interests include non-invasive temperature estimation using MNP, and characterization of MNP.

Invited Speaker

Industrial Use of Smart Sensors and Sensing Systems in Internet Environment for Contaminant Detection of Drinking Water, A Case Study of Remote Surveillance

Prof. Joyanta Kumar Roy

Abstract

More than three million people in the world die of water-related diseases due to contaminated water, which includes 1.2 million children. In India, it is reported that groundwater in one-third of India’s 600 districts is not fit for drinking as the concentration of fluoride, iron, salinity and arsenic exceeds the tolerance levels. The treated surface water is better than the ground water but stringent surveillance of quality monitoring and control are very essential under single umbrella. Water management system deserves single point Water Quality Monitoring & Surveillance (WQM&S) from source to the entire distribution network. It is a grand challenge to monitor large number of remote access points which may under water contamination threat and are very difficult to protect. The deployment of Smart online water quality sensors, programmable logic controller based wireless remote terminal unit (RTU) at various points along with Supervisory Control and data acquisition (SCADA) system provides single point continuous surveillance to potable water from source to the distribution end. It monitors plant and process parameters, logs all data in real time, analysis the data with historical trends. It integrates online data from sensor along with laboratory data and publishes the same for water generation and supply management. ICT infrastructure provides real time pictures of treatment plant and on line water quality parameters through internet and which is accessible globally through secure channel. A typical application in water treatment plant is discussed. This talk covers key aspects of real time monitoring of water quality using smart sensors and linked water testing laboratory data under cloud based ICT and IoT environment. This talk also focuses on the challenges, current technology, experiences gained during implementation.
Author’s Short Biography

Joyanta Kumar Roy graduated from the Department of Physics from University of Calcutta, India and received Master of Science degree in Physics in 1977. He started his carrier as entrepreneur in the year 1984 founded a small manufacturing enterprise named System Advance Technologies Pvt. Ltd., dealing turnkey execution of SCADA, Automation and industrial instrumentation system. Now he is associated with his company as founder chairman and technical advisor. In 2004 he obtained PhD (Technology) degree in Applied Physics from University of Calcutta, India and executed number of projects, related to control, automation and instrumentation in several engineering sectors. After long association with industry he started his academic carrier from 2005. He worked with many Educational Institutes as Principal and Dean. He was associated with MCKV Institute of Engineering as Dean (Research and Consultancy). He executed several projects on Instrumentation, SCADA and remote monitoring on IoT environment and developed number of indigenous sensors and sensing technology for industrial process.

He is technical speaker and active researcher in inter-disciplinary field of Science and Technology. He received several awards and published book and book chapters on low cost sensors and sensing system. He published many research articles in international & national journals and organized many conferences in national and international level. He is senior member IEEE, Chairman and EC member IET (UK) Kolkata Network, Fellow of IWWWA and Fellow of IETE. Presently he is working as Editor of S2IS and regular reviewer of research articles. His present research interest includes development of smart measurement and control system for water production and distribution, multifunction sensor, ICT based m health, Technology Assisted Living, smart home and city.
Invited Speaker

Unobtrusive Smart Sensing and Pervasive Computing for Healthcare: Cardio-respiratory and Physical Rehabilitation Assessment

Prof. Octavian Adrian Postolache

Abstract

The ageing phenomena requires the development in the near future of new systems and services that will provide healthcare quality with costs optimization. In this context the distinguished lecture will present a set of unobtrusive sensing solutions for health status and daily activity monitoring for regular elderly people and user under physical rehabilitation process. Will be highlighted vital signals acquisition and processing by sensing modules embedded in clothes and/or accessories and walking aid equipment. The strength and drawbacks of different solutions for cardiac and respiratory assessment will be discussed special attention will be granted to the ballistocardiography and radar ballistocardiography implementations but also to other cardiac assessment sensing solutions.

Motor activity monitoring for normal users but also for users under physical rehabilitation represent an important field of research. Novel solutions for motions assessment based on microwave radar motion sensor, MEMS inertial sensors associated with walking aids used in gait rehabilitation process for objective evaluation of applied rehabilitation plan success will be presented together appropriate signal processing techniques. Elements of the electronic health record as so as the interaction between user and the mixed reality scenarios developed for physical therapy are also included in the talk. Additional as part of remote physical rehabilitation unobtrusive sensing solution integration with virtual reality serious games will be considered for the presentation as so as several elements concerning the usage of thermography to evaluate the physical rehabilitation sessions effectiveness.
Author’s Short Biography

Octavian Adrian Postolache graduated in Electrical Engineering at the Gh. Asachi Technical University of Iasi, Romania, in 1992 and he received the PhD degree in 1999 from the same university, and university habilitation in 2016 from Instituto Superior Tecnico, Universidade de Lisboa, Portugal. In the period 1992-2000 he worked as assistant and assistant professor at Technical University of Iasi. In 2000 he became principal researcher of Instituto de Telecomunicações where he is now Senior Researcher. He served as invited professor at EST/IPS Setubal, Portugal between 2001 and 2012 when he joined Instituto Universitario de Lisboa/ ISCTE-IUL Lisbon where he is currently Aux. Professor. His fields of interests are smart sensors for biomedical and environmental applications, pervasive sensing and computing, wireless sensor networks, signal processing with application in biomedical and telecommunications, non-destructive testing and diagnosis based on eddy currents smart sensors, computational intelligence with application in automated measurement systems. He was principal researcher of different projects including EHR-Physio regarding the implementation of Electronic Health Records for Physiotherapy and he is currently principal researcher of TailorPhy project Smart Sensors and Tailored Environments for Physiotherapy. He served as technical principal researcher in projects such Crack Project related non-destructive testing of conductive materials. He is vice-director of Instituto de Telecomunicações/ISCTE-IUL delegation, director of PhD program Science and Communication Technologies at ISCTE-IUL, and he was leader of several collaboration projects between the Instituto de Telecomunicações and the industry such as Home TeleCare project with Portuguese Telecommunication Agency for Innovation (PT Inovação), Integrated Spectrum Monitoring project with National Communication Agency (ANACOM). He is active member of national and international research teams involved in Portuguese and EU and International projects. Dr. Postolache is author and co-author of 9 patents, 4 books, 16 book chapters, 67 papers in international journals with peer review, more than 220 papers in proceedings of international conferences. He is IEEE Senior Member I&M Society, Distinguished Lecturer of IEEE IMS, chair of IEEE I&MSTC-13 Wireless and Telecommunications in Measurements, member of IEEE I&M TC-17, IEEE I&M TC-18, IEEE I&MS TC-25, IEEE EMBS Portugal Chapter and chair of IEEE IMS Portugal Chapter. He is Associate Editor of IEEE Sensors Journal, and IEEE Transaction on Instrumentation and Measurements, he was general chair of
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<td><strong>S5: Invited Talks</strong>&lt;br&gt;Fast and Noninvasive Temperature Measurement by Using Magnetic Nanoparticles (Prof. Wenzhong Liu, Huazhong University of Science and Technology (HUST), China)&lt;br&gt;Industrial Use of Smart Sensors and Sensing Systems in Internet Environment for Contaminant Detection of Drinking Water, A Case Study of Remote Surveillance (Prof. J. K. Roy, System Advance Technologies Pvt. Ltd, Kolkata, India)&lt;br&gt;Unobtrusive Smart Sensing and Pervasive Computing for Healthcare: Cardio-respiratory and Physical Rehabilitation Assessment (Prof. Octavian Adrian Postolache, ISCTE-IUL, Lisboa, Portugal)</td>
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<td>11:00 - 12:30</td>
<td><strong>S6A: Sensors for Novel Applications I</strong>&lt;br&gt;<strong>S6B: Healthcare Applications I</strong>&lt;br&gt;<strong>S6C: Special Session 1A : Sensor signal processing for machinery fault diagnosis and prognosis</strong></td>
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<td><strong>S7: Combined Lunch and Short Oral Session</strong></td>
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<td>14:10 - 15:40</td>
<td><strong>S8A: Magnetic Sensors I</strong>&lt;br&gt;<strong>S8B: Capacitive Sensors</strong>&lt;br&gt;<strong>S8C: Optical Sensors I</strong></td>
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<td><strong>S9A: Sensors and Signal Analysis III</strong>&lt;br&gt;<strong>S9B: Intelligent Sensing</strong>&lt;br&gt;<strong>S9C: Sensors for Novel Applications III</strong></td>
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## Sunday, November 13

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<td>S10B: Special Session 1B : Sensor signal processing for machinery fault diagnosis and prognosis</td>
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<td>11:00 - 12:30</td>
<td>S11A: Microwave, ElectroMagnetic Sensors and Optical Sensors</td>
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<td>13:30 - 14:00</td>
<td>S12: Closing Ceremony and Prize Distribution</td>
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ICST 2016 will be held at Zhongshan Hotel in Nanjing, Jiangsu Province, China

No.307, Zhongshan Road, Xuanwu District, Nanjing
Banquet

The ICST 2016 Conference Dinner will be held on November 12th at Zhongshan Hotel in Nanjing, Jiangsu Province, China
Technical Programme

Friday, November 11

S0: Opening Session
Chair: Aiguo Song (Southeast University, P.R. China)

S1: Keynote
Chair: Prof. Subhas Mukhopadhyay, Massey University, New Zealand

From Sensors to Sensor Informatics
Prof. Robert X. Gao

Thin-film Coated Optical Fibre Sensors
Prof. Ignacio R. Matias

S2A: Acoustic, Image and Near-Infrared Sensors
Chair: Ian G Platt (Lincoln Agritech Ltd, New Zealand)

11:40 Analysis of acoustic emission signal characteristics based on the crack pattern of stress corrosion cracking

Yujiao Shao, Yuan Yu, Yin Zhang, Shaowen Wei and Xuefeng Li (Tongji University, P.R. China)

The problem of stress corrosion cracking (SCC), which causes sudden failure of metals subjected to stress in the high temperature-high pressure water environment. Fortunately, Acoustic emission (AE) monitoring technique shows a promising method for detecting the initiation and propagation of SCC. In this study, a simplified fracture propagation model of type 316LN stainless steel is established based on the moment tensor theory, the inner connection between the energy release rate of AE source and morphological aspect of crack formation is analyzed. Based on the nonlinear finite element method (FEM), The AE waveform data from the crack formation of various depths are obtained, and the energy release rates from various AE sources are analyzed. The results of modal analysis show that energy released by
the growing crack is linearly proportional to crack depth. Moreover, their frequency characteristics are almost unchanged from analysis results by fast Fourier transform (FFT). Therefore, SCC initiation and propagation can be evaluated based on this detection method. And, the appropriate AE sensors and detection systems have the potential to achieve remote real-time monitor of initiation and propagation of SCC. This analysis method can also extended to almost all solid materials and structural crack detection.

11:58 Study on an improved differential box-counting approach for gray-level variation of images

Cancan Li and Kexue Lai (Hubei University of Technology, P.R. China); He Tao (first Affiliation, P.R. China); Lang Chen, Kun Yu and Weisong Zhou (Hubei University of Technology, P.R. China)

The fractal dimension, an important parameter as a measure of roughness of image, has been widely utilized to image classification, recognition and segmentation etc.. Differential box-counting approach is widely applied to estimate fractal dimension in the calculation approaches of fractal dimension. However, this approach can not accurately calculate fractal dimension of image which have smaller gray level. In response to the issue, this paper proposes an improved differential box-counting method on the height h of box. In order to verify the superiority of the improved algorithm, DBC, RDBC, SDBC and improved DBC are separately utilized to estimate fractal dimensions of random images with different gray levels and texture image with different sizes ,and then to compare. Experimental results demonstrate that: improved differential box-counting approach is more stable for random images with different gray levels.
12:16 Highly sensitive visible and near-infrared photo-FET based on PbS quantum dots embedded in the gate insulator

Xiang Liu, Tayeb Mohammed-Brahin and Emmanuel Jacques (University of Rennes 1, France); Wei Lei (Southeast University, P.R. China)

New photo Thin-Film Transistor able to detect light in red and near-infrared wavelength range with high detectivity and high speed, is developed. Detectivity of 1013 Jones at 850 nm is obtained. The rise time and the fall time of the answer to pulsed light are 46 ms and 10 ms respectively. Responsivity value is 1700 A/W at 760 nm and 13 A/W at 1.3 µm. The photo-transistor is based on the light absorption by PbS quantum-dots that are embedded in an epoxy based (SU8 photoresist) thin-film matrix. This thin-film acts as the gate insulator of the transistor and it replaces the usual silicon dioxide gate insulator. The TFT's fabrication is made through a usual top-gate LTPS-TFT process only replacing the top-gate insulator by the mixed QDs-SU8 film. Present TFTs can be easily integrated in any Large-Area electronics process.

S2B: Sensors for Environmental Monitoring
Chair: Zhongyang Cheng (Auburn University, USA)

11:40 A video-based monitor for assessing free-fall droplet motion

Chih-Yen Chen and Chun-Jen Weng (Instrument Technology Research Center, National Applied Research Laboratories, Taiwan); Chi-Hung Hwang (Instrument Technology Research Center, Taiwan); Chi-Wen Hsieh (National Chiayi University, Taiwan)

A newly video-based monitoring technique was developed in this study to characterize the shape and free-fall velocity of water droplets. The disdromter system integrates three main components which are containing the CCD image sensor for capturing video images, the backlight source for illuminating the water droplets, and the computation unit for the image acquisition and function control.
Subsequently, the high-speed CCD image sensor was used to capture images in 160 fps and the exposure time was set at 100 us. With high contrast images, we mark out every droplet by detecting its contour. Later, a flowchart of droplet tracking was executed to obtain the velocity of the free-fall droplets. In our study, the glass balls and the water droplets generated from a sprinkler were both introduced for the verification of the system performance. The experimental results support the proposed free-fall droplet monitoring system while the combination of droplet detection and droplet tracking algorithms are capable to provide a promising approach to measure the free-fall droplets. Additionally, this apparatus could be improved by replacing a CCD with larger sensing area or the faster sampling rate in our next attempt.

11:58 Development of Selective and Sensitive Gas Sensors for Manhole Gas Detection

Sugato Ghosh (Indian Institute of Engineering Science & Technology, India); Hiranmay Saha (Jadavpur University, India); Raghunath Bhattacharyya (Indian Institute of Engineering Science & Technology, Shibpur, India)

Loss of life of the workers inside manhole is a common problem for many parts of the world. To resolve this issue a portable, low cost, simple manhole gas detection unit has been designed and developed which is capable to detect the poisonous gases like carbon monoxide, hydrogen sulfide, and explosive gas like methane within a minute and raise alarm if the concentration of any gas is beyond the threshold limit. Commercially available sensors were found sensitive, but less selective towards its target gases. To improve the selectivity, the authors have developed ZnO based sensing materials for detecting selectively methane, carbon monoxide and hydrogen sulfide from a mixture of gases. The materials were found highly sensitive and selective towards its target gases at either room temperature or at low operating temperature around 1000C. Different surface activation processes like
plasma treatment, composite materials were used to enhance the selectivity of the sensing materials.

**12:16 Highly Selective Ion Imprinted Polymer based Interdigital Sensor for Nitrite Detection**

*Md Eshrat E Alahi, Nasrin Afsarimanesh and Subhas Mukhopadhyay (Macquarie University, Australia); Lucy Burkitt and Pak Yu (Massey University, New Zealand)*

This research proposed the real-time detection of nitrite by employing electrochemical impedance spectroscopy (EIS) technique incorporating an interdigital capacitive sensor. A self-assembled monolayer functionalized the sensing surface with embedded ion-imprinted polymer (IIP) to introduce selectivity for nitrite ions. Synthetization and characterization of IIP are also explained to validate the polymerization technique. Some initial results using different concentrations of nitrite sample to validate the proposed method are also presented. The promising results highlight the extraordinary potential to develop low-cost, in-situ measurement system to detect nitrite contamination with real-time monitoring.

**S2C: Wearable Sensors**

Chair: Lingfei Mo (Southeast University, P.R. China)

**11:40 Chew Count Estimation from Piezoelectric Sensor Signals**

*Muhammad Farooq (University of Alabama, USA); Edward Sazonov (The University of Alabama, USA)*

Research suggests that there might be a relationship between chewing rate and final energy intake. Wearable sensor systems have been proposed for automatic detection of food intake. This work presents the use of linear regression for estimation of chew counts from piezoelectric sensor signal. For known chewing sequences, four features are computed (number of peaks, valleys, zero crossings and duration of
chewing), and linear regression models were trained and tested for estimation of chew counts using cross-validation scheme. Adjusted R2 and mean absolute error (of chew counts) are used for performance evaluation. ANOVA along with Tukey Kramer test was used to compare the performance of different models. Results suggest that best performance was achieved with multiple linear regression model (all features as predictors) with adjusted R2 of 0.95 and mean absolute error of 9.66% ± 6.28%. Results suggest that linear regression models can be used for estimation of chew counts from piezoelectric strain sensor signals.

11:58 Wearable Preimpact Fall Detector using SVM

Tianyi Zhen, Lilei Mao, Jiawei Wang and Qiang Gao (Soochow University, P.R. China)

In order to distinguish falls from normal activities exactly, a fall early warning wearable detector combining angle with acceleration features was proposed in this paper. The detector consists of MEMS inertial sensor and smartphone. The application to solve classification algorithm using Support Vector Machine is developed. Experimental trials which young adults participated in involved 250 falls (4 types, forward, backward, left and right) and 250 normal activities (10 types, bowing, jogging, ascending stairs, etc.). The results of experiment showed the detector provided a sensitivity of 99%, a specificity of 96.5% and the average lead-time is 268 ms. The approached detector's feasibility and efficiency in detecting falls from daily events were verified.

12:16 Human daily activity recognition with wearable sensors based on incremental learning

Lingfei Mo, Zengtao Feng and Jingyi Qian (Southeast University, P.R. China)

This paper proposes a human physical activity (PA) recognition method
based on incremental learning, which deal with the accuracy loss of traditional recognition system caused by the difference of different individuals. Firstly, the paper introduces the principle of incremental learning, which mainly introduced Learn++ algorithm principle and the process of the algorithm, and describes the differentiation feedback optimization link based on incremental learning in specific details. Then, taking the body sensor network built in the previous work as the data acquisition platform, this article conducts 7 activity experiments on five experimental individual, and finally verify the differentiation feedback optimization algorithm of this paper. According to the experiment results, the algorithm described in this paper has an obvious improvement effect on the physical activity recognition performance of certain specific individual.

S3A: Wireless Sensor Networks I
Chairs: Daniel Riordan (Institute of Technology, Tralee, Ireland), Bo-Ru Yang (Sun Yat-sen University, P.R. China)

13:45 PER Evaluation of K-min Viterbi Decoder for Wireless Sensors

Thi Hong Tran (Nara Institute of Science and Technology (NAIST), Japan); Duc Phuc Nguyen and Yasuhiko Nakashima (Nara Institute of Science and Technology, Japan)

Wireless transceiver is a mandatory component of any kind of wireless sensors. Inside wireless transceiver, Viterbi decoder (VD) is needed to improve the decoding performance of the transceiver. In this paper, we propose a low complexity Viterbi decoder algorithm for wireless sensors that aims to support Internet of Thing (IoT) applications. Our algorithm is named as K-min Viterbi decoder because only K nodes with minimum distance at each layer of the decoder are selected for processing. To evaluate packet error rate (PER) performance of the algorithm, we develop an 802.11ah simulator that using 64-state VD. The PER performance of our K-min VD in relation with several factors such as channel type, decoder’s trace-back length, and modulation type, has been evaluated. Our analysis shows that the proposed K-min
VD achieves the same PER performance as the conventional VD does, while its complexity is smaller by approximately 12.8 times to 21.3 times. Therefore, our K-min VD is suitable for IoT wireless sensors which must be small size, low-cost, and low-power consumption.

14:03 A Comparative Study of Fuzzy Vault based Security Methods for Wireless Body Sensor Networks

Sandeep Pirbhulal (Institute of Biomedical and Health Engineering Shenzhen Institute of Advanced Technology Chinese, P.R. China)

Wireless Body Sensor Networks (WBSNs) are widely used for healthcare monitoring applications. Owing to the significance of confidentiality and security, the transmissions of medical information in WBSNs have to be severely protected. This research aims to develop an Intel Galileo based WBSN platform. The physiological characteristics such as (Electrocardiogram) ECG captured from human body can be used as exclusive way for entity identifications (EIs) to authenticate data in WBSNs. In this paper using Matlab software, we also compared the performance of some of recently developed fuzzy vault based data authentication methods for entity identification in WBSNs.


Xin Cao (Institute of Automation, Chinese Academy of Sciences); Xiaoqin Wang and Xiao Lin (Institute of Automation, Chinese Academy of Sciences, P.R. China)

During recent years, with the rapid development of wireless sensor technologies, Wireless Sensor Network (WSN) systems are widely used in various applications, such as environmental monitoring, smart home and so on. A WSN system is a self-configuring network of sensor nodes connected by wireless links. The union of sensor nodes forms an arbitrary topology. Routing in a WSN system is a critical task.
Therefore, the routing protocol has much effect on the throughout performance and energy consumption of the whole network. Most available routing protocols employ distributed structure that is complex and has high energy consumption. Compared with these distributed protocols, a novel centralized routing protocol with a central node is proposed. And all kinds of routing management of the whole WSN systems are centralized in the central node. The centralized management strategy reduces routing overhead and energy consumption of the whole network. Finally, a WSN system with Raspberry Pi and OpenWrt is designed to evaluate the new method. Experiment results show that it is very efficient.

14:39 MAC protocol with traffic adaptive dynamic contention window for Wireless Sensor Networks

Anurag Patro, Manu Elappila, Nandanwar Damodar and Suchismita Chinara (National Institute of Technology Rourkela, India)

Wireless Sensor Networks are used in various fields. Medium Access Control (MAC) Protocols, are at the lower layers of WSNs' protocol stack. They have a greater influence on performance and energy consumption of the network. SMAC is one of the most widely used MAC protocol for WSN networks. SMAC has some drawbacks in back off mechanism. The contention window used here is fixed. We here develop an improved back-off algorithm that adjusts the contention window as per requirement instead of fixed one. We here also ensure that the contention window is not changed drastically. NS-2 is used for simulation. Different traffic levels and topologies are simulated. Results show that the proposed protocol has better throughput, lesser delay, and greater energy efficiency when compared to SMAC protocol.
14:57 Energy-efficient Flooding with Minimum Latency for Low-Duty-Cycle WSNs

Zhen Xu (Wuhan Polytechnic University, P.R. China)

Flooding a message from the sink has been widely used in wireless sensor networks (WSNs) for many purposes like synchronization, code dissemination etc. However, relatively little work has been done for flooding in low-duty-cycle WSNs with unreliable links. For energy-constrained WSNs, we present an energy-efficient flooding algorithm with minimum latency (EFML) in asynchronous low-duty-cycle WSNs, in which the shortest path tree firstly is constructed based on the paths with the minimum delay from the sink to other nodes, then construct a spanning tree with the given delay constraint by locally adjusting the shortest path tree to reduce the energy cost of WSNs. Simulation results show that EFML achieve good performance in terms of flooding delay and energy efficiency.

S3B: Vision and Range Sensors
Chair: Chih-Yen Chen (Instrument Technology Research Center, National Applied Research Laboratories, Taiwan)

13:45 Acoustic and Optical Sensing Configurations for Bulk Solids Mass Flow Measurements

Niall O’Mahony and Trevor Murphy (Institute of Technology Tralee & IMaR Technology Gateway, Ireland); Krishna Panduru (Institute of Technology Tralee, Ireland); Daniel Riordan and Joseph Walsh (Institute of Technology, Tralee, Ireland)

The emergence of trends such as the Industrial Internet of Things (IIOT), Industry 4.0 and Process Analytical Technology (PAT) will see the deployment of large sensor arrays to monitor process parameters which has heightened the demand for real-time, in-line, affordable sensors. The mass flow rate of bulk solids is a parameter that is invaluable to process understanding in many applications. Despite this
the availability of affordable sensors is limited. This paper will investigate some novel sensing arrangements utilising cost-effective components including optical and acoustic sensors with a comparison of these methods against a commercial sensor for their evaluation. Experimental results demonstrate that reliable monitoring of powder flow parameters is achieved and that the system is able to track fluctuations of powder flow in pipes in both free-fall and pneumatic conveyance applications.

14:03 Improving performance of an omnidirectional range sensor for 3D modeling of environments

Roberto Marani (National Research Council (CNR), Italy); Nicola Mosca (CNR, Italy); Vito Renò (ISSIA CNR – Bari, Italy); Massimiliano Nitti (Consiglio delle Ricerche - ISSIA, Italy); Grazia Cicirelli (National Research Council of Italy, Italy); Ettore Stella (Consiglio delle Ricerche - ISSIA, Italy); Tiziana D'Orazio (National Research Council, Italy)

High resolution in distance (range) measurements can be achieved by means of accurate instrumentations and precise analytical models. This paper reports an improvement in the estimation of distance measurements performed by an omnidirectional range sensor already presented in literature. This sensor exploits the principle of laser triangulation, together with the advantages brought by catadioptric systems, which allow the reduction of the sensor size without decreasing the resolution. Starting from a known analytical model in two dimensions (2D), the paper shows the development of a fully 3D formulation where all initial constrains are removed to gain in measurement accuracy. Specifically, the ray projection problem is solved by considering that both the emitter and the receiver have general poses in a global system of coordinates. Calibration is thus made to estimate their poses and compensate for any misalignment with respect to the 2D approximation. Results prove an increase in the measurement accuracy due to the more general formulation of the
problem, with a remarkable decrease of the uncertainty.

14:21 Automatic Detection of Pavement Distress in Road Freight Transport Risks

Zhang Qiuge (Southeast University, P.R. China); Chihang Zhao (Southeast University of China, P.R. China)

Intelligent and Automatic detection of pavement distress is one necessary means to guarantee the safety and the comfort of road freight vehicles, which plays an important role on the pavement maintenance and the freight transportation. Based on analyzing neighboring gray difference, local minimum gray analysis and the sub-block label, one joint automatic detection method of the pavement distress is proposed in this paper. Theoretical analysis and experimental results show that the proposed joint detection method of pavement distress is more effective, and the detection rate of pavement images is 96.7%.

14:39 Multi-channel Features Fitted 3D CNNs and LSTMs for Human Activity Recognition

Yang Qin, Lingfei Mo, Jing Ye and Zhening Du (Southeast University, P.R. China)

human activity recognition has been widely used in many fields, especially in video surveillance and virtual reality, etc. The paper investigates a general feature combination method for a relatively new 3D CNNs and LSTMs fusion model in human activity recognition. All the features used in this combination method are from human activity videos without manually extracting features or any prior knowledge, and the model has good generalization performance. Through extracting multichannel features of the motion optical flow vector, gray scale and body edge, putting them to 3D convolutional neural network, and processing time characteristics within Long-Short Term Memory neural network, the recognition rate of the model rises greatly. The
experiment selects KTH data set as data source. The model based on RGB is used to compare with the model based on multichannel features. It shows that multi-channel features can improve recognition accuracy rate obviously, and have greatly robustness in different scenes, which proves that it is an efficient feature combination method fitted 3D CNNs and LSTMs.

14:57 Design and Development of an Acoustic Sensor Array for Anomaly Detection

Dibyendu Roy (TCS Innovation Lab Kolkata, India); Vempada Ramu Reddy and Parijat Deshpande (Tata Consultancy Services, India); Ranjan Dasgupta (Tata Consultancy Services Ltd, India)

Anomaly detection is the identification of an anomaly with regards to misplaced objects or intruders in an indoor environment. It can be done by mapping a room along with its stationary objects with an ultrasonic acoustic frequency response. In this paper, we explore the feasibility of using active acoustic imagery in air and simulate phased array beam forming techniques to achieve a suitable acoustic sensor array design for a portable mobile robot which can be applied to detect the presence/absence of anomalous objects in a room. The selected room is insonified with a broadband acoustic signal and the multi-path reflection effects contained in the reflected signal time-series in enclosed rooms are analyzed to detect anomalies. The related hardware is designed with the same feasibility criterion that the developed system needs to be deployed on a portable mobile robot. There is a trade-off between image resolution and range with the array size, number of elements and the imaging frequency and has to be iteratively simulated to achieve the desired acoustic sensor array design. The designed acoustic imaging array system is targeted for use in surveillance missions for intruder alerts (anomaly detection) and imaging objects during dark and smoky scenarios where conventional optic based systems do not function very well.
13:45 Research on Dynamic Positioning of Model-Converted ROV Anti-waves Based on Micro Inertial Navigation Sensors

Qingjun Zeng, Song Liang, Huiting Liu, Ming Zhang and Xiaoqiang Dai (Jiangsu University of Science and Technology, P.R. China)

In terms of the uncertainties induced by wave disturbances when an underwater vehicle is operated by the surface of water, a dynamic model based on CFD is built to analyze 6DOF positioning combining with the novelty Model-Converted Remotely Operated Vehicle (MC-ROV) of ocean engineering. A strategy of force and moment allocations is designed according to positioning error, then compensating it with an algorithm known as Non-singular Terminal Sliding Model (NTSM) to low the impact brought by waves likewise. And based on Micro-Electro-Mechanical Systems (MEMS) devices, an integrated micro inertial navigation system is designed. The Unscented Kalman Filter (UKF) is used to improve the navigation accuracy and estimate the real-time location information of MC-ROV. Simulation results show that the proposed algorithm can make the underwater vehicle reach a pre-given position rapidly and effectively, moreover it can adjust the strategy of force and moment promptly when encounters with perturbations so that reduces the negative effects.

14:03 A motion tracking method by combining the IMU and camera in mobile devices

Wei Fang and Zheng Lianyu (Beihang University, P.R. China); Deng Huanjun (Beijing Baofengmojing Technologies Co., Ltd, P.R. China)

Motion tracking is a technique to estimate the localizations of mobile devices in an unknown environment. Recently, it attracts significant attentions for the popularity in various potential applications. This paper presents an architecture combining a monocular camera and an inertial
measurement unit (IMU) in ubiquitous mobile devices. The IMU module can provide acceleration and angular velocity with high-frequency, but due to the bias and noise, the IMU-based motion tracking is more inclined to collapse due to the drift integration. While the vision-based motion tracking can provide higher accuracy to the low cost IMU deviation over time, but which cannot work in environment with weak texture or dynamic. Based on the fusion of the IMU and camera by the error-state Extended Kalman Filter in resource-constrained mobile devices, the robustness and efficiency of the motion tracking with mobile devices can be enhanced, it can realize the ego-motion estimation in real time. Finally, the validity of the proposed motion tracking method is evaluated by experiments.

14:21 3D terrain mapping vehicle for search and rescue

Kevin I-Kai Wang, Opender Singh, Eu-Lee Teh and Kean C Aw (The University of Auckland, New Zealand)

The emergence of urban search and rescue robotics (USAR) as a field of research is largely attributed to the failure of robots in the field thus far. Existing platforms are unable to fulfill the task of finding survivors because they are expensive, specialized, and require a very long lead time to construct and use. Further, they cannot be localized once a survivor is found. This project seeks to address the issues by developing an untethered unmanned ground vehicle with a multitude of sensors to map its path in 3D, coupled with an intuitive graphical user interface for facilitating two-way communication with the onboard Raspberry Pi micro-computer. In the current prototype, wireless communication is achieved through the Transmission Control Protocol (TCP) over a Wi-Fi connection. Dead reckoning has been used as the technique to process proprioceptive sensor data, meaning the system is not reliant on external support to produce the 3D terrain model. The developed graphical user interface allows easy and intuitive visualization of the terrain model and allows users to mark the model for rescue purpose. The developed prototype has successfully
demonstrated its ease of construction, intuitive user interface and capability of automatic terrain mapping.

14:39 An USV-based Laser Fluorosensor for Oil Spill Detection

Deqing Liu, Xiaoning Luan and Feng Zhang (Ocean University of China, P.R. China); Jiucai Jin (The First Institute of Oceanography, SOA, P.R. China); Jinjia Guo and Ronger Zheng (Ocean University of China, P.R. China)

Unmanned surface vehicle (USV) as a new platform has obvious advantages in the marine environmental monitoring. For the requirement of oil spill detection, especially for the sea area of oil spills occur frequently, such as coastal ports, an USV-based laser fluorosensor was developed in this paper. Firstly, the overall scheme of USV-based laser fluorosensor system has been proposed, which consists of shore-based terminal and laser fluorosensor. And the laser fluorosensor system has been designed in detail. The axis of the transmitter and receiver in the system are coincident. A micro-pulse nitrogen laser and an ICCD are used as the excitation source and detector respectively. The laser and ICCD are both working at external trigger mode, and a delay generator outputs two TTL signals with fixed delay time to accomplish the time sequence control of the laser and ICCD camera that is to accomplish range-gated detection. Afterwards, the performance of the system has been tested in the laboratory and field. It was determined that the optimal gate pulse delay and gate width of range-gated detection are 112~113ns and 10ns respectively under the condition of 5m detection range. Moreover, the stability of the system has been tested by repeated measurements, and the results showed that the relative standard deviation of repeated measurements is 3.47 %. At last, the field test had verified that the system has certain ability of field detection
14:57 A novel method and verification of vehicles detection based on RSSI variation

Xiongxiong Li (Nanjing University of Science and Technology, P.R. China)

this paper introduces a new type of vehicle detection method based on the strength of the signal transmission with adopting CC1101 wireless communication chip transmission signal, and RSSI signal strength value of data receiving node is not the same when parking cars and no cars. Through a large number of nodes arranged in the parking lot, data receiving nodes send data included signal strength value of the RSSI (Received Signal Strength Indication) and parking state information to gathering node constantly, next gathering node receives data and upload to the upper machine. The experiment results show that the vehicle detection method is of high accuracy, strong robustness and good reliability.

S4A: Biosensors I
Chair: Khalid M Arif (Massey University, New Zealand)

15:40 Nanoplasmonic Cytokine Biosensor towards Precision Medicine

Pengyu Chen (Auburn University, USA)

The framework of precision medicine envisions a world in which diseases are diagnosed not simply on the basis of a patient’s symptoms but on accumulated data that reveals the fundamental mechanistic bases of human diseases. This raises an emerging clinical demand for transformative tools/biosensors that can measure the biochemical and biological markers to understand the dynamical response of the patient status in a rapid and accurate manner. Nanoplasmonic biosensors have shown great promise to enable such phenotypic measurements with high precision, sensitivity, specificity and simplicity. In this paper, we present a gold nanorod based opto-microfluidic sensing platform for monitoring functional immune response and their translation in clinical applications towards precision medicine. Specifically, we show a label-
free, barcode LSPR nanoplasmonic biosensor for high-throughput, multiplex detection of cytokine biomarkers in a complex serum matrix and patient serum samples. Our strategy of monitoring immune functions using optofluidic nanobiosensors achieved high accuracy and sensitivity with much less sample volume and shorter assay time than that of the conventional methods, which provides new insight into disease severity and therapeutic response and offers great potential in future medical treatment for personalized medicine.

15:58 Development of Molecular Imprinted Polymer Interdigital Sensor for C-Terminal Telopeptide of Type I Collagen

Nasrin Afsarimanesh, Md Eshrat E Alahi and Subhas Mukhopadhyay (Macquarie University, Australia); Pak Yu (Massey University, New Zealand)

This paper presents a label-free and non-invasive technique for selective detection of C-terminal telopeptide type I collagen (CTx-I) by employing Electrochemical Impedance Spectroscopy to measure sample impedance. Molecular imprinted polymer, containing artificial recognition sites for CTx-I was prepared by precipitation polymerization using CTx-I peptide as a template, methacrylic acid as a functional monomer and ethylene glycol methacrylate as the cross-linker. A high penetration depth planar interdigital sensor was functionalized by a self-assembled monolayer along with the synthesized MIP. Different concentrations of CTx-I sample solutions were tested using the proposed sensing system. High-Performance Liquid chromatography diode array system was used to validate the results.

16:16 Rapid Detection of Small Quantities of Specific Bacteria Using Phage-Based Wireless Biosensors

Bryan Chin, Shin Horikawa, Yuzhe Liu, Songtao Du, I-Hsuan Chen, Michael Crumpler, Steve Best, Howard Wikle and Zhongyang Cheng (Auburn University, USA)
This paper presents a method for rapid detection of small quantities of specific bacteria. The method combines wireless phage-coated magnetoelastic (ME) biosensors, a surface-scanning detector, and a motorized translation system, enabling real-time monitoring of the growth of specific bacteria in a nutrient broth. The ME biosensor used in this investigation is composed of a freestanding, strip-shaped ME resonator upon which an engineered bacteriophage is coated to capture a pathogen of interest. E2 phage with high binding affinity for Salmonella Typhimurium was used as a model study. The specificity of E2 phage has been reported to be 1 in 10^5 background bacteria. The phage-coated ME biosensors were first exposed to a low-concentration Salmonella suspension to capture roughly 300 cells on the sensor surface. When the growth of Salmonella in the broth occurs, the mass of the biosensor increases, which results in a decrease in the biosensor's resonant frequency. Monitoring of this mass-induced resonant frequency change allows for real-time detection of the presence of Salmonella. Detection of a few bacteria is also possible by growing them to a sufficient number. The surface-scanning detector was used to measure resonant frequency changes of 25 biosensors sequentially in an automated manner as a function of time. This methodology offers direct, real-time detection and quantification of specific bacteria. The rate of the sensor's resonant frequency change was found to be largely dependent on the number of initially bound cells and the efficiency of cell growth.

**16:34 Study of Dielectric Permittivity and Fatty Acid Composition for Fats and Oil in wide frequency spectroscopy measurement at 0.5 - 50 GHz**

*Masyitah Amat Sairin (University Putra Malaysia, Malaysia); Nina Naquiah Ahmad Nizar and Samsuzana Abd Aziz (Universiti Putra Malaysia, Malaysia); Fakhrul Zaman Rokhani (University Putra Malaysia, Malaysia)*

The study focused on application of spectral permittivity technique subjected to wide frequency range of from microwaves to millimeter
waves (i.e. 0.5 - 50 GHz) at the temperature of 60°C to understand the relationship of dielectric permittivity and fatty acid composition in fats and oil. Results showed that the dielectric constant of 4 animal fats and 2 vegetable oil exhibited same frequency dependence. The dielectric constant of fats and oil increases with an increase in the degree of unsaturation in vegetable oil. The dielectric constant decreases with the increase of composition of palmitic and oleic acid in animal fat. The understanding obtained in this work could be useful towards distinguishing fats and oils especially lard using rapid permittivity spectroscopy based on accurate chemical composition, suitable for Halal product analysis.

16:52 An interrogating circuit and device for magnetostrictive biosensors

Zhongyang Cheng and Kewei Zhang (Auburn University, USA); Anxue Zhang (Xi’an Jiaotong University, P.R. China); Bryan Chin (Auburn University, USA)

High performance biosensors for the detection of bacterial in various media have been developed using magnetostrictive resonators (MSRs). For the MSR sensors to be employed in the real detection, it is critical to develop a handhold device to interrogate the MSR sensors. In this paper, a circuit that is suitable for the development of handhold device is developed to interrogate the MSR sensors and a methodology to enhance the signal of the MSRs is introduced.

S4B: Mechanical Sensors I
Chair: Norbert Schwesinger (Technische Universität München, Germany)

15:40 An Autonomous, Non-invasive Vibration Measurement System using Stroboscope

Dibyendu Roy (TCS Innovation Lab Kolkata, India); Sushovan Mukherjee (TCS Innovation Lab, India); Brojeshwar Bhowmick (TCS, Kolkata, India); Arijit Sinharay (Tata Consultancy Services Ltd., India); Ranjan Dasgupta (Tata Consultancy Services Ltd, India); Arpan Pal
This paper presents a novel methodology of calculating an object's frequency of vibration autonomously using a camera and the mechanism of strob ing. The camera used, has a frame rate of 30 fps and therefore, in the conventional fashion, it is unable to capture meaningful information about any vibration frequency higher than that. To circumvent this problem, we utilize the strobing concept with an illumination frequency higher than camera frame rate and modulo (of division) between object's frequency and strobing frequency is captured in video. Motion in the video is tracked using robust optical flow technique. Finally, frequency is calculated from the frequency plot and the illumination frequency of the strobe. Experimental results show that our method is effective in various real scenarios. The method is noninvasive, computationally less expensive and more scalable compared to the existing systems.

15:58 Inertia Sensing for Bulk Solid Measurement in Process Analytical Technology Systems

Trevor Murphy and Niall O’ Mahony (Institute of Technology Tralee & IMaR Technology Gateway, Ireland); Krishna Panduru (Institute of Technology Tralee, Ireland); Daniel Riordan and Joseph Walsh (Institute of Technology, Tralee, Ireland)

The mass flow measurement of a bulk solid is one of the most common parameters monitored in the materials processing industries and enjoys a wide range of sensory options to accurately quantify the mass flow of a given material. The emergence of Process analytical technology has heightened the demand for such information to be provided to process analysers, in real time in order to allow for continuous monitoring and control of manufacturing processes. Many of the methods and techniques applicable to this form of measurement can incur heavy costs due to the complexity of the sensors design and/or operation. This paper investigates the use of a novel method of mass flow measurement of a bulk solid using a low cost inertia (shock)
sensor located within a pneumatic conveyance system test rig. Also included in this paper is the techniques employed to successfully integrate the sensor into the test rig in order to achieve favourable test results. The inertia sensor operates on the principle of mechanical displacement and emits an output signal proportional to the level of shock absorbed. A calibrated microwave mass flow sensor was used as reference data to investigate correlation between the sensor outputs located within the test rig. The resulting test data from the laboratory experiment was then analysed and compared to that of the pre-calibrated microwave mass flow sensor with results indicating a strong correlation in the output signals of the inertia sensor with respect to the microwave mass flow sensor. Test data from the inertia sensor will show the sensors ability to successfully detect variations in the flow of material through the test rig with relative accuracy. It is the intention of this paper to demonstrate that inertia sensors can be a viable, low cost and simplistic form of mass flow measurement capable of integrating into manufacturing process monitoring and control systems such as PAT.

16:16 Design and Research of ultra-miniature pressure sensors

Bing Wang (Kunshan Shuangqiao Sensor Measurement Controlling Co, LTD, P.R. China); Zhao Yulong (State Key Laboratory for Manufacturing Systems Engineering, P.R. China); Xinli Cheng (Suzhou University of Science and Technology, P.R. China); Wenxiang Wang (Kunshan Shuangqiao Sensor Measurement Controlling Co, LTD, P.R. China)

This paper reports the design and fabrication of dynamic ultra-miniature pressure sensor. Based on bulk silicon MEMS micromachining technology, the Si-Si direct vacuum bonding and thinning technology with precision control were used to fabricate the subminiature silicon piezoresistive chip for absolute pressure measurement. The sensors with outer diameter Φ2.0mm were packaged with miniature probe mode, which have the natural frequency of 300~1000 kHz. The ultra-
small dynamic pressure sensors may be used to aerodynamics research successfully.

16:34 Design and Experiment Study for MHD Microradian Angular Vibratory Sensor

Tong Li and Kundong Wang (Shanghai Jiao Tong University, P.R. China)

Measurement of microradian angular vibratory could be used for acquiring posture and vibratory information of the satellite platform, laser weapons and optical remote sensing platform, so that it could control posture of platform steadily. Without mechanical wear of traditional gyroscope and limited by optics comparing with optical gyroscope, the angular vibratory sensor based on magnetohydrodynamics(MHD) principle has the characteristics of high precision, broadband, long lifetime, surge suppression, small size and light-weight. This paper introduces study process in different institutions, and then describes the sensitive principle of the MHD microradian angular vibratory sensor. Here we choose our designing scheme through comparing products based on the MHD principle internationally. After that, we give out the transfer function, structure, magnetic field and current path design and technology realistic way to display a prototype. Eventually, we provide the result of the sensor test experiment, analysis and summary. We evaluate the current achievement and indicate the direction of next step. This paper lays the foundation for realizing engineering application.

16:52 Study on Spinning Process and Constant Tension Control System of Absorbable Suture

Xiuwu Sui and Shuo Wang (School of Mechanical Engineering, Tianjin Polytechnic University, P.R. China)

In the producing process of absorbable suture, in order to solve the problem of suture diameter and the tensile strength are uneven,
constant tension control system of absorbable suture is designed. Detection device using three rollers tension sensor whose sensitive element is the resistance strain gauge; Control device using programmable controller; Execution device using three-phase motor; Display device using weinview touch screen. Experiments show that the constant tension control system can control the controlled tension error in less than 0.1N. The system has good real-time performance and high reliability. The suture made by the constant tension control system is completely in line with the standard of the USP thirty-second edition of the collagen suture.

**S4C: Sensors and Signal Analysis I**
Chair: Fakhrul Zaman Rokhani (University Putra Malaysia, Malaysia)

15:40 Detection of Three-Dimensional Fluorescence Spectra of Mineral Oil Based on PCA-ENN Method

*Kai-zeng Niu (University of YanShan, P.R. China)*

Propose a new method of using neural networks for pattern recognition, combine with principal component analysis (PCA) and extension neural network (ENN) to identify three-dimensional fluorescence spectra of oil pollutant. For the problem of identifying mixture components, choose standard solution measurement samples of diesel, gasoline and kerosene. Using full-featured FS920 fluorescence spectrometer to measure data, using principal component analysis to reduce dimension of the neural network input vector and extension neural network for classification. The results show PCA-ENN algorithm has higher recognition accuracy and efficiency, and this algorithm can also be used to identify other areas of spectra of organic substances.

15:58 Real time measurement of water level using Admittance method and fuzzy based linearizer

*Joyanta Kumar Roy (MCKV Institute of Engineering & System Advance Technologies Pvt. Ltd., India); Bansari Deb Majumder*
Admittance type level transmitter is not popular in industries. Because it has significant cross sensitivity in temperature and ionic concentration of the liquid, thus producing unreliable results in the measurement. Theoretical study was already being made successfully to remove cross sensitivity using fuzzy based linearizing system in MATLAB platform. In this paper real-time linearization has been attempted using NI Labview and data acquisition system based on early experience. Result from real-time measurement reveals good linearized, reliable and acceptable output. Therefore this approach may be a gateway to develop continuous measurement of level in industrial process using admittance method.

16:16 Design Successive Approximation Register Analog-To-Digital Converter with Vcm-Based Method for M-PAM Receiver and Sensor Application

Wen Cheng Lai and Ho Chang Lee (National Taiwan University of Science and Technology, Taiwan)

In this paper proposed successive approximation register (SAR) analog-to-digital converter (ADC) implemented for M-PAM receiver and computational intelligence application is presented. By applying Vcm-based switching method that reduces switching power of the DAC, the proposed SAR ADC uses less capacitor in the DAC array. Also, asynchronous control logic is used which an external high frequency doesn't need clock to drive ADC. This design provide on the automatic gain control (AGC) scheme for pulse amplitude modulation (PAM) with analog-to-digital converters (ADCs).

16:34 A Novel Vehicle Dynamics Identification Method Utilizing MIMU Sensors Based on Support Vector Machine

Lei Jiang, Yu Wang, Xinhua Zhu and Yan Su (Nanjing University of Science and Technology, P.R. China)
The major challenge of inertial navigation system (INS) is the rapid navigation error drift when aiding sensors are unavailable. However, if the dynamics of land vehicle can be detected, these errors can be corrected or restrained. A method based on support vector machine (SVM) using the outputs of MIMU is proposed here to identify the dynamics of land vehicle. This method computes part of the time-domain features and frequency-domain features. Then, a subset of these features is selected based on wrapper evaluation criteria. Afterwards, SVM is trained based on these selected features. Finally, the trained SVM is used in identification tests. The identification results show that this method can correctly identify the stationary, straight-line and cornering states.

**16:52 Designs of Driving Module and Signal Processing Module of VOx IRFPA**

Yong Song, Dingchao Xie and Yufei Zhao (Beijing Institute of Technology, P.R. China); Youchun Song (Kedun Science & Technology CO LTD, P.R. China); Beiyan Liang and Yue Yang (North Guangwei Technology Inc, P.R. China); Qiang Wu (Kedun Science & Technology CO LTD, P.R. China)

Compared with the infrared focal plane array (IRFPA) based on amorphous silicon (α-Si), IRFPA based on vanadium oxide (VOX) has the advantages of big temperature coefficient, low noise and so on. Therefore, it is believed that VOX IRFPA has important application in both military and civil field. In this paper, the designs of driving module and signal processing module of VOx IRFPA are proposed. Firstly, the hardware designs of the driving module and signal processing module of VOx IRFPA are discussed in detail. Secondly, the design of the system configuration programs based on FPGA are introduced. Finally, some experiments were carried out to verify the validity of the developed modules, the results indicated that our work will lay a foundation for the implement of micro and low-cost infrared imaging
system, and promote the application of infrared imaging technology in the field of civil consumption.
Saturday, November 12

S5: Invited Talks
Chair: Ruqiang Yan (Southeast University, P.R. China)

Fast and Noninvasive Temperature Measurement by Using Magnetic Nanoparticles
Prof. Wenzhong Liu, Huazhong University of Science and Technology (HUST), China

Industrial Use of Smart Sensors and Sensing Systems in Internet Environment for Contaminant Detection of Drinking Water, A Case Study of Remote Surveillance
Prof. J. K. Roy, System Advance Technologies Pvt. Ltd, Kolkata, India

Unobtrusive Smart Sensing and Pervasive Computing for Healthcare: Cardio-respiratory and Physical Rehabilitation Assessment
Prof. Octavian Adrian Postolache, ISCTE-IUL, Lisboa, Portugal

S6A: Sensors for Novel Applications I
Chair: Guiyun Tian (Newcastle University, United Kingdom)

11:00 An approach to design a Bourdon tube Pressure Transmitter for remote measurement
Bikas Mondal (Indian School of Mines, India); Joyanta Kumar Roy (MCKV Institute of Engineering & System Advance Technologies Pvt. Ltd., India); Nirupama Mandal (Indian School of Mines, Dhanbad, India); Rajan Sarkar (Asansol Engineering College, India)

C-type Bourdon tube is most common and popular pressure measuring instrument in process industry. Due to simple and rugged low cost construction, Bourdon tube is still used for local pressure monitoring system. The key challenge of this elastic-mechanical pressure sensor is its non electrical output. In this paper, a secondary element, LVDT is attached with the C-type Bourdon tube which act as primary sensing element to get electric signal as output. The sealed tip of the Bourdon tube is mechanically coupled with the core of the LVDT. The applied
input pressure causes deflection of the tip of the Bourdon tube. This deflection is sensed by LVDT and produce electric signal proportional to the applied pressure. The signal after conditioning converted to 4-20mA DC signal for industrial compatibility. This current signals can drive loop powered digital indicator, universal controller and remote telemetering system. The experimental data follows good static characteristics with acceptable linearity and repeatability.

**11:18 A High Performance VCO Using Adaptive Class C Technique for Sensor Application**

*Wen Cheng Lai, Sheng–Lyang Jang, Wei–Te Liu and Ching-Wen Hsue (National Taiwan University of Science and Technology, Taiwan)*

This letter presents a 1.1V low power Voltage Control Oscillator (VCO) is designed and implemented in a 0.18μm COMS 1P6M process. The proposed circuits are using adaptive class C technique that can reduce power consumption. At the supply voltage 1.1V, the output frequency is 2.155GHz and the phase noise is -129 dBc/Hz at 1MHz offset. Tuning range is about 155MHz (6.9%) between 2.155 to 2.31GHz while control voltage was tuned from 0 to 2V. Excluding output buffers the VCO consumes the power 0.5 mW under a standard supply of 1.1 V.

**11:36 Teach robots understanding new object types and attributes through natural language instructions**

*Jiatong Bao, Ze Hong and Hongru Tang (Yangzhou University, P.R. China); Yu Cheng, Yunyi Jia and Ning Xi (Michigan State University, USA)*

Robots often have limited knowledge about the environment and need to continuously acquire new knowledge in order to collaborate with the humans. To address this issue, this paper presents a method which allows the human to teach a robot new object types and attributes through natural language (NL) instructions. A simple yet robust vision algorithm is proposed to segment objects and describe the relations.
between objects. The segmented objects as well as their relations are regarded as the basic knowledge of the robot. The NL instructions are processed to domain-specific representations for the robot to identify the target objects. The target objects as well as the object type or attribute labels referred in the NL instructions are collected as training samples for the robot to learn. Experimental results demonstrate the effectiveness and advantages of the proposed method.

11:54 Correlating electronic nose and field olfactometer for industrial odor concentration measurement using PLS and MLR

Sharvari Deshmukh (CSIR-National Environmental Engineering Research Institute, India); Arun Jana (Centre for Development of Advance Computing, India); Rajib Bandyopadhyay (Jadavpur University, India); Nabarun Bhattacharyya (Centre for Development of Advance Computing, India); R Pandey (National Environmental Engineering Research Institute, India); Hemant Purohit and Atul Vaidya (CSIR-National Environmental Engineering Research Institute, India)

Industrial odor concentration measurement in continuous mode is challenging task using olfactometers, as it's expensive and requires human involvement for prolonged time. This paper presents the development of an indigenous metal oxide sensor based electronic nose system for measurement of industrial odor in ou/m3. The results of electronic nose and field olfactometer were correlated using multilinear regression and partial least square regression techniques. The results showed satisfactory prediction by both the models, with RMSE (6.70, & 4.02), RAE (0.29 & 0.16) and NAE (0.89 & 0.96) respectively for MLR and PLS. The results indicated better performance of PLS compared to MLR. The objective of the present work is to train and employ artificial olfaction system for continuous measurement of obnoxious emissions emitted from industries bypassing involvement of olfactometer.

12:12 Mechanism for Developing a Kinesthetic Haptic Feedback System
Ahmed Farooq, Philipp Weitz, Grigori Evreinov and Roope Raisamo  
(University of Tampere, Finland)

Kinesthetic information is beneficial in detecting, recognizing, and interpreting haptic objects in virtual space. Unfortunately, kinesthetic feedback requires linkage-based high-powered multi-dimensional manipulators, such as exoskeletons or robotic arms, which are currently not possible to integrate with mobile devices. To overcome this challenge, we describe a novel system that is able to apply linkage-free directional forces to a stylus tip, in order to control user input behavior and provide haptic information. Elaborating on the theoretical approach introduced by Reznik and Canny in their 'Universal Planar Manipulator', this paper illustrates the development of the novel "Stick-slip" Kinesthetic Display Surface (SKDS) prototype. The SKDS prototype is an evolution of various design efforts, highlighting the efficiency, accuracy, and reliability of the system. We demonstrate how it is possible to generate directional forces on an interactive display in order to move a linkage-free stylus over a touchscreen in a fully controlled and efficient manner.

**S6B: Special Session 1A:** Sensor signal processing for machinery fault diagnosis and prognosis  
Chair: Zhongkui Zhu (Soochow University, P.R. China)

**11:00 Sparse Representation of Transients Based on Improved Matching Pursuit Algorithm for Gear Fault Diagnosis**

Lin Wang, GaiGai Cai, Juanjuan Shi, Weiguo Huang and Zhongkui Zhu  
(Soochow University, P.R. China)

Localized faults on gears tend to result in periodic transient components under a constant speed operation. Extraction of such transient components is crucially important for gear fault diagnosis. Sparse decomposition based on matching pursuit (MP) is one of the effective methods to extract the weak feature contaminated by strong background noise and has been extensively used for transient feature
extraction. In this paper, a practical and effective method is proposed for MP based sparse representation, which is enhanced in terms of sparse dictionary construction and computational complexity of MP. A special wavelet basis matching with the transients is developed to construct the sparse dictionary for fault vibration signal. The inner product operation in MP is replaced by cross-correlation implemented by fast Fourier transform (FFT) to address the problem of enormous computational complexity of MP algorithm. Simulation and experiment show that the gear fault feature can be effectively extracted and the computational efficiency is essentially improved by the proposed method.

11:18 Wayside Acoustic Fault Diagnosis of Railway Wheel-bearing Paved with Doppler Effect Reduction and EEMD-based diagnosis information enhancement

Yongbin Liu (National Engineering Laboratory of Energy-Saving Motor & Control Technology); Qiang Qian, Ynagyang Fu, Fang Liu and Siliang Lu (Anhui University, P.R. China)

Wayside acoustic monitoring technique is promising for health monitoring of wheel-bearing for railway vehicles. However, due to the high relative moving speed between the railway vehicle and the wayside mounted microphones, the recorded signal is embedded with Doppler Effect. What's more, the background noise is relatively heavy which makes it difficult to extract the diagnosis relevant information. To solve these problems, this paper introduced a railway wheel-bearing wayside acoustic fault diagnosis scheme based on Doppler Effect reduction and Ensemble Empirical Mode Decomposition (EEMD). Firstly, an improved Doppler Effect reduction method is introduced incorporating with the kinematic parameters estimation and signal resampling method. Secondly, the EEMD is employed to extract the diagnosis relevant Intrinsic Mode Function (IMF). Finally, the envelope spectrum analysis is employed to identify the local fault. The effectiveness of the proposed method is verified by experimental cases analysis.
11:36 Multi-Domain Sequential Signature Analysis for Machinery Intelligent Diagnosis

Jinjiang Wang, Yulong Zhang, Lixiang Duan and Xuduo Wang (China University of Petroleum (Beijing), P.R. China)

Feature extraction plays an important role in machinery fault diagnosis and prognosis. The features extracted from time, frequency and time-frequency domains are widely investigated to describe the properties of overall signal from different perspectives, seldom considering the sequential characteristic of time-series signal in which the fault information may be embedded. This paper investigates a novel approach combing modified Symbolic Aggregate approximation (SAX) framework and Kernel Principal Component Analysis (KPCA) to extract fault information by analyzing sequential pattern in time-series signal for fault diagnosis. SAX reduces the dimensionality of raw data by transforming the original real valued time series into a discrete one with analyzing signal sequential characteristic and then multiple features are fused by KPCA for fault classification. The proposed approach has high computational efficiency and fault diagnosis accuracy. Experimental studies on reciprocating compressor valve demonstrate that the presented approach outperforms the methods of SAX-entropy using support vector machine for classification.

11:54 Machine Health Monitoring with LSTM Networks

Rui Zhao (Nanyang Technological University, Singapore); Jinjiang Wang (China University of Petroleum (Beijing), P.R. China); Ruqiang Yan (Southeast University, P.R. China); Kezhi Mao (Nanyang Technological University, Singapore)

Effective machine health monitoring systems are critical to modern manufacturing systems and industries. Among various machine health monitoring approaches, data-driven methods are gaining in popularity due to the development of advanced sensing and data analytic techniques. However, sensory data that is a kind of sequential data
cannot serve as direct meaningful representations for machine conditions due to its noise, varying length and irregular sampling. A majority of previous models focus on feature extraction/fusion methods that involve expensive human labor and high quality expert knowledge. With the development of deep learning methods in the last few years, representation learning from raw data has been redefined. Among deep learning models, Long Short-Term Memory networks (LSTMs) are able to capture long-term dependencies and model sequential data. Therefore, LSTMs is able to work on the sensory data of machine condition. Here, the first study about an empirical evaluation of LSTMs-based machine health monitoring systems is presented. A real life tool wear test is introduced. Basic and deep LSTMs are designed to predict the actual tool wear based on raw sensory data. The experimental results have shown that our models, especially deep LSTMs, are able to outperform several state-of-arts baseline methods.

**12:12 VMD based adaptive multiscale fuzzy entropy and its application to rolling bearing fault diagnosis**

Zheng Jinde (School of Mechanical Engineering, Anhui University of Technology, P.R. China); Jiang Zhanwei (School of Mechanical Engineering, Anhui University of Technology, Maanshan, Anhui, P.R. China); Pan Ziwei (School of Mechanical Engineering, Anhui University of Technology, P.R. China); Zhang Kang (Changsha University of Science and Technology, P.R. China)

Based on the recently proposed method for nonlinear and non-stationary vibration signal, variational mode decomposition (VMD), an adaptive multiscale fuzzy entropy (AMFE) method is introduced in this paper. Firstly, the VMD method is used to decompose the vibration signals of rolling bearing into a number of intrinsic mode functions (IMFs). Then the fuzzy entropy of each IMF is computed. Meanwhile, combining with support vector machine (SVM), a new rolling bearing fault diagnosis approach is put forward. The proposed method is applied to the experimental data of rolling bearing and the analysis results show the effectiveness of the proposed method.
Analysis of a Coverstitched Stretch Sensor for Monitoring of Breathing

Raul I. Ramos-Garcia (The University of Alabama, USA); Fernanda Da Silva (Federal University of Itajuba - Itabira, Brazil); Yashvanth Kondi (International Institute of Information Technology - Bangalore, India); Lucy Dunne (University of Minnesota, USA); Edward Sazonov (The University of Alabama, USA)

Textile-based sensors are being integrated into garments for the monitoring of physiological signals from the human body. Commonly, textile sensors are implemented through knitting methods, while the response of these sensors from other structures has been less studied. This work analyzed the feasibility of using a textile-based stretch sensor with a coverstitch formation integrated into a commercial shirt for monitoring breathing patterns. For comparison, a Respiratory Inductive Plethysmograph (RIP) based breathing system was used. Data from three subjects performing eight different activities were collected in a controlled environment. The performance of the textile sensor was evaluated based on the mean absolute error breathing rate captured using different segment sizes and as the degree of correlation to the RIP sensor. Results showed an average breathing rate error of 0.97±0.42 breaths/epoch for an epoch size of 10s. The average correlation with the RIP sensor signals was p=0.41±0.2. Results suggest that this garment-integrated sensor could be potentially used in the monitoring of breathing rate.

Characterization of the Implantable Intra-body Communication based on Capacitive Coupling by Transfer Function

Maoyuan Li, Yong Song, Guangfa Wang, Qun Hao and Kai Zhang (Beijing Institute of Technology, P.R. China)
Implanted miniaturized device could enable efficient healthcare and clinical applications, such as monitoring, diagnosis and treatment, etc. In this paper, characterization of the implantable intra-body communication based on capacitive coupling has been researched. The transfer function of implantable intra-body communication based on capacitive coupling was derived and the corresponding parameters were discussed. The validity of the developed model has been verified by measurements. Finally, the characteristics of this communication mode have been discussed in detail, while some important conclusion has been achieved. Our results indicate that the implantable intra-body communication based on capacitive coupling can be regarded as a potential ideal way for the communication among implanted devices.

11:36 Novel Application of Kinect Sensor to Prevent Collision Accidents between Machine and Operator

Yosuke Ota, Haruya Tamaki and Tsugunosuke Sakai (Tokyo University of Science, Japan); Hiroshi Takemura (Noda Tus, Japan); Hiroshi Mizoguchi (Tokyo University of Science, Japan); Fusako Kusunoki (Tama Art University, Japan); Shigenori Inagaki (Kobe University, Japan); Masanori Sugimoto (Hokkaido University, Japan)

Many collision accidents between operators and machine tools are reported. However, no effective way of preventing these accidents has been proposed to date. Therefore, the authors propose the implementation of a danger decision by measuring the human posture and face direction. By performing a danger decision, the authors aim to realize the effective prevention of collision accidents. The posture and face direction were measured by using a Kinect sensor, which has the ability to obtain information about the posture and face direction. This paper presents the results of experiments aimed at examining whether it is possible to realize a danger decision. The experimental results confirm the feasibility of using a danger decision based on the measurement of the operator’s posture and face direction.
11:54 **Transparent biocompatible sensor patches for touch sensitive prosthetic limbs**

*Anindya Nag and Subhas Mukhopadhyay (Macquarie University, Australia); Jürgen Kosel (King Abdullah University of Science and Technology, Saudi Arabia)*

The paper presents the fabrication of transparent, flexible sensor patches developed using a casting technique with polydimethylsiloxane (PDMS) as substrate and a nanocomposite of carbon nanotubes (CNTs) and PDMS as interdigital electrodes. The electrodes act as strain sensitive capacitor. The prototypes were used as touch sensitive sensors attached to the limbs. Experiments results show the sensitivity of the patches towards tactile sensing. The results are very promising and can play a key role in the development of a cost efficient sensing system attached to prosthetic limbs.

12:12 **Ballistocardiogram: Model and Sensing Systems**

*Eduardo C Pinheiro (Instituto Superior Tecnico & Instituto de Telecomunicações, Portugal); Octavian Adrian Postolache (Instituto de Telecomunicações, Lisboa/IT & Instituto Universitario de Lisboa, ISCTE-IUL, Portugal); Pedro M. B. Silva Girão (Instituto Superior Técnico, Portugal)*

Heart motion and blood ejection during the cardiac cycle originates a set of body vibrations that are sensed through the usage of different sensing systems that provide the information on cardiac mechanics and cardiac output. Ballistocardiogram (BCG) and seismocardiogram (SCG) are the recording of body vibration induced by heart bit. The sensing of the BCG requires mechanical contact between the user body parts equipment and furniture embedded BCG sensing to provide data for that can be used to validate the BCG models. The heart activity generates a set of forces and reverberations that may be modeled in two directions, anteroposterior and dorsoventral. As the ballistocardiogram sensing is usually done at the person's back or at
the posterior pelvic region the cardiac forces models are associated with these two directions. Additionally a set of results including the designed models simulations and the BCG validation signals obtained from BCG sensing systems prototypes are included in the paper.

**S7: Combined Lunch and Short Oral Session**
Chairs: Ian G Platt (Lincoln Agritech Ltd, New Zealand), Joyanta Kumar Roy (MCKV Institute of Engineering & System Advance Technologies Pvt. Ltd., India)

**12:30 Memory Storage Administration of Security Encryption Keys for Line Topology in Maritime Wireless Sensor Networks**

*Walid Elgenaidi, Thomas Newe, Eoin O’Connell, Daniel Toal, Gerard Dooly and Joseph Coleman (University of Limerick, Ireland)*

Handling the security in Wireless Sensor Networks (WSNs) requires cryptographic mechanisms to detect faulty and unstable nodes that lead to the inactivity of network during packet travelling. Although, cryptographic security mechanism operations demand a high calculation of computational time and memory resources, while the sensor nodes have low memory and low computation capability. Alternatively, trust management schemes are tools to address some main issues in WSNs including memory and storage space, key generation, and re-keying. In this work, we will present solution of memory resources consumption and key management processing issues for a secure maritime coastal monitoring system. This system is a symmetric security scheme with a dynamic update key based on a trusted node configuration, called a leader node, which works as a trusted third party.

**12:34 An FPGA Based Reconfigurable IPSec ESP Core suitable for IoT applications**

*Muhammad Rao, Joseph Coleman and Thomas Newe (University of Limerick, Ireland)*
This work implements an FPGA (Field Programmable Gate Array) based reconfigurable IPSec ESP core. The IPSec protocol, developed by the IETF (Internet Engineering Task Force) in 1998, is a popular solution to facilitate protection of the data being transferred at the IP layer. IPSec ESP is one of the two main IPSec protocols (AH: Authentication Header and ESP: Encapsulation Security Payload). IPSec ESP is used to provide data confidentiality security services with Authenticity (optional). Implementation of the IPSec is a computing intensive work, that's why hardware implementation of IPSec is a best solution. Here, to design IPSec ESP core an encryption algorithm AES is used. Proposed design also supports ESP-tunnel and ESP-transport mode of operation. This core is tested by applying default length of 576 bytes for an IPv4 datagram and results are reported on Virtex-5 and Virtex-6 FPGAs. The proposed IPSec ESP core can be used to provide data confidentiality security to IoT applications.

12:38 Review and Evaluation of WSN Simulation Tools in a Cloud Based Environment

Thomas Newe, David McLoughlin, Eoin O'Connell, Walid Elgenaidi and Joseph Coleman (University of Limerick, Ireland)

A wireless sensor network (WSN) is a collection of sensor nodes which can monitor the physical activities and attributes of a whole spectrum of objects and environments. The purpose of collecting this data and processing it in a meaningful manner requires that it adds significant value to the end user. WSN are deployed ever more frequently and applications vary from providing an early alert system on the activity of a volcano, to controlling the movements of livestock so that farming output can be maximized using virtual fencing. There are many challenges facing wireless sensor networks, with one being found in the uniqueness of each application, and challenges arise when WSN developers try to adequately test such applications when they are deployed with varying numbers of nodes, in all ranges of environmental conditions. To implement such systems in hardware involves a huge
financial investment and from a development perspective prevents the developer from changing hardware platforms or communications protocols throughout the testing phase without incurring further financial hardship. Due to this fact, tools which can accurately simulate the behaviour and performance of real world WSN applications are in high demand and a crucial aspect in the continued growth of WSN in the Internet of Things (IoT). This paper presents a cloud based system which makes various simulation platforms available to multiple users who wish to test WSN routing protocols or the hardware constraints of the various WSN platforms. This simulation testbed is hosted on a Dell PowerEdge R720 server in the communications laboratory in the University of Limerick and it is made available to users through the use of a virtual machine. This offers users access to many of the popular WSN simulation environments with vast computing resources and storage but at far reduced costs for protocol simulation.

12:42 A SVM-based Adaptive Stance Detection Method for Pedestrian Inertial Navigation

Zhechen Zhang, Hongyu Wang and Zhonghua Zhao (Shanghai Jiao Tong University, P.R. China); Zhejun Wu (North Carolina State University, USA)

This paper presents a foot-mounted inertial sensor system for pedestrian localization, and aims to find an adaptive stance detection method for pedestrian gait analysis. The approach is based on a Support Vector Machine (SVM) classifier, which divides the gaits into two types: walking and running. For walking, the algorithm uses two threshold conditions and a median filter to detect stance and still phases. For running, a new step detection method based on Extended Kalman Filter (EKF) is used to roughly identify every step of running at first, and then empirical formulas are summarized between the average velocity of each step and thresholds. The corrected thresholds based on empirical formulas are used in the second-round accurate stance detection. The localization accuracy for running is largely improved in
this algorithm.

12:46 Cladding etched single mode optical fiber refractometer based on Lossy Mode Resonances

Joaquin Ascorbe and Jesus Corres (Public University of Navarra, Spain); Francisco J Arregui (Universidad Publica de Navarra, Spain); Ignacio R. Matias (Public University of Navarra, Spain)

Fabrication and characterization of an optical fiber refractometer based on Lossy Mode Resonances is presented. Tin oxide (SnO2) coatings deposited on cladding etched single mode optical fibers are used as LMR supporting coatings, which are sensitive to the external medium refractive index. These refractometers showed an average sensitivity of 3726 nm/RIU with a dynamic range of 196 nm, for a surrounding medium refractive index range of 1.3339 to 1.3865. Chemical etching of the SMF provides a simple method to get access to the evanescent field of light, without affecting the core of the optical fiber and with highly repeatable results on the final dimensions. LMRs have been proved, for the first time, to be a good phenomenon to make this structure sensitive to the surrounding medium refractive index.

12:50 A Fast Direct Acquisition Algorithm of GPS L2C CL Signal Based on Time-Frequency Dual Folding Technique

Xuefen Zhu (Southeast University, P.R. China)

L2C is the second civilian signal broadcasted on the modernized block of GPS satellites. Compared with L1C/A, the length of L2C code is longer, and includes the civil moderate code (CM code, 20ms) and the civil long code (CL code, 1.5s), which are based on time division multiplexing. For the long CL code, rapid acquisition is difficult due to the large search space. To accelerate the search process and improve detection performance, a fast direct GPS L2C CL signal acquisition algorithm based on time-frequency dual folding technique is introduced in this paper. By folding both the incoming and local signals, the method can be used to significantly accelerate the acquisition speed, and the
degraded code correlation properties are insignificant. The effectiveness of the method of fast direct acquisition algorithm based on the time-frequency folding technique is proven through both theoretical performance analysis and real GPS L2C signal experiments.

12:54 A study of the impact of smoothing on parallel factor model of fluorescence emission excitation matrix

Jing Xu, Yutian Wang, Lijuan Zhang, Xu Zhao, Xijun Wu and Zhao Pan (Yanshan University, P.R. China)

Fluorescence technique serves as a soft sensor with the ability to estimate the shape of emission and excitation spectrum and the information of concentrations of each fluorophore in multi-component fluorescent substances. Noise exist in each measurement inevitably. The impact of smoothing on parallel factor model of fluorescence emission excitation matrix is studied by compare nine methods. Smoothing can obtain more smooth resolved spectra, while the advantage of predication concentrations is not so obviously with the methods and processes used in this paper. Other more smoothing methods need to attempt to discover the obvious advantage of predication concentrations.

12:58 Chaotic Circuit Design Methodology and Case Study

Peng Xiao (Soochow University, P.R. China); Li Cui (China Tower, P.R. China); Wenshi Li and Feng YeJia (Soochow University, P.R. China)

As an important signal source, chaotic circuit can play key one of Codec blocks in fields of weak signal detection and high speed security communication and non-linear control. First we review the chaotic circuit design methodology into three kinds of methods like blocks stickiness with 3-blocks, decreasing and increasing, for the root cause of period three implying chaos. Then two novel chaotic circuits are
reported in core features of 1L-1C plus 1 multiplier and 1 operational amplifier, and 2L-3C plus 1T-MOSFET. The phase diagrams of tested independent variables show that new circuits are both chaotic with the greatest Lyapunov’s Exponents more than zero. At last our conclusions are thrown up in deep thinking of precision measurements based on chaos.

13:02 Acoustic Emission Inspection Based on Wireless FBG Sensing System

Dandan Pang (Shandong Jianzhu University, P.R. China)

In this paper a novel optical wireless sensing system to monitor the real-time acoustic emission (AE) signals using fiber Bragg grating (FBG) was presented. In this proposed system, a relocatable optical wireless AE sensor node was developed incorporating a wireless module with a FBG AE sensor in a compact package. The results of the sinusoidal waves with different amplitudes experiment indicated that the optical wireless AE sensing system has excellent time domain response under 90dB, 80dB, 70dB amplitude sinusoidal waves. Also the frequency responses of the designed system were investigated. It has demonstrated that the system has shown a good performance in discriminating AE waves with different resonant frequencies.

13:06 Design of Automated Batch Calibrating System for MIMU

Juan Yin, Xinhua Zhu and Zhiqiang Wu (Nanjing University of Science and Technology, P.R. China)

Considering the disadvantages of low efficiency and the huge demand for manpower, the automated batch calibrating system for MIMU is designed. The system mainly consists of multi-channel data acquisition, data storage and data processing module and automatic control module. Data are transmitted through Ethernet interface and control instruction is transmitted via serial port. The system can calibrate at most 16 MIMUs at the same time and can calculate
calibration parameters automatically. The system also has the function of power automation control and fault alarm, etc. The results of practical test indicate that the system greatly enhances the efficiency of calibrating MIMU and reduces the manpower to a great extent.

13:10 Enhancement of Electroactive Phases of PVDF by Mixing SiC Nanowires for Pressure Sensing

Jiefang Huang, Songjia Han and Hui-Juan Chen (Sun Yat-sen University, P.R. China); Zhenhua Luo (University of Southampton, United Kingdom); Han-Ping Shieh (National Chiao Tung University, Taiwan); Zixin Wang and Bo-Ru Yang (Sun Yat-sen University, P.R. China)

Poly(vinylidene fluoride) (PVDF) is one of the ideal materials for wearable pressure sensing owing to its excellent piezoelectric property, good flexibility, and easy fabrication processing. In this work, we mixed PVDF matrix with silicon carbide (SiC) nanowires acting as an efficient nucleating agent to transform the non-polar α phase to polar β and γ phases to improve the crystallinity of electroactive phases and enhance the piezoelectricity of PVDF thin film.
Research on a new type of portable petroleum pollutants fluorescence spectrum detection system

Zhe Yang (University of Yanshan, P.R. China); Yutian Wang (Yanshan University, P.R. China)

The ability to accurately and efficiently detect the contents and constituents of oil pollutants is critical for the health and sustainable development of our ecological system. The fluorescence spectrum technology is applied to petroleum pollutants with high precision and good selectivity. Propose a new type of portable petroleum pollutants fluorescence spectrum detection system based on multichannel fluorescence spectroscopy on sample cells and its optical structure. It is able to amplify the fluorescence signal without changing the volume of sample cell by increasing the optical path of the detection system using the parallel excitation of multiple microchannel sample cells. Through the experiments, it verifies the effectiveness of the microchannel fluorescence spectrum detection system and shows that the multichannel fluorescence spectrosopy has a stronger detection signal compared with general fluorescence spectrometer in the same experiment samples under the condition of the spectrum detection performance. It takes us one step closer to the realization of the real-time detection using fluorescence spectroscopy.

Voltammetric Ion Selective Electrode-based Two-Electrode Ion Sensing System for pH Detection

Yazhuo Li (Jianghan University, P.R. China)

A simple voltammetric two-electrode ion sensing system has been developed and utilized for pH value detection. In this system, active carbon (AC) electrode with constant electrode potential and good electrical conductivity is employed as the counter electrode. A solid contact voltammetric ion selective electrode (VISE), prepared by drop coating a layer of voltammetric ion selective membrane on a glassy carbon electrode, acts as the working electrode. Via cyclic voltammetry,
the reduction peaks of the cyclic voltammograms are collected for quantification purposes. pH values have been detected by this system, using a voltammetric H+-selective working electrode. Furthermore, the results show a good linearity ($r = 0.998$) and precision (RSD = 1.05 %) which are comparable with those of conventional three-electrode system. This two-electrode system proposed here allows for quantification of pH values in complex samples (e.g. tap water and coffee solution). The detection results obtained here were in good agreement with the values detected by commercial glass pH meter.

13:22 The Measuring Method of the Inner Deformation for High Concrete Faced Rockfill Dam with Pipe-robot Monitoring System

Mingshuai Yao (Nanjing Hydraulic Research Institute, P.R. China)

The design theory and construction technology of the concrete faced rockfill dam (CFRD) had reached the advanced world level at the present stage. But the traditional measuring method is not suitable for the safety monitoring of the high concrete faced rockfill dam with the height of more than 300m. The new safety monitoring technique and design theory were proposed in this paper. By summarizing the basic technical requirements and key technical design of the inner deformation measuring method for the high concrete faced rockfill dam, the pipe-robot monitoring system which could measure the inner deformation of dam in pipes with the length of 1000m was exploited. The analysis of error control shows that the measuring error of single measuring point or the all points can meet the measurement accuracy requirements. On the basis of modeling test with 1:1 scale and comparative analysis of results, the feasibility and applicability of the utilization of the pipe-robot technique for measuring the inner deformation of the high concrete faced rockfill dam were tested and verified.
13:26 Analysis on Parameters of Grating Eddy Current Displacement Sensor

Kun Li (Shanghai Jiaotong University, P.R. China)

The grating eddy current sensor is based on the principle of lateral eddy current. Its precision is greatly influenced by the coil and reflector parameters. It is important to analyze and optimize those parameters so as to improve the precision. Therefore, it is necessary to make further research on how the sensor nonlinear error is influenced by parameters, such as reflector size, shape and coil turns, so that the sensor can be tuned for more high precision occasions. Models of the coil and reflector of the grating eddy current sensor are established with finite elements method (Maxwell software) in this paper. Reflectors with different size and shape and coils with different turns are simulated and calculated. The analytical results demonstrate that the coil turns should be as many as possible and reflector with semicircular on both sides is better. Besides, the optimal reflector length (the length corresponding to the smallest nonlinear error) has a linear relationship with coil width and length. The research has provided a guide to set reasonable parameters of coil and reflector to improve the precision.

13:30 Analysis of Shunt Over Range Measurement Errors Based on Finite Element Method

Rundong Han, Tianzheng Wang and Qi Wang (Shanxi Electric Power Research Institute, P.R. China); Yaxuan Zheng (State Grid Shanxi Electric Power Company, P.R. China); Like Dong (Shanxi Electric Power Research Institute, P.R. China)

In this paper, the thermoelectric coupling finite element model of 150A/75mV shunt and 1000A/75mV shunt were established, and the temperature rises of them when the measuring current was over range were analyzed. The electromagnetic finite element models of shunts were established simultaneously, and the electromagnetic forces on manganin sheets of shunts were analyzed. Then the measurement
errors were estimated according to the results of temperature rises and
the electromagnetic forces.

13:34 A Diameter Control System of Absorbable Suture Based on
Generalized Predictive Control Algorithm

Xiuwu Sui (School of Mechanical Engineering, Tianjin Polytechnic
University, P.R. China); Yao Li (Tianjin Polytechnic University, P.R.
China)

During the spinning forming process of chitosan and collagen
absorbable suture, the diameter is uneven. To solve this problem, this
article provides a diameter control system of absorbable suture which
based on generalized predictive control (GPC) algorithm. The system
consists of the diameter detection module based on linear CCD, the
control module based on STM32, the actuator of reverse series type
double hydraulic cylinder. The control algorithm adopts self-adaptive
generalized predictive control (GPC) algorithm which successes in
realizing closed loop control of large time delay system in the process
of absorbable suture forming. The results of the experiment show that
the control system has good rapidity and good stability, the control
accuracy reached 1%.

13:38 A preliminary study of thermal energy harvesting for industrial
wireless sensor networks

Liqun Hou and Shudong Tan (North China Electric Power University,
P.R. China)

The energy-constrained battery has become one key issue that hinders
the application of industrial wireless sensor networks (IWSNs). Energy
harvesting is a promising solution for this problem. After comparing
several energy harvesting approaches, thermoelectric energy
harvesting for IWSNs is explored in this paper. The behavior of
commercial thermoelectric module is analyzed based on its finite
element analysis models. The corresponding experimental setup
including thermoelectric module, set-up conversion circuit, and sensor node is then built up and evaluated. To tackle the problem of current design, the future work and possible solutions are discussed as well.

13:42 Research of Thermal Gas Flow Measurement Based on Single Sensor

Mingming Miao (NJUST, P.R. China)

The paper analyses heat transfer principle of thermal gas flow meter, and presents a method of the flow measurement based on single platinum resistance. The sensor works in CTD controlling mode. The measurement circuit and the signal acquisition circuit are designed to control the platinum resistance at two different temperatures. The gas mass flow is obtained from the voltage of the sensor on both terminals of the platinum resistance, which effectively eliminates the effects of the gas temperature and improves measurement accuracy.

13:46 Digital Filter Design and Performance Analysis of Dynamic Temperature Signal Denoise based on FPGA

Chenyang Zhao (North University of China & School of Instrument and Electronics, P.R. China)

Introduce: Temperature is the main parameters measured and controled in industrial and agricultural production and scientific experiment, dynamic change of temperature need to be tested in many areas, such as thermal equipment, weapon equipment, power machinery, nuclear power engineering and other fields. Temperature as test object, its process of rising performance fast, reaching the milliseconds level, and its measurement conditions is hostile with a variety of environment factors such as high temperature, high pressure and high impact air. Due to test system performs poor for inhibiting noise in complex environment, dynamic temperature signal get is shown with random noise and pulse peak in the time domain, and is shown with low SNR in frequency domain, so it's difficult to distinguish
between effective signal and noise. Although traditional denoising of software after the test finished performs high precision, but it cannot meet the real-time in intensive test process. Logic slices in FPGA is rich, its parallel processing capacity is strong, possessing to the performance of digital filter, reasonable structure can reached high filter performance and operation speed. IIR is no strictly of phase requirements compare with FIR, but its features of low order number and high performance make hardware logic slices used much effective, contributing to achieve higher performance of filter as well as the faster operation. Principle: In general test, external interference is mainly from environment factors. When signal is acquired by sensitive component, it will be influenced by test environment in process of transmission, producing a inclusion with much high-frequency noise of analog signal, then it will be converted to digital signal by ADC, so the link of noise signal inhibiting can be placed behind the system of data storage(software processing), or between sensitive components and the unit of data storage(hardware processing), this paper adopt the way of hardware processing. Based on the above principles, designed an IIR filter structure based on XILINX FPGA Board, including modules and internal connections. Denoising filter adopts the way of separated zero and pole to design hardware structure, two parts are both seen as independent structure of no feedback loop, whole closed loop process can be implement just by taking out subtraction between zero and pole structure and division operation achieved by shift register. Due to characteristics of feedback structure, it's necessary to strictly control timing to achieve accurate calculation of two part structure, then operation type cannot appeared delay, but it limits system operation's speed. To improve operation speed, considering the features that zero structure coefficient is far smaller than pole one, operation uses full parallel structure with shift and add operation, using shift and add instead of constant coefficient multiplication, for example, moving left one bit equivalent to multiplied by 2,then constant coefficient multiplication can be decomposed into the addition form with several N-power of 2,so multiply operation can convert to shift and add operations. Pole structure adopts a parallel multiplication. It uses IP
core of multiplier to realize constant coefficient multiplication, IP core is set as optimize speed, and coefficient quantification adopts the N-power of 2, then division operation is replaced by N times right-shift operation. According to the different quantitative bits, all precision arithmetic is achieved by increasing register length in the process of zero, pole and increasing accumulation operations. The only link of error generated lies in a division operation, as well as cutting output after the division. Verify: After finish the design of denoising filter module, test bench is compiled in ISE platform, introducing sequence of Gaussian white noise, to test whether the filter inhibits noise in effective work band. Due to filter's performance is effected by coefficient of quantitative bits, then coefficient quantitative bits respectively take 12-bits, 16-bits and 20-bits, getting different filter bandwidth, compare the filter effects on Gaussian white noise. It verifies that 12-bits quantification of filter cut-off frequency is higher than 16-bits and 20-bits quantification, cut-off frequency of 16-bits and 20-bits quantification is consistent, the performance of filters are close to the the design of software. In the time domain, the performance of filters of different quantitative bits on Gaussian white noise are verified. The trends of Gaussian white noise signal for three species of quantitative bits are obviously mitigated, filters' effects of 16-bits and 20-bits coefficient quantification are better than 12-bits quantification, and filters of coefficient quantification of 16-bits and 20-bits perform are almost same, but operation speed of 16-bits quantification is apparently faster, so coefficient quantitative bits of 16-bits can meet requirement of precision. Then, 4th order IIR denoising filter of the 16-bits quantification of previous design is tested. Simulating input speed of the test system in sampling frequency of 1MHz, operation speed of IIR filter is tested by timing simulation. It uses integrated FIR IP core in Xilinx ISE platform to design three kinds of FIR filter of same performance with three structure characteristics. The three kinds of structure respectively is serial, parallel and distributed, their speeds are compared with IIR filter. The IIR get the first output for given value after 2.015μs, but the earliest time getting the first output in three FIR structures is 10.385μs of distributed structure. The operational speed
of IIR filter is obviously faster than other FIR ones. In order to verify the actual effect of denoising filter for dynamic, complete spectrum analysis for the signal of laser heat acquired by thermal couple sensor signal. According to frequency domain specification of the measured signal, filter coefficients are adjusted, then, use Logic Analyzer to input binary signal, after downloading the filter module to Xilinx Spartan-6, getting a denoised temperature signal. In the frequency domain, effective power of temperature signal are concentrated between 8.5kHz and 9.5kHz, and the effective bandwidth of the filter is 14kHz, then the stopband is cut-off rapidly. After calculation, the SNR of denoised signal is 30.68dB. The filter keeps the effective power of the signal while inhibit some high frequency noise; In the time domain, the dynamic signal temperature becomes smooth by passing the filter; Burr signals are effectively eliminated in the process of rising; The amplitude of signal is no attenuation; The signal has no delay in the output process.

Conclusion: This paper designs a digital denoising filter using FPGA as the core of signal processing, verifies that denoising filter for inhibiting high frequency noise effective is effective, improving SNR of test system; The speed of signal processing reaches the microsecond level, comparing with high-order FIR filters, the advantage of speed is obvious, which manifest the filter can be used in dynamic temperature measurement with high requirement of real-time.

13:50 Advanced AODV Approach For Efficient Detection And Mitigation Of WORMHOLE Attack IN MANET

Hemant Ghayvat (Massey University, New Zealand); Sharnil Pandya (Parul University, India); Moi Hoon Yap (Manchester Metropolitan University, United Kingdom); Subhas Mukhopadhyay (Massey University, New Zealand)

Wireless Communication is an inevitable part of Smart Home domain. A Mobile Ad-Hoc Network (MANET) is defined as an arrangement of wireless mobile nodes which creates a temporary network for the communication. MANET suffers from both kinds of attacks, active and
passive attacks at all the layers of the network model. The lacks of
security measures of routing protocols allow attackers to intrude the
network. Wormhole, the attack is generated by tunnels creation and it
results in complete disruption of routing paths on MANET. The
proposed security approach is to detect and mitigate wormhole attack.
It is secured AODV approach which efficiently finds wormhole attack
present in a MANET and Digital signature is used to prevent it. This
approach is based on a calculation of tunneling time taken by tunnel to
analyze the behavior of wormhole. Afterward, it decides some static
threshold value. Based upon this tunneling time and threshold value, it
decides whether given node is wormhole node or trustworthy node. A
digital signature and hash chain algorithm is applied to mitigate the
wormhole node.

13:54 A Novel Hybrid based Recommendation System based on Clustering
and Association Mining

Hemant Ghayvat (Massey University, New Zealand); Sharnil Pandya
(Parul University, India); Subhas Mukhopadhyay (Massey University,
New Zealand); Moi Hoon Yap (Manchester Metropolitan University,
United Kingdom); Jaimeel Shah (Parul University, India); Narayan A
Joshi (Nirma University, India)

In the recent years, E-commerce has turned into another style which is
growing rapidly, However before the emergence of E-commerce,
individuals can't skim all things within brief time so therefore
recommendation was introduced. The principle point of the
recommendation system is to prescribe the best appropriate things to
the user. Proposal framework will naturally recommend the items in
view of user's advantage. Many of the recommendation system mainly
use content based method, collaborative filtering method, demographic
based method and hybrid method. In this paper certain issues such as
"data sparsity" and "cold-start problem" is the major challenge, To
overcome the certain problem we propose a new methodology by
combining the clustering algorithm with Eclat Algorithm for better rules
generation. Firstly we cluster the rating matrix based on the user
similarity. Then we convert the clustered data into Boolean data and applying Eclat Algorithm on Boolean data efficient rules generation takes place. At last based on rules generation recommendation takes place. our experiments shows that approach not only decrease the sparsity level but also increase the accuracy of a system.

13:58 A new trigger mechanism of handover based on the regular mobile route and the handover invitation

Guihua Kang and Hongbo Kang (Hohai University, P.R. China)

For the traditional trigger mechanism of handover based on the received signal strength has uncertainty and low reliability under a high speed mobile environment, the quality of service for users is greatly declined. The cooperative cell-cluster is constructed according to the regular mobile route of the mobile terminal and the location information of its adjacent base station, and a new trigger mechanism based on the regular mobile route and the handover invitation is proposed in the paper. The handover is more timely, accurate and reliable by new mechanism in the communication environment which the mobile rout is relatively fixed and more regular, and mobile speed is relatively high. But also the mechanism can make the handover process to shorten the time of handover, and prevent the occurrence of "ping pong handover" phenomenon. Moreover, it can improve the speed and efficiency of handover, and the user quality of service.

14:02 Design and Simulation of Multi-sensor Insertion Flowmeter Adaptive to Non-uniform Velocity Profiles

Quansheng Duan, Renting Ma and Yuting He (North China Electric Power University, P.R. China)

Flowrate is one of the significant parameters in energy and resource engineering. This paper presents a multi-sensor insertion flow measurement system and a flow measurement method that includes an integration procedure based on cubic B-spline interpolation. The
flow field around measuring section at different straight pipe length in circular conduit was simulated by FLUENT software and a comparative analysis of three measurement methods was presented—(1) single-sensor measurement; (2) multi-sensor measurement based on arithmetic average method; (3) multi-sensor measurement based on cubic B-spline interpolation method. The result of the comparative analysis suggested that the multi-sensor measurement method based on cubic B-spline interpolation could be adaptive to non-uniform velocity profiles and considerably improve the measuring accuracy of fluid flowrate by means of insertion flowmeters for non-fully developed pipe flow.

14:06 Research on a Wall Climbing Robot Based on Electrostatic Adhesion

Xie Li, Zhang Zhi Xiang and Qin Lan (Chongqing University, P.R. China)

A wall climbing robot with crawler type, using electrostatic adhesion pads (EAP), which enables strong adaptability to wide range of wall surfaces, relatively light weight, simple structure and low power consumption, has been proposed in this paper. Firstly, the principle of the electrostatic adhesion and the equivalent calculation of adhesion force are presented. Secondly, the robot quasi-static force analysis is discussed for the safety of the robot on the wall. Furthermore, the electrostatic adhesion pads are designed and manufactured, and the electrostatic adhesion force (EAF) of the electrostatic adhesion pads has been experimented on the variety of wall materials. Finally, a wall climbing robot prototype is designed and the performance tests of the robot are accomplished on different wall surfaces.

S8A: Magnetic Sensors I
Chair: K. Tashiro (Shinshu University, Japan)

This paper presents a zero-crossing method for two-axis magnetometers that compensates the measurement offsets when sensor outputs are distorted due to the time-varying hard-iron interference and zero drift effects. The compensation method is derived based on a Kalman filter which can be used for real-time estimation. The performance of proposed method is evaluated using HMR2300r magnetometer with a ferromagnetic turntable. The angle estimation error after compensation was on the order of 1 to 2 degrees.

**14:28 High-Lift-Off of Rail Displacement Sensor Using Triangle Spiral Coil**

**Daiki Mori (Showa University, Japan)**

Eddy-current rail displacement sensors are used for confirming rail displacement. However, collision with gravel and snow due to the short distance between rail head surface and sensor causes failures or malfunctions. Therefore, it is necessary to increase the distance from the rail head surface to the eddy-current rail displacement sensor. In this paper, the use of triangle spiral coils make rail displacement detection possible from the rail head surface, which is twice that of the conventional eddy-current rail displacement sensor up to a distance to the sensor.
14:46 Sensitivity Enhancement for Coupled Core Fluxgate Magnetometer Utilizing Negative State Feedback

Yanzhang Wang, Jingjie Li, Siyu Chen and Hongyu Shi (Jilin University, P.R. China)

Recent theoretical works have shown that spontaneous oscillations can be induced by unidirectionally ring coupling the overdamped bistable nonlinear systems, subject to the proper initial states and coupling strength. These techniques have been adopted in the practical realization of the coupled core fluxgate magnetometer (CCFM) which obtains better magnetic field detection performances with residence times difference (RTD) readout strategy compared with the single core fluxgate magnetometer. In this paper, the effects of negative state feedback on CCFM have been investigated. Numerical simulations and preliminary experimental results, which have a good consistency, show a distinct benefit from the standpoint of sensitivity enhancement for CCFM utilizing negative state feedback.

15:04 Simple and fast liquid inspection method using step response in electromagnetic sensor

K. Tashiro and Hiroyuki Wakiwaka (Shinshu University, Japan)

The simple and fast liquid inspection method using step response in electromagnetic sensor is presented. When the liquid sample is set inside the cylindrical electromagnetic sensor, the impedance profile of the sensor changes in accordance with the electromagnetic properties of the liquid. First of all, the theoretical background is explained with a simple RLC circuit analysis. To provide a simple and fast measurement, this paper focuses on both the maximum value of the voltage and the time constant. An experimental demonstration of liquid inspection is also presented.
15:22 Statistical Test Method Used to Measure the Thickness Based on the Electromagnetism Way

Yuhua Cheng (University of Electronic Science and Technology of China & School of Automation Engineering, P.R. China); Lulu Tian (University of Electronic Science and Technology of China, P.R. China); Chun Yin (University of Electronic Science and Technology of China & School of Automation Engineering, P.R. China); Libing Bai (University of Electronic Science and Technology of China, P.R. China)

In this paper, the statistical test method is used to process the single data. The data is vary huge in the measuring system, because the detecting speed of the measuring system is fast. So this method holds an important role in the platform. For each detecting point, the probe would detect for many times and obtain the data that stored in the computer. This statistical test method is used to select a suitable signal to the computing algorithm based on the distribution parameters skewness and kurtosis. After selecting the data from the huge data set, the Fast Fourier Transform Algorithm (FFT) is used. By analyzing the frequency of the detecting signal, it could be used to measure the thickness, because the eddy current frequency spectrum have close relationship with the thickness. For different thickness, the frequency spectrum is different and the frequency spectrum is wider when the thickness is thinner. The results could show that the proposed method could solved the problems of the huge data set and could improve the accuracy.

S8B: Capacitive Sensors
Chair: Joyanta Kumar Roy (MCKV Institute of Engineering & System Advance Technologies Pvt. Ltd., India)

14:10 A Novel, Cost Effective Capacitive Sensor for Estimating Dissolved Moisture in Transformer Oil

Mithun Sakthivel and Bibin Thankachan (Sree Buddha College of
The life of a transformer depends upon the condition of the insulating oil which is used inside it. One of the key factors that deteriorate its insulation strength is the presence of dissolved moisture, which eventually leads to the failure of transformer. In the past two decades more than 4% of the transformers failed due to this. Hence it will be very effective, if a sensor is used to predict the concentration of this moisture, real-time. In this work, the design of such a sensor is presented, which happens to be much cost-effective than all other similar sensors available in the market. The sensing mode used here is capacitive sensing in which the capacitance of an oil-cell changes with respect to the concentration of dissolved moisture present in the oil. In order to design this sensor, first the oil-cell was simulated in a FEA software. Then its associated signal conditioning circuitry was laid on board and the outputs obtained were verified using suitable simulations to ascertain its reliability. The conceptual prototype developed demonstrated adequate sensitivity and hence found promising enough for replacing the existing costly moisture sensors available in the market.

14:28 The Research on High Sensitivity and Anti-Saturation of Capacitance Sensors for Measuring Yarn Evenness

Gang Yan (Nanjing University of Aeronautics and Astronautics, P.R. China)

Yarn evenness is an important physical parameter of yarn quality. Capacitance sensors provide signals that are used to enable automatic measurement of yarn evenness. These capacitance sensors are expected to be extremely sensitive, highly linear, and electronically homogeneous. But, extremely sensitive sensors can saturate the circuit output under the influence of ambient temperature and humidity. Hence, 3D models of a cylindrical capacitance sensor and parallel plate capacitance sensor are constructed by using finite element analysis. Detection performance of the two types of sensors is compared in terms of sensor sensitivity, linearity, and evenness. We also propose a highly
sensitive phase-sensitive detection circuit for the transformer bridge that converts capacitance into a voltage signal. In order to address the problem of premature saturation in the conditioning circuit, this paper proposes a compensation circuit that consists of a programmable capacitor to detect and compensate for output drift in the circuit in real time. Experimental results demonstrate the performance of the proposed capacitance sensor.

14:46 Study on different touch object recognition algorithm based on Android and capacitive touch panel

Zhu Qiwen (Southeast University - School of Electronic Science & Engineering, P.R. China); Huang Xueqin, Sun Jun and Zhou Hongmei (Nanjing-JieNuo Environmental Technology Limited Company, P.R. China); Tang Yongming (Southeast University, P.R. China)

Nowadays, touch panel technology has become the mainstream of human-computer interaction. Based on a smart phone equipped with Atmel's latest touch chip---maxTouch874 and the Eclipse software, a system that can gather the original signals from self-capacitance and mutual-capacitance is developed. The recognition of four kinds of touch objects is achieved with the different characteristics of different touch objects. The test result verifies the accuracy of the algorithm.

15:04 Capacitive Sensor Array for Fingerprint Recognition

Yeong Eun Jeon, Young Jin Lee, Min Kuk Jang, Bo Min Seo, In Hye Kang, Min Taek Hong and Jong Mo Lee (Hoseo University, Korea); Emmanuel Jacques and Tayeb Mohammed-Brahin (University of Rennes 1, France); Byung Seong Bae (Hoseo University & Engineering, Korea)

Touch function is merged to the display for the convenient interfaces between man and machine, particularly in mobile phones. In addition, the fingerprint recognition module is also adopted in mobile phones for the security purpose. In this paper, capacitive sensor array with oxide thin film transistors (TFTs) was investigated for fingerprint recognition.
For the transparent sensor array, oxide TFT were used and also the transparent indium thin oxide (ITO) electrode was investigated for 450 X 450 pixel arrays. The simulation results for the sensor array with oxide TFT shows that ITO can be used in capacitive pixel sensor array to achieve its transparency. The electrode area dependence of the sensing signal was investigated for the various glass thicknesses. The rather thick glass gives much reduced sensing signal and the allowed thickness was lower than 8 μm, therefore, for the high sensing signal the coating material with enough hardness is necessary.

S8C: Optical Sensors I
Chair: Ignacio Matias (Universidad Pública de Navarra, Spain)

14:10 Experimental Study of Distributed Optical Fiber Sensor in Measuring the Deformation of Large Filling Bag with Dredged Soil

Binhua Xu (Nanjing Hydraulic Research Institute, P.R. China)

It is very significant to research the key technology of adopting the dredged soil as new construction material in port engineering for the resources shortage and environmental restriction. The traditional point-supporting measuring technology could not be utilized to measure the deformation of large filling bag in its filling and loading process. The engineering practical problems such as measuring the deformation of large filling bag with dredged high clay content soil received much concern at the present stage. Based on the laboratory calibration tests and filed prototype tests, the selection of optical fiber sensor, cemented fixation and protection, measuring accuracy and error analysis, application testing in project prototype were carried out in this paper. And the application feasibility of distributed optical fiber sensor to measure the deformation of large filling bag with dredged soil was discussed. The results showed that the optical fiber sensor with flexible sheath should be adopted for measuring the deformation of large filling bag with dredged soil. And the measuring accuracy would be ±30με with apposite optical fiber sensor. The monitoring spatial resolution could be 0.1m. The maximum strain measurement range could be 30000με. The distributed optical fiber sensor could be adopted as a new
reliable method to monitor the deformation of large filling bag with dredged soil.

14:28 Design and analysis of a new type of pressure sensor based on the high-birefringent photonic crystal fiber

Yuan Yu, Yujiiao Shao, Yin Zhang, Shaowen Wei and Xuefeng Li (Tongji University, P.R. China)

In this paper, a new type of fiber optic press sensor based on the polarization modulation is proposed and analyzed. The sensor is equipped with a high-birefringent photonic crystal fiber (HB-PCF) as sensing unit and used to measure the pressure in gaseous and liquid media. The linear polarized light inject into HB-PCF with 45º angle at the slow axis and the output light is separated into two perpendicular polarized light with 0° and 90°. Then one of them is rotated 90º angle, which combine with the other to form light interferometer. Pressure load affects the birefringence of HB-PCF, leads to the variety of output light intensity. The analysis result shows that the centripetal pressure increases the effective refractive index of polarization model in both fast and slow axes with a linear relationship of 8.97×10^-6 RIU/MPa and 6.48×10^-6 RIU/MPa respectively, so that tends to counteract the birefringence of the HB-PCF caused by its asymmetric structure, with a linear relationship of 2.49×10^-6 RIU/MPa. Consequently, the pressure vary from 0 to 100 MPa can be inferred by the output light visibility. The proposed sensor has many advantages such as small volume, simple structure, strong environmental tolerance, can be widely used in pressure measurement and structure health monitoring.

14:46 Research on Reflective Pulse Oximetry Based on Fiber Optic Spectrometer

Zheng Liu (Beihang University, P.R. China); Dezhi Zheng (Beijing University of Aeronautics and Astronautics, P.R. China); Weining Zhou and Meiling Zhou (Beihang University, P.R. China)

Human oxygen saturation detection is based on the Lambert-Beer Law, but since the human body is a strong scattering tissue instead of a
homogeneous medium, the influence of scattering need to be considered, so the basic Lambert-Beer Law is not applicable. In this paper, a fiber optic spectrometer is used to detect the blood oxygen saturation in vivo with reflective method. Based on the dynamic spectrum theory, the concept of equivalent attenuation is proposed, converting the three-dimensional data measured in real time into two-dimensional characteristic spectral data. In spite of the baseline drift and dark noise of the spectrometer, the two-dimensional characteristic spectral data can be corrected by multiple scatter correction, which can eliminate the influence of the scattering and baseline drift, and improve the accuracy of the model building.

15:04 Calibration of a Contact Probe for Micro-nano CMM

Qiangxian Huang, Jian Mei, Qiang Guo, Ruijun Li, Ermin Gong and Lijuan Chen (Hefei University of Technology, P.R. China)

In order to obtain the transformation model between the three output signals of the contact probe of the Micro/nano coordinate measuring machine (CMM) and the three-dimensional space coordinates of the probe ball, a calibration model based on Taylor expansion is proposed. The probe consists of a 3-DOF coaxial beam sensor with the displacement measurement based on the principle of Michelson interference and two angles measurement based on the autocollimation principle, a suspension mechanism and a ruby ball. According to the relationship between the coordinate vector of the ball centre and the output signal vector of the probe, the calibration model based on Taylor expansion is proposed. The reliability of the model is verified by experiment tests. Performance tests show that the maximum calibration error of the model is 92 nm. The results demonstrate the calibration model features the feasibility and the validity, which can meet the calibration requirement of the Micro/nano CMM.

15:22 Signal processing for distance measurement using laser voltage fluctuation due to self-coupling effect

Takeshi Yoshimatsu, Norio Tsuda and Jun Yamada (Aichi Institute of
When a part of the scattering light from the target is enter to the laser cavity, the terminal voltage of semiconductor laser diode slightly fluctuates. This voltage fluctuation has the information related to a distance to the target. However, the terminal voltage fluctuation has also many noises. Discrimination of distance signal with many noises is almost impossible. Therefore, a statistical signal processing which utilizes the all information in terminal voltage fluctuation is newly proposed. A system is constructed using Field-Programmable Gate Array (FPGA). This system can measure the distance of 21cm to 45cm with the average error of about 2 %.

S9A: Sensors and Signal Analysis III
Chair: Vempada Ramu Reddy (Tata Consultancy Services, India)

16:00 Shore-based Terminal of OUC-Raman Instrument Node for Seafloor Cabled Observatory Network

Wangquan Ye, Ying Li, Wendong Li, Fujun Qi and Ronger Zheng (Ocean University of China, P.R. China)

The establishment of the seafloor cabled observatory network will help to learn how the ocean operates. This study reports the design of a shore-based terminal for the OUC-Raman (OUC: Ocean University of China) sensor node in an observatory network. Based on Raman spectrometry, it is used to detect radical ion in situ. The shore-based terminal is divided into three main modules: communication module, data management module and user interface. Its functions include data collecting from underwater system, data processing and data transmitting. The terminal worked well and stably during a 40-days' land-based joint trial and sea trials.

16:18 Design and Reliability Analysis for Underwater Control System in OUC-Raman Instrument Node of Seafloor Observatory Network

Xiaorui Liu, Fujun Qi, Wangquan Ye, Zhiyu Song and Ronger Zheng
Considering seafloor observatory network's requirement for its sensor nodes, this article designs control system for OUC-Raman underwater system. It's composed of power management module and controller module. Power management module ensures the electronic character of OUC-Raman instrument node meeting standard of seafloor network, controller module could make shore-based terminal manipulate underwater instrument. This control system has redundancy structure to ensure its reliability in seafloor environment. Up to now, OUC-Raman instrumental node has received multiple test with satisfactory results. It's hoped the developed system could be utilized in seafloor cabled observatory network.

16:36 A Novel Scheme of Finger Recovery based on Symmetric Rehabilitation, Specially for Hemiplegia

Pengwen Xiong, Shuo Gao, Zhipu Liu and Lingyan Hu (Nanchang University, P.R. China); Xukai Ding (Georgia Institute of Technology, USA)

Finger recovery is much harder than other parts on the upper limbs, because finger recovery movement has several key problems need to overcome, including high precision of movement, high control resolution requirements, variable data with different person, as well as the fuzzy signal during the movement. In order to overcome the difficulties, a new scheme of finger recovery is presented in the paper based on symmetric rehabilitation. In the paralyzed hand side, a mechanical exoskeleton hand is designed and simulated to provide skeletal traction, while in the regular hand side, the curve magnitude of every joint during movement is detected. Then the hand motion is analyzed and recognized using Multi-class SVM. Many candidates were chosen to perform the experiment, and the data produced by the candidates were divided the training parts and recognition parts. Experiments shows that the Multi-class SVM is effective and practical for classification and recognition, and could be helpful in the finger recovery process.
16:54 A Prediction Method for Deck-motion of Air-carrier Based on PSO-KELM

Xixiang Liu, Yongjiang Huang, Qiming Wang, Qing Song and Liye Zhao
(Southeast University, P.R. China)

Prediction for deck-motion is a practical measure to improve the landing/taking off safety of carrier-based aircraft when those deck-motions in six-degree freedoms cannot be effectively controlled/restrained. Deck-motions excited by waves and winds own characteristics of randomness and nonlinearity. It is generally believed those classical feed-forward neural networks, such as back propagation networks have excellent nonlinear fitting ability but suffers from slow training speed and local optimum falling which cannot satisfy those real-time and high accuracy requirements for deck-motion. In this paper, a prediction method based on extreme learning machine, support vector machine and particle swarm optimization (PSO-KELM) is introduced to fulfill deck-motion. In this method, the fundamental structure of extreme learning machine is used but the hidden function is substituted the kernel function from support vector machine. Further, aiming to select optimal parameters including penalty coefficient and kernel parameter, auto-adaptive particle swarm optimization is adopted. Simulation results indicate that the prediction method based on PSO-KELM owns advantages of simple structure, fast training speed and good generalization ability, and can obtain high accuracy prediction results when used for deck-motion prediction of air-carrier.

17:12 EEG pattern recognition based on Dual-Tree Complex Wavelet Transform and Particle Swarm Optimization

Miao Minmin, Wang Aimin, Zhao Changsen and Liu Feixiang
(Southeast University, P.R. China)

Aiming at the issue of motor imagery electroencephalography (EEG) pattern recognition in the research of brain-computer interface (BCI), a novel method based on dual-tree complex wavelet transform (DTCWT)
and particle swarm optimization (PSO) was proposed. The advantage of DTCWT over discrete wavelet transform (DWT) was discussed in depth and the ERD/ERS phenomenon was verified at first. Then, the signal component related to sensory motor rhythms was extracted based on dual tree complex wavelet decomposition and reconstruction. Afterward, PSO algorithm was implemented to search the optimal time interval automatically for feature extraction. Finally, average energy, root mean square and signal variance were extracted as features and linear discriminant analysis (LDA) was applied for classification. The results show that the proposed method can find the relatively optimal time interval for feature extraction automatically and the maximum classification accuracy is 90%, which is better than the BCI competition winner.

**S9B: Intelligent Sensing**

Chair: Chi-Hung Hwang (Instrument Technology Research Center, Taiwan)

**16:00 A Resonance Temperature-Sensing Structure Based on Quartz Tuning Fork**

*Xin Li, Jun Xu, Hui Li and Zhou Liu (Harbin University of Science and Technology, P.R. China)*

A resonance temperature-sensing structure based on quartz tuning fork (QTF) is proposed and numerically investigated by using theoretical and numerical simulation in this paper. Reasonable selecting the quartz wafer cutting angle and Setting electrode configuration, the QTF resonator can be worked in flexural vibration mode. The numerical simulation results show that the change of the resonance frequency of the QTF is inversely proportional to the temperature changes with the environment. The structure of QTF resonator has been analyzed and optimized by the FEM software of ANSYS. Moreover, in order to investigate the thermal characteristic of QTF, A testing system of QTF has been successfully developed based on LabVIEW. The experimental results show that in the range from 0 °C to 100 °C, the thermal QTF as temperature sensor has a high thermo-sensitivity of -2.979 Hz/°C, hysteresis degree of 0.023%, linearity of 0.019% and
resolution of 0.05°C respectively. Furthermore, after operation the test system features good stability and reliability, so it provides a feasible solution for test the characteristics of the sensor and can be applied to practice.

16:18 An Improved Gray Weighted Method for Sub-pixel Center Extraction of Structured Light Stripe

Yuehua Li, Jingbo Zhou, Fengshan Huang and Lijian Liu (Hebei University of Science and Technology, P.R. China)

Center extraction of structured light stripe is an essential problem for the development of line structured light sensors (LSLS). To obtain the sub-pixel center coordinates precisely, an improved gray weighted method (IGWM) is proposed with an adaptive sampling region. Firstly, the center of the stripe is computed using gray weighted method (GWM) for each pixel column. Then these center points are fitted using moving least squares algorithm to estimate the tangential vector, the normal vector and the radius of curvature. For each center point, a rectangular region is defined with two sides parallel with the normal vector. The other two sides that parallel with the tangential vector alter their length automatically according to the radius of curvature. After that, the center coordinate at this point is recalculated based on the GWM, but in the normal vector direction and only takes into account the pixels within the rectangular region. The experimental results show that this method is not only suited for the center extraction of smooth laser stripes, but also the ones with sharp corners. The noise can also be obviously suppressed than that of the traditional GWM.

16:36 3-D reconstruction of an axisymmetric flame based on cone-beam tomographic algorithms

Yuting He (North China Electric Power University, P.R. China); Gang Lu and Yong Yan (University of Kent, United Kingdom)

This paper presents a method of 3-D (three-dimensional) reconstruction of an axisymmetric flame based on cone-beam
tomographic algorithms. A FDK-based analytic tomographic algorithm is developed. Computer simulations are undertaken to evaluate the structural similarity between the template and the reconstructed volume so as to evaluate the effectiveness of the algorithm developed. Experimental tests were also conducted using a CCD camera to capture images of a candle flame. The 3-D reconstruction of the flame is then performed. The simulation and experimental results demonstrate the feasibility of the proposed cone-beam based tomographic algorithm for 3-D flame image reconstruction.

16:54 Design and Evaluation of a dual channel high frequency Quartz Crystal Microbalance

Jing Zhang and Jinxing Liang (Southeast University, P.R. China); Toshitsugu Ueda (Waseda University, Japan)

AT-cut Quartz crystal Microbalance (QCM) has been used as a high precision sensor for decades, which could detect the slight mass deposited on the crystal surface. The accuracy of QCM can be achieved ng level. When used as biosensor in liquid, the resonant frequency is not only affected by the mass change, but also by the liquid density and viscosity, which are greatly dependent on the liquid temperature. For minimizing the fluctuation induced by temperature, a novel structure of two QCMs have been fabricated on a single quartz wafer as dual-channel quartz crystal microbalance. One resonator works as biosensor coated with functional membranes and the other works as a reference sensing only on the liquid property. The sensitivity of QCM is directly proportional to the square of the fundamental frequency of QCM. With wet etching methods, we can successfully fabricate the dual-channel QCMs with 40MHz, which are merely 5 or 9 MHz for traditional QCM. In the meanwhile, to enhance the mechanical stability an inverted mesa-type structure has been proposed. The key problem of dual-channel QCMs is interference between two channels, which is influenced by distance of adjacent resonators. The diameter of reference electrode has been designed into several values to find the optimal parameter. The modification or QCMs structure is proved to be an effective solution to minimize the interference of dual-channel QCM.
And the convex design of inverted mesa-type can reduce the coupling between two resonators. Experimental results demonstrated that the two QCMs could vibrate individually and the frequency stability can be greatly improved by using the reference QCM.

17:12 Based on Stress-impedance Effect Exciting Signal Source of a New Amorphous Alloy

**Amandary Pei (Nanjing University of Science and Technology, P.R. China)**

The stress-impedance (SI) effect is a new special physical effect which has the value of research and application in amorphous alloy found in recent years. The SI effect of an amorphous alloy powder/silicone rubber piezomagnetic composite is investigated on theory and experiment. Optimal excitation method and various parameters are obtained, which provide a useful basis for the design of a signal source. Several key technologies, including the frequency of the oscillator, and design of time constant are discussed. Experimental results prove the work principle of exciting signal source is simple, realizable and the amorphous alloy can be used to produce force-sensitive elements in new type pressure sensors, which has wide application prospect and popularization value.

**S9C: Sensors for Novel Applications III**

Chairs: Sharnil Pandya (Parul University, India), Norbert Schwesinger (Technische Universität München, Germany)

16:00 Two Types of Overoxidized Poly(3, 4-ethylenedioxythiophene) Films on Au Microelectrode: Electrochemical Preparation and Characterization

**Yun Hui (University of Chinese Academy of Sciences, P.R. China); Chao Bian, Jinfen Wang and Jianhua Tong (Institute of Electronics Chinese Academy of Sciences, P.R. China); Shanhong Xia (Institute of Electronics, CAS, P.R. China)**
Poly (3, 4-ethylenedioxythiophene) (PEDOT) films were prepared by electro-oxidation in an aqueous solution on Au microelectrode. Electrolyte solutions and polymerization cycles were optimized previously for further overoxidation. The effect of overoxidation time has been optimized by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), which signifies that overoxidation film with 45s at 1.35V presents strong adsorption as well as good conductivity. The other one-step overoxidation film by direct CV ranging from -0.6V to 1.35V was polymerized for comparison. Scanning electron microscope (SEM) and fourier transform infrared (FTIR) spectroscopy were used for monitoring the functional groups evolution and morphological changes. Both of them presents increased abundant oxygen functional groups and roughness, yet exhibit dendritic morphology and piles of spherical protrusions respectively. Moreover, double-step overoxidized film show better electrochemical performance toward lead ion sensing. These characterizations may bring out the appearance of novel properties that may be beneficial for specific sensing applications.

16:18 Design and Algorithm Research of Indoor Underwater Target Positioning System

Yunge Zang (Southeast Univ, P.R. China); Xiyuan Chen (Southeast University, P.R. China)

This paper proposed an indoor underwater target positioning system and an improved positioning algorithm. The principle of the system is based on the underwater acoustic positioning method for marine positioning. In addition, the structure of the system and the positioning algorithm are improved for the indoor underwater fixed target. The system is based on the short-baseline principle, combined with an ultrasonic transducer, three hydrophones, and a water depth meter to compose an improved short-baseline array, which is used to locate the underwater target. And the artificial bee colony algorithm is used to deal with the distance information. Then the nonlinear optimization problem is solved, and the positioning accuracy of the system is improved. In this paper, the hardware structure, the positioning principle and the positioning algorithm are discussed. The experimental results show that
the underwater target positioning system has the advantages of high precision and high stability, and the performance of the algorithm is obviously better than that of other algorithms.

16:36 Research on Modeling and Filtering Method of Atomic Spin Gyroscope’s Random Drift

Shuangshuang He (Southeast Univ, P.R. China); Xiyuan Chen (Southeast University, P.R. China)

Atomic spin gyroscope is a new kind of gyro based on quantum mechanics, with ultra-high precision, simple structure, small size, etc. Therefore, to study the characteristics of random drift for improving the accuracy of atomic spin gyro is significant. Firstly, through the analysis of the gyro static output data and preprocessing, the stationary time series gyro random error has obtained. Then established the gyro drift error model based on time series ARIMA, and through analysis of residual test the applicability of the model. Finally, through the establishment of the Kalman filter based on the model to filter out the gyro random drift, and the use of Allan variance analysis of the filtering results. The results show that the modeling and filtering method and can effectively reduce the atomic spin gyro random drift error, so as to effectively enhance the output accuracy of atomic spin gyro and stability of the system.

16:54 Fault Diagnosis Method Based on Minimum Entropy Deconvolution and Fruit Fly Optimization Algorithm

Jingsheng Jiang (School of Mechanical & Electrical Engineering & Beijing University of Chemical Technology, P.R. China); Huaqing Wang and Gang Tang (Beijing University of Chemical Technology, P.R. China); Liuyang Song and Peng Chen (Graduate School of Bioresources, Mie University, Japan)

Aiming at the problems of fault diagnosis for rotating machinery, this paper proposed a fault diagnosis method combining minimum entropy deconvolution (MED) with fruit fly optimization algorithm (FOA). In the
MED method, the objective function method (OFM) is used to find the set of filter coefficients under the condition of maximal kurtosis. Given that the filter coefficients obtained by OFM are local optima not global optima and MED is difficult in parameter selection, FOA is applied instead. A filtered signal is obtained by FOA and MED, and envelope demodulation is carried on it for fault diagnosis. Results from rolling bearing fault simulation experimental system show that the proposed method has better noise reduction performance and is able to extract fault features of rolling bearings, and it is better adapted to engineering applications as compared with prior MED method.

17:12 AC Magnetic Nanothermometry: The Influence of Particle Size Distribution

Wenzhong Liu and Shiqiang Pi (Huazhong University of Science and Technology, P.R. China)

Magnetic nanothermometry is of great promising in future biomedical and industrial applications. However, the diameters of the used thermosensitive materials, magnetic nanoparticles, are commonly nonuniform, which will impact the performance of the magnetic nanothermometry. To achieve future high performance magnetic nanothermometer, we study the influences of the particle size distribution of magnetic nanoparticles on the response signal and the temperature estimation error in this paper.
**S10A: Sensors for Novel Applications II**

Chairs: Sugato Ghosh (Indian Institute of Engineering Science & Technology, India), Jinxing Liang (Southeast University, P.R. China)

**09:00 Sensor Platform for Non-Invasive Ubiquitous Current Sensing**

Malinda Dilhara Malwala Arachchige, Don Elvitigala and Jayathu Samarawickrama (University of Moratuwa, Sri Lanka)

We present a novel non-invasive current measuring platform that estimates the current through a bundled cable. The sensor platform contains eight triple axis magnetometer breakout sensors. We develop a regression model to estimate the current flowing in the wire using captured data from the sensor platform. The model in the paper demonstrated accurate results for current estimation of two core wire (7.2 mm diameter) with mean absolute error as low as 0.03 A and root mean square error as low as 0.06 A. This work can be used to develop a plug and play instrument that can non-invasively measure current in a system without disturbing its behavior in operating environment.

**09:18 A continuous-flow concentrator based on ion concentration polarization**

Hailong Pi (Institute of Electronics, Chinese Academy of Sciences and University of Chinese Academy of Sciences, P.R. China); Jianhua Tong (Institute of Electronics Chinese Academy of Sciences, P.R. China)

In this paper, we present a novel and simple method to fabricate a continuous-flow concentrator based on ion concentration polarization phenomenon (ICP). With the capillary force, the Nafion solution can fill the Nafion resin channels, and nanoporous junctions were created to generate ICP. To demonstrate the concentration ability of the device, we conducted the experiments with Rhodamine 6G (positively charged) and fluorescein sodium (negatively charged). As a result, the device is more appropriate to concentrate the negatively charged
species with concentration up to 2-fold. For further application, the method is convenient and simple to achieve a high-throughput concentration flow and a higher preconcentration factor.

09:36 Investigation on the frequency dependence of lateral field excited quartz crystal resonator on liquid permittivity

Chaolin Liu, Ting Kong and Jinxing Liang (Southeast University, P.R. China)

This research reports a high frequency lateral-field-excited quartz crystal resonator sensor (LFE-QCR) arranging the two excitation electrodes on one side. It is well known that when used in liquid LFE QCR could detect both mechanical and electrical property changes. However, the mechanism and exact relationship between the liquid permittivity and the frequency shift is not clear. In order to observe the real-time change of frequency, a flow-inject-based system is established, which consist of a syringe pump, a sample injector, and a custom-made micro-flow cell. Sensitivity of LFE-QCR for permittivity has been confirmed by using different concentrations of 2-propanol. In addition, according to the reliable and incredible experiment data, we present that when the basic frequency rise, the frequency shift could not only be determined by the permittivity, but also affected by the density and viscosity of 2-propanol

09:54 Local Implicit Surface Based Virtual Fixtures in Point Cloud Virtual Environment for Teleoperation

Dejing Ni (Southeast University, P.R. China); Andrew Nee and Soh Khim Ong (National University of Singapore, Singapore); Ai-guo Song (Southeast University, P.R. China)

It is a critical task to teleoperate a robot in a partially known or unstructured environment without any assistance. In this paper, local implicit surface based virtual fixtures are generated real time in a point cloud augmented virtual environment for operation guidance. The point-set implicit local surface method is modified to accomplish local
forbidden region virtual fixtures. The robot-centered potential force field model is applied for the guidance virtual fixture generation. The resultant force generated from both forbidden region virtual fixtures and guidance virtual fixtures are fed back in real time to the human operator through a haptic device. With assistance from the guidance force, human operators can implement obstacle avoidance tasks efficiently. The experiment results show that the proposed method is effective for robot teleoperation.

10:12 A Thermostatic Control Strategy Based on Multi-sensor Data Fusion and Fuzzy-PID Method

Fei Shen and Ruqiang Yan (Southeast University, P.R. China)

The steady temperature is vital to organ-saving out of body in a hypothermic machine perfusion (HMP) system. A thermostatic control strategy based on multi-sensor data fusion and fuzzy-PID method is proposed in this paper to improve the control accuracy. Firstly, the basic frame of HMP system and the installation of sensors are expounded. Then the data fusion based on modified Bayes estimation is carried out to eliminate the possible measurement error, resulting from the sensor faults and noise interference. Specially, the cascaded Bayes method is proved to have better error-recovery ability compared to the single stage. Secondly, the fuzzy and the fuzzy-PID (Proportion Integration Differentiation) controller are adopted respectively according to the deviation of temperature. Here the purpose of the former fuzzy algorithm is to offer the control variation of compressor and the latter is to gain three control coefficients of PID algorithm. The dynamic and static tests indicate that the thermostatic control result meets the need of HMP system although it is also affected by some extra factors, such as the external temperature, flow speed of solution and working mode.
Sparse subspace clustering for bearing fault classification

Chuang Sun (Xi’an Jiaotong University, P.R. China); Baojian Wang (Xi’an Jiaotong University); Shaohua Tian (Xi’an Jiaotong University, P.R. China); Xuefeng Chen (Xian Jiaotong University, P.R. China)

Bearing is a critical component in machine, and its operational state affects performance of the machine. Fault classification to bearing that aims to identify category of bearing fault is helpful to improve reliability and safety of bearing. In this paper, a classification process is presented based on sparse subspace clustering. A sample corresponds to a specific fault state of the bearing is represented by its neighbourhood. Coefficient for data representation is solved by sparse representation. Spectral clustering is performed on the coefficient to classify the samples into its category. Effectiveness of the presented method is validated by test data of bearing with seeded fault. Comparison between sparse subspace clustering and other subspace analysis methods shows its effectiveness for classification further.

Multi-classifiers Ensemble with Confidence Diversity for Fault Diagnosis in Induction Motors

Hongxing Tao (Southeast University); Lingfei Mo, Fei Shen, Zhening Du and Ruqiang Yan (Southeast University, P.R. China)

Motor is a kind of imperative driving device, whether a motor can monitor its state precisely and diagnose fault timely have a profound impact. This paper mainly investigates the improvement of the general method of motor defect diagnosis to achieve higher accuracy. Unfortunately, every classifier has their own respective advantages and disadvantages and using the typical machine learning methods
separately cannot achieve the expectant classify results. So, fusing the result of multiple classifiers to fully exploit the advantages of each sensor to reach the requirement of improving the classification accuracy. In this paper, three types of classifiers are fused: naïve Bayes classifier, Random Forest classifier, and SVM classifier. By the algorithm of multi-classifier, the states of the motor can be predicted correctly.

09:36 Multi-Scale Stochastic Resonance Spectrogram for Rolling Element Bearing Defect Diagnosis

Qingbo He and Enhao Wu (University of Science and Technology of China, P.R. China)

It is not easy to identify nascent defect of a bearing by analyzing the vibration data because of the disturbance of background noise. With the help of stochastic resonance (SR) technology, the weak and unrecognizable output signal of a non-stationary mechanical system can be enhanced with the aid of the additional noise of the system. However, the effect of current SR methods still has room for improvement, especially for identifying sensitive fault information in non-stationary signals. This paper presents a new method called multi-scale SR spectrogram (MSSRS) for bearing defect diagnosis. The new method realizes the SR in every scale of the time-frequency distribution of the input signal and so is able to well deal with the non-stationary transient signal. The proposed method can also highlight the defect-induced frequency component by selecting a proper scale corresponding to the impulse information. We analyze the experimental bearing vibration data with defect information using the new method put forward by this paper, the result has shown that there is a better effectiveness with our method than the former SR methods in bearing defect identification.

09:54 Gearbox fault classification using S-transform and convolutional neural network

Weihua Li (South China University of Technology, P.R. China)
A problem of mechanical fault diagnosis is essentially a problem of pattern recognition, which can also be transformed into that of time-frequency image recognition. This study presents a new method based on convolutional neural network (CNN) for the gearbox fault identification and classification, which does not need the complex feature extraction process as those traditional recognition algorithms do, and it also depress the uncertainty of arbitrary feature selection. The vibration signals of the gearbox under normal and hybrid fault conditions were collected, and all kinds of signals were transformed to time-frequency images by using S-transform. Then the time-frequency matrices were input to the CNN to classify different types of faults. To explore the optimal CNN structure for fault diagnosis, we investigated how the structural parameters, such as convolutional kernel's size, number of kernels, batch size and number of iterations, influenced the recognition results. To evaluate the performance of the CNN, other two deep learning algorithms, deep belief network (DBN) and stacked auto-encoder (SAE), were adopted to classify the gearbox fault for comparison. Experiment results demonstrated that CNN can be effectively used for fault classification. With regards to image recognition, CNN is better than DBN and SAE, and its classification rate could reach as high as 99.37%.

10:12 Fault Feature Extraction of Planetary gear Using an Optimized Matching Pursuit Decomposition

Weigang Wen (Beijing Jiaotong University, P.R. China)

This paper presents a novel method for fault feature extraction of planetary gear using optimized matching pursuit algorithm, which is applied to vibration sensor signal feature extraction and fault diagnosis of planetary gearbox. This method combined optimization algorithm, planetary gearbox vibration model, and matching pursuit to implement planet gear fault characteristic extraction. Genetic algorithm and matching pursuit were integrated to decompose the vibration sensor signals into parameterized planetary gearbox model bases. Then the parameters of model bases were compositied to extract fault feature of planetary gear. Different planet gear faults were tested for verifying the
presented methods in different scenarios. All results of experiment analysis demonstrated its effectiveness and reliability.

**S11A: Microwave, ElectroMagnetic Sensors and Optical Sensors**
Chair: Hiroyuki Wakiwaka (Shinshu University, Japan)

**11:00 A Monte Carlo Approach to Determining Bessel Beam Source Parameters**

_Ian G Platt (Lincoln Agritech Ltd, New Zealand); Adrian Tan (Lincoln Agritech Limited & Lincoln University, New Zealand); Ian M Woodhead (Lincoln, New Zealand); Kim Eccleston (Lincoln Agritech, New Zealand)_

In this paper we derive a robust Markov Chain Monte Carlo formulation to determine the suitable driver amplitudes for a microwave antenna to generate a Bessel beam. We show that the resulting solutions provide a robust driver for a well collimated beam with high SNR over a region of 0.5 - 3 m, easily sufficient for close proximity sampling.

**11:18 Distinguishing edible oil using dielectric spectroscopy at microwave frequencies of 8.2-12.1 GHz**

_Masyitah Amat Sairin (University Putra Malaysia, Malaysia); Samsuzana Abd Aziz (Universiti Putra Malaysia, Malaysia); Fakhrul Zaman Rokhani (University Putra Malaysia, Malaysia)_

The study focused on application of spectral permittivity technique subjected to high frequency range of 8.2 - 12.1 GHz at the temperature of 25°C to identify animal fats from vegetable oils. Analysis of Variance (ANOVA) technique was used as a statistical data analysis to determine whether the samples are statistically distinctive. Principal Component Analysis (PCA) was used to classify animal fats and vegetable oils on their permittivity spectral. ANOVA analysis results showed that there is a significant difference between animal fats and vegetable oils with respect to their spectral permittivity at different frequencies. PCA classification plots showed that vegetable oil could
be grouped into different clusters from the animal fats. From the results obtained in this study, spectral permittivity technique could be used to distinguish animal fats and vegetable oils.

11:36 Noise Character and Filtering Algorithm in Fiber Optic Current Transducer

Min Cao, Bo Li and Cong Lin (Electric Power Research Institute of Yunnan Power Grid Co. Ltd, P.R. China); Qingchan Liu (Yunnan Power Grid Company, P.R. China); Guangjin Wei (Southeast University, P.R. China)

Compared with electromagnetic current transducer and electronic current transducer, fiber optic current transducer (FOCT) represents the developing direction of current transducer, which has a series of advantages, such as wide bandwidth, good insulation performance, high measuring accuracy, and so on. FOCT is one kind of new-type precise sensor based on the principle of Farady magneto-optical phase circling, its complicated structure results in shot noise, intensity noise, hot phase noise, and electromagnetic interference noise, which have great effect on FOCT's performance. Relativity of noise random process in time domain and stability of noise random process in frequency domain are analyzed, based on the analysis results, noise identification model and algorithm are proposed, and different type noise in FOCT showing main character is quantified by using noise identification model and algorithm. Aiming on decreasing the influence of noise to FOCT performance, filtering algorithm is applied in FOCT data processing. Experiments show that noise character is complex, noise dentification model and noise filtering algorithm are effective in FOCT noise processing system.
11:00 A handwritten digit recognition method based on hybrid features extraction and its application to a temperature sensor array

Lei Wang (Nanjing Institute of Technology, P.R. China & City College of New York, USA); Hongsheng Li (Nanjing Institute of Technology, P.R. China); Jizhong Xiao (The City College of City University of New York, USA); Liang Yang (City College of New York, USA)

This paper proposed a hybrid feature extraction method to improve the correct recognition rate of a handwritten digit recognition device based on temperature sensor array. The hybrid features are based on the temperature changes of the temperature sensor array during the process of handwriting, and the Principal Component Analysis (PCA) method is used for choosing the principal component of the features. Then the Support Vector Machine with the kernel of Radial Basis Function (RBF) is used for the online handwritten digit recognition. Lastly the above methods are applied in the online handwritten digit recognition system based on the temperature sensor array, and its performance is evaluated with well-designed comparative experiments. The experimental results demonstrate that the correct recognition rate of the hybrid features extraction based method exceeds 99%, which is 4% better than static features based method and 37.5% better over dynamic features based method.

11:18 Low-cost eye-tracking glasses with real-time head rotation compensation

Yanxin Wang and Hong Zeng (Southeast University, P.R. China); Jia Liu (Nanjing University of Information Science & Technology, P.R. China)

Nowadays capturing the image of eyeball with camera and estimating gaze points using pupil positions is the most common method for eye-tracking devices. Head-mounted eye-tracking equipment has a wide
range of application because of its flexibility and high gaze estimation accuracy. But the user's head should keep still using a chin rest or other tools, or will lead to enormous gaze estimation errors. In this paper, a head rotation compensation method is proposed for head-mounted eye-tracking glasses. The whole cost of our system is 38 USD. According to our preliminary result, the mean error of gaze estimation is reduced from 8.0162° to 0.5748°, which shows that our method can compensate head rotation effectively. The data in the task based experiment reveal that our system can be used as an alternative input device to mouse.

11:36 Comparative Analysis of Several Feature Extraction Methods in Vehicle Brand Recognition

Shengmei Lin (Southeast University, P.R. China); Chihang Zhao and Xingzhi Qi (Southeast University of China, P.R. China)

Several feature extraction methods, such as the local energy shape histogram, the local binary pattern model and the gradient histogram, are comparatively used to characterize vehicle face images, and Support Vector Machines (SVM) are proposed to classify vehicle brands. Theoretical analysis and experimental results show that the vehicle brand recognition method based on HOG feature extraction and SVM exceeds the other four methods, and the recognition rate is up to 92.40%.

11:54 Comparative analysis of several vehicle detection methods in urban traffic scenes

Minhui Zhao (Southeast University, P.R. China); Chihang Zhao and Xingzhi Qi (Southeast University of China, P.R. China)

Several vehicle detection methods in urban traffic scenes, such as vehicle detection method based on symmetrical features, vehicle detection method based on license plate, vehicle detection method based on Gabor features and Support Vector Machines (SVM), and vehicle detection method based on Haar-like features and AdaBoost
classifier, are comparatively used in this paper. The theoretical analysis and experimental results show that the vehicle detection method based on symmetrical characteristics is superior to other three methods, and The detection accuracy is up to 91.2%.

**12:12 Optimal Design Work for High-frequency Quartz Resonators**

*Jing Ji (Xidian University & School of Electro-Mechanical Engineering, P.R. China); Toshitsugu Ueda and Satoshi Ikezawa (Waseda University, Japan)*

My research focused on improving the performance of AT-cut high-frequency quartz resonators, which have been used in a wide range of applications including frequency generators, frequency control of telecommunication systems. New research findings about optimal design of AT-cut high-frequency quartz resonators fabricated by newly developed etching process were presented through improving energy trapping and reducing spurious vibration couplings. The simulation and experimental verification were carried out, and the effectiveness of the optimal design

**S11C: Chemical and Gas Sensors**

Chair: Octavian Adrian Postolache (Instituto de Telecomunicações, Lisboa/IT & Instituto Universitario de Lisboa, ISCTE-IUL, Portugal)

**11:00 High Performance Combustible Gas Monitoring System**

*Jun Xu, Xin Li and Tang Yanan (Harbin University of Science and Technology, P.R. China)*

A high performance monitoring system of combustible gas based on RS485 bus mode, which consists of a central controller and a unit controller was presented in this paper. The system is composed of center controller and unit controller, the Modbus protocol mode was used to communicate with the unit controller, realized the combustible gas alarm indication, storage and query of unit controller, and completed the sensor signal zero adjusting, calibrating and fault
monitoring. A unit controller acquires the concentration of combustible gas and temperature signal, using the RBF neural network to compensate the temperature drift of combustible gas, achieving accurate measurement of combustible gas concentration. The experimental results show that the measurement error is less than 2% LEL, the alarm error is less than 3% LEL. The system has the advantages of easy for operation and fixing, real-time and low cost, wide application prospect.

11:18 Taste Sensor using Strongly Hydrophobic Membranes to Measure Hydrophobic Substances

Xiao Wu, Ke Ji, Rixin Wang, Yusuke Tahara, Rui Yatabe and Kiyoshi Toko (Kyushu University, Japan)

A taste sensor using a lipid/polymer membrane, i.e., an electronic tongue with global selectivity, has been developed for objective evaluation of the taste of foods and beverages. Moreover, the taste sensor has been also contributing to safety of foods, e.g., the sensor membrane with strong hydrophobicity was used to detect sodium dodecyl sulfate (SDS), a negatively charged surfactant, which was generally added into the pesticide because of its strongly melting effect. An immersion process in monosodium glutamate (MSG) solution, called "MSG preconditioning" was needed to obtain the change in membrane electric potential caused by adsorption (CPA) for sensor membrane before measurement. However, what happened to sensor membrane during MSG preconditioning is unclear. In this paper, we examined the relationship between the CPA value and the period of MSG preconditioning. The amount of adsorbed SDS and MSG was measured to figure out whether the CPA value is related to the amount of adsorption. As a result, with the precondition process progressed, the CPA values showed concentration dependence on SDS concentration, and increased to a peak by preconditioning for one day then decreased to a stable state after that. The amount of adsorbed SDS depended on the SDS concentration but did not change with the increasing of preconditioning time. In conclusion, we revealed that the most suitable time of MSG preconditioning for the membrane
for SDS was one day. The CPA value was affected by both the surface charge density and the amount of absorption.

**11:36 Metal oxide nanotechnologies for analysis of skin microbiota activity in artificial sweat**

Andrea Ponzoni (National Institute of Optics, CNR, Italy); Veronica Sberveglieri (CNR-INO Sensor Lab, Italy); Giulia Zambotti, Estefania Nunez Carmona, Dario Zappa, Matteo Falasconi and Elisabetta Comini (University of Brescia, Italy); Andrea Pulvirenti (University of Modena and Reggio Emilia, Italy); Giorgio Sberveglieri (University of Brescia, Italy)

This work describes metal oxide gas sensor technologies based on chemiresistor and surface ionization devices with respect to their integration an electronic nose sensing system, namely a sensor array whose collective response is handled through a pattern recognition software. Potentialities and challenges of the proposed approach are presented with respect to their capability to discriminate among different microbiota populating human skin, once inoculated into an artificial sweat solution.

**11:54 Detection of VOC using titania nanomaterials**

Vardan Galstyan (Sensor Lab., CNR-INO and University of Brescia, Italy); Elisabetta Comini (University of Brescia, Italy); Andrea Ponzoni (National Institute of Optics, CNR, Italy); Veronica Sberveglieri (CNR-INO Sensor Lab, Italy); Nicola Poli, Guido Faglia and Giorgio Sberveglieri (University of Brescia, Italy)

Nb containing titania nanomaterials have been obtained for fabrication of sensor devices. The sensing properties of the obtained structures have been studied for different concentrations of acetone and ethanol. The preliminary results have shown that the prepared material is a promising structure and may be used in fabrication of electronic noses for the detection of volatile organic compounds.
**12:12 From an ancestral technique (enfleurage) to the nanowire gas sensors for evaluating the Balsamic Vinegars**

Giulia Betto and Estefania Nunez Carmona (University of Brescia, Italy); Vardan Galstyan (Sensor Lab., CNR-INO and University of Brescia, Italy); Veronica Sberveglieri (CNR-INO Sensor Lab, Italy); Paolo Giudici (University of Modena and Reggio Emilia, Italy)

Balsamic Vinegar of Modena and Traditional Balsamic Vinegar of Modena and Reggio Emilia are typical and valuable Italian products, worldwide appreciated thanks to their unmistakable flavors. Since the characterization of aromatic profile of balsamic vinegars (BVs) is one of the most important factors in quality control and authenticity assessment of these products, enfleurage coupled with S3 nanowire sensors device has been applied with the aim to establish a new, rapid, easy, economic and environmentally friendly approach. In fact, thanks to enfleurage the lipophilic volatile compounds were extracted from balsamic vinegar while acetic acid and its derivatives whose high concentration negatively influences MOX sensors sensitivity were not involved in the process. The obtained results suggest that enfleurage coupled with S3 nanowire sensors device could be useful in quality

**S12: Closing Ceremony and Prize Distribution**

Chairs: Subhas Mukhopadhyay (Massey University, New Zealand), Ruqiang Yan (Southeast University, P.R. China)
# Timetable

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<td>11:40 - 12:34</td>
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<td>S2B: Sensors for Environmental Monitoring</td>
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<td>16:00 - 17:30</td>
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## Sunday

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<td>11:00 - 12:30</td>
<td>S11A: Microwave, ElectroMagnetic Sensors and Optical Sensors</td>
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