Programme of the 2011 Fifth International Conference on Sensing Technology

November 28 – December 1, 2011

Massey University

Palmerston North

New Zealand

November 28, 2011: Tutorial

Venue: R12 Presentation Lab, Riddet Building, Massey University, Palmerston North campus

Tutorial #1: Basics of Terahertz Technology

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

Tutorial #2: Basics of optical fibre sensors and their applications

Speaker: Prof. Tong Sun
City University London, Northampton Square, London EC1V 0HB

Tutorial #3: Fundamentals of Wireless Sensors Network with Practical Demonstration

Speaker: Prof. Subhas Mukhopadhyay, FIEEE, Massey University, New Zealand

Time schedule:

9:00 to 10:00 Tutorial #1

10:00 to 10:30 Tea Break

10:30 to 11:30 Tutorial #1 (contd.)

11:45 to 12:45 Tutorial #2

12:45 to 13:45 Lunch

13:45 to 14:45 Tutorial #2 (contd.)

15:00 to 16:00 Tutorial #2

16:00 to 16:30 Tea Break

16:30 to 17:30 Tutorial #3 (contd.)

ICST 2011 Programme at a glance

Venue: SSLB, Social Science Lecture Block, Massey University, Palmerston North campus

Day	Time	Description
Tue	09:00-09:30	S0: *Inaugural Ceremony*
	09:30-9:50	*Tea Break#1*
	9:50-11:20	S1: *Keynote address #1*
	11:30-12:50	S2A: *MEMS and NEMS*, S2B: *Sensors for Robotics Applications* S2C: *Image Sensors*
	12:50-13:35	*Lunch#1*
	13:35-15:35	S3: *Invited Presentations* #1
	15:35-15:55	*Tea Break#2*
	15:55-17:55	S4A: *Magnetic Sensors* S4B: *Gas Sensors,* S4C: **Special Session on Autonomous Sensors and Sensors Systems**
Wed	08:30-09:30	S5A: *Sensors* for Novel Applications – I S5B: Sensors for Health and Biomedical Applications S5C: Sensors for Dielectric Measurements
	09:30-09:50	*Tea Break#3*
	09:50-11:20	S6: *Keynote* Address #2
	11:30-12:50	S7A: *Temperature and Humidity Sensors*, S7B: *Thick and Thin Film Sensors*, S7C: *Optical, Fibre Optic Sensors and Smart Grid*
	12:50-14:00	S8: Lunch cum Poster Session - I
	14:00 – 16:00	S9: Invited Session - II
	16:00 – 16:20	*Tea* Break #4
	16:20-17:20	S10A: *Sensors Interfacing and Signal Analysis* S10B*: Sensors for Aquaculture and Agricultural Applications* S10C: *Capacitive Sensors - I*

Thu	09:00-10:00	S11A: **Sensors for Special Applications - I** S11B: **Electronic Nose / Tongue and Ultrasonic Sensors** S11C: **Sensors for Novel Applications - II**
	10:00-10:20	*Tea Break #5*
	10:20-12:00	S12A: Special session on Ubiquitous Systems for HealthCare S12B: Sensors System for Structural Health Monitoring S12C: Special Session on Environmental Sensing and Monitoring
	12:00-13:40	S13: Lunch cum Poster Session - II
	13:40-15:00	S14A: Capacitive Sensors - II S14B: Sensors for Special Applications - II S14C: Chemical and Biological Sensors

15:30 CLOSING CEREMONY

Banquet Dinner: Wednesday, 30th November at 6.30pm – 10:00pm

Venue: Travelodge Hotel, 175-185 Cuba Street, Palmerston North

Tel: 06- 355 5895

Programme in details

09:00 - 09:30 S0: Opening Ceremony

9.30 – 9.50 - Tea Break

09:50 - 11:20

S1: Keynote Address - I

Chair: Prof. Subhas Mukhopadhyay (Massey University, New Zealand)

9:50 – 10:35 #1: Terahertz Radar for Stand-Off Through-Clothes Imaging, Dr. Goutam Chattopadhyay, Jet Propulsion Laboratory, NASA, USA

Security experts around the world have long been demanding an imaging system for detection of weapons or contraband from a safe stand-off distance concealed on persons. There has been some demonstration of active and passive millimeter- and submillimeter-wave imagers in recent years. However, passive imagers at terahertz frequencies do not provide enough contrast as they rely on the difference between the emitted radiation and the background "sky" temperature. Unfortunately, due to high atmospheric absorption at these frequencies, the background sky is very warm, providing very little contrast. On the other hand, active terahertz imagers have to deal with glint and require the imaging objects to be precisely placed at certain angles. We, at JPL, developed a radar based imaging system at terahertz frequencies which overcomes all these challenges and is capable of near video-rate imaging. In effect, the terahertz radar imager does an electronic strip-down revealing person-borne illicit materials and weapons from a safe stand-off distance. In this talk, a overview of the state of terahertz imagers will be provided, specifically focusing on radar imagers.

10:35 – 11:20 #2: Prof. K.T.V. Grattan, City University London, UK

11:30 - 12:50

S2: S2A: MEMS and NEMS

Chair: Dr. Cheng-Hsin Chuang (Southern Taiwan University, Taiwan)

11:30 – 11:50 *High sensitivity FET based MEMS deflection sensor*
Charanjeet Malhi (Indian Institute of Science, India); Rudra Pratap (Indian Institute of Science, India)

FET based sensors, where a deflecting micromachined structure works as the moving gate of the transistor, are being used for sensing deflection in micro-electro-mechanical transducers. The transistor is biased in the strong inversion region where the drain current (Id) varies quadratically with the difference in the gate-to-source voltage (Vgs) and threshold voltage (VT). This work proposes a sub-threshold based high sensitivity deflection sensor built on a fully depleted SOI substrate. The transistor is biased in the sub-threshold region (Vgs < VT) in order to enhance the sensitivity of the sensor. This results in an exponential variation in the drain current with a linear change in the displacement of the moving gate for a constant Vgs, thus improving the sensitivity. It is seen from simulations that the output drain current of the proposed sensor is very sensitive to deflection when it is biased in the sub-threshold region as compared to the threshold region. We also simulate the performance of a typical acoustic sensor and highlight the role of different design variables to be optimized in order to obtain the desired performance characteristics.

11:50 – 12:10 *Quantitative Analysis of Silver Nanoparticle Ink using Laser-induced Breakdown Spectroscopy*

Satoshi Ikezawa (Waseda University, Japan)

This paper describes the quantitative analysis of silver nanoparticle ink using laser-induced breakdown spectroscopy (LIBS). LIBS can be used to obtain information about the density and chemical composition of silver particles, even ultrafine particles. Metal particles have been attracting much attention because of their increased use in new micro-nano technologies. In this work, LIBS was used as a fine metal particle measurement system for nanometallic materials used in printing.

12:10 – 12:30 *Nano-Level 3-D Shape Measurement System Using RGB Color Interference Fringes*

Seiji Hata (Kagawa University, Japan)

Nano-level 3-D measurement is one of the key technologies for the current and future generation of production systems for semi-conductors, LCDs and nano-devices. To meet with these applications, wide range nano-level 3-D shape measurement method using combination of RGB lights has been developed. It measures the height of nano-objects using RGB lights interference color fringes. To analyze the RGB color fringes, the adaptive phase analysis method of interference fringes has been developed and achieved its efficiency. But it cannot measure the shape of edges. To meet with the difficulty, the color analysis method on xy-color plane has been introduced. The combination of the phase measurement method and the color analysis method has measured the 4 micrometer columns precisely. As more practical application, the shape of needles for AFM has been extracted, successfully.

12:30 – 12:50 *Sensors based on metal oxide nanostructures synthesized by arc discharge*

Vivian Fang (GNS Science, New Zealand); John Futter (GNS Science, New Zealand); John Kennedy (GNS Science, New Zealand); Andreas Markwitz (GNS Science, New Zealand)

Different synthetic methods have been developed to fabricate metal oxide nanostructures, but most of them require exotic reagents or are unsuitable for mass production. Till now, we've successfully synthesized zinc oxide (ZnO), tungsten oxide (WO3) and titanium dioxide (TiO2) nanostructures by arc discharge and the ability to tune the morphology of those nanostructures makes this method idea for fabrication of chemical sensing materials. In this paper, we present a review on metal oxide nanostructures synthesized by arc discharge demonstrating that arc discharge is a fast and inexpensive synthesis method which can be used to produce high quality metal oxide nanostructures for chemical sensing measurements. UV and gas sensing properties of ZnO nanostructures have been demonstrated as an example.

S2: S2B: Sensors for Robotic Applications

Chair: Dr. Goutam Chattopadhyay (CalTech, JPL, USA)

11:30 – 11:50 *Development of FBG sensor system for Force-feedback in Minimally Invasive Robotic Surgery*

Jungju Lee (Korea Advanced Institute of Science and Technology, Korea); Hoseok Song (Korea Advanced Institute of Science and Technology, Korea); Heechul Kim (Korea Advanced Institute of Science and Technology, Korea); Juwon Jeong (Korea Advanced Institute of Science and Technology, Korea)

Force feedback plays a very important role in medical surgery. In minimally invasive surgery (MIS), however, the very long and stiff bars of surgical instruments greatly diminish force-feedback to the surgeon. In the case of minimally invasive robotic surgery (MIRS), force-feedback is totally eliminated. Previous researchers have reported that the absence of force-feedback increased the average force magnitude applied to the tissue by at least 50%, and increased the peakforce magnitude by at least a factor of two. Therefore, it is very important to provide force information in MIRS. Recently, many sensors are being developed for MIS and MIRS, but some obstacles to their application in actual medical surgery must be surmounted. The most critical problems are size limit and sterilizability. Optical fiber sensors are among the most suitable sensors for the surgical environment. The optical fiber Bragg grating (FBG) sensor in particular offers an important additional advantage over other optical fiber sensors in that it is not influenced by the intensity of the light source. In this paper, we present the initial results of a study on the application of a FBG sensor to measure reflected forces in MIRS environments and suggest the possibility of successful application to MIRS systems.

11:50 – 12:10 ***Interaction in Robotics with a Combination of Vision, Tactile and Force Sensing***

Angel del Pobil (Universitat Jaume I, Spain)

This paper presents an approach for integrating vision, tactile and force sensors in a robotic interaction framework for manipulation. Having an initial estimation of the object pose in the environment, a position-based visual servoing loop controls the hand for task execution, based on the input received from a model-based articular pose estimator following the Virtual Visual Servoing approach. The visual control is combined with another control signal obtained from tactile feedback, through a set of selection matrices that can be modified at runtime in order to select the best modality for a given cartesian degree of freedom. The result of the preliminary integration is modified by an impedance force controller, in charge of performing the task motion along the task direction, at the same time that forces are regulated on the rest of directions. The design of the controller allows to perform the task even if a sensor is not available or provides inaccurate data. Several experiments are performed, first by considering only force feedback, and then adding vision and, finally, tactile information. Errors in the estimation of the object initial position are manually introduced in the experiments, and results show how the vision-tactile-force combination is able to deal with them, performing much better than the vision-force and force-alone approaches.

12:10 – 12:30 ***New Generation of Optical Robotic Sensor applied to Small Notch Detection***

Aime' Lay-Ekuakille (University of Salento, Italy); Nicola Ivan Giannoccaro (University of Salento, Italy); Alessandro Massaro (IIT, Italy); Luigi Spedicato (University of Salento, Italy); Patrizia Vergallo (University of Salento, Italy); Roberto Cingolani (IIT, Italy); Athanassia Athanassiou (Italian Institute of Technology, Italy)

In this paper the experimental application of a new class of an optical pressure sensors based on polydimethylsiloxane (PDMS)-Au is shown. The sensor consists of a tapered bended optical fiber, where an optical signal goes across, embedded into a PDMS-gold nanocomposite material (GNM) and it is used for scanning surfaces while it is moved automatically by a controlled servomotor. The sensor data during the scanning may be used for detecting a small notch on a beam. The experimental results are very encouraging for foreseeing successful use of this new sensor in robotic applications.

12:30 – 12:50 ***Dynamic Focusing Technique with Magnification Adjustment in an Electro-optical Lens***

Dong Hwan Kim (Seoul National University of Science and Technology, Korea)

In a scanning electron microscope, secondary electrons emitted from the specimen are collected at PMT, later being converted into electron signal to form an image. Usually, most surface perpendicular to the electron beam can be easily measured, however, side surface is not possible to be measured without rotating the specimen. With this tilts, the original focusing depth is changed, which makes the image blurry or mismatched dimension with original specimen. In this article, an adjustment technique is introduced, yielding the consistent image acquisition for various changes of focusing depth due to specimen tilting.

S2: S2C: Image Sensors

Chair: Prof. Ignacio R. Matias (Public University of Navarra, Spain)

11:30 – 11:50 ***Development and Application of the Human Visual Using Image Tracking System***

Kuei-Shu Hsu (Chia Nan University of Pharmacy & Science, Taiwan); Yueh-Min Huang (National Cheng Kung University, Taiwan); Tsung-Han Lee (Tatung University-Department of Mechanical Engineering & Tatung University, Taiwan)

The main purpose of this paper is to promote the efficiency of a control system using a scheduling policy control design. In this system, the management of a computer's input and output information is handled appropriately by the program language. The scheduling policy control design is used in the robotic vision tracking system. The advantage of this control design is to activate each procedure running simultaneously when the transient overload of the information's input and output in the control system occurs. Therefore, the time run in the scheduling policy control system will be shorter than that of a traditional control system. In this paper, case studies of the scheduling police

control application used in image tracking vision control are elaborated. The results reveal that the speed of the tracking system can be improved by using the scheduling policy technique under a prompt procedure plan.

11:50 – 12:10 ***From a Review of HDR Sensing and Tone Compression to a Novel Imaging Approach***

Amal Punchihewa (Massey University, New Zealand)

This paper reviews current high dynamic range (HDR) image sensing techniques and tone compression briefly. Then outline a novel approach for imaging which encompasses sensing and tone compression based on pixel based high dynamic range image capture using adaptive integration. Luminance domain processing will be explored to come up with a technique that will be a part of a novel system-on-chip (SOC) architecture. Currently we are working on an imaging system for special applications that need to take care of both adaptive HDR sensing and programmable tone compression. We explore the possibility of performing certain signal processing in the sensor integration itself and/or using a FPGA as immediate peripheral circuit operate in a pipeline and parallel process scheme on photo diode output

12:10 – 12:30 ***Objective Evaluation of Imager Performance***

Nicholas Paulter, Jr. (National Institute of Standards and Technology, USA)

We describe a method by which the evaluation and characterization of the performance of an imager can be done objectively and scientifically, that is, without routine operator interpretation. Although this method is demonstrated herein for passive long-wave infrared imagers (thermal infrared cameras) used by firefighters, it is applicable to any imaging system.

12:30 – 12:50 ***An Intelligent Scanner with Handwritten Odia Character Recognition Capability***

Debasish Basa (Biju Patnaik University of Technology, India); Sukadev Meher (National Institute of Technology, Rourkela, India)

Character recognition plays an important role in the modern world. It can solve more complex problems and make human's job easier. Difficulties in recognition of handwritten text in Indian scripts include extreme cursiveness in their handwritten form due to the presence of vowel modifiers and compound characters. Here we propose a simple yet robust structural solution for recognizing handwritten characters in Odia (the official language of Odisha, a state in Republic of India).In the proposed system, a given text is segmented into lines and then each line is segmented into individual words and then each word is segmented into individual characters or basic symbols. Basic symbols are identified as the fundamental units of segmentation used for recognition. All the characters are divided into two groups (Group-I and Group-II) according to the property i.e. whether a vertical line is present or absent at the right-most part.All the characters of the two groups are resized into 20X14 pixels, which are directly subjected to train the two neural networks (one for Group-I and another for Group-II). Using the proposed system we have found better result for proper recognition rate as compared to other methods. The proposed sensing system is also found to be efficient in compressing the script data quite efficiently.

12:50 – 1:35 Lunch Break

13:35 - 15:35

S3: Invited Session - I

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

13:35 – 14:05 ***New Ultrasonic Thermometry and its applications to Temperature Profiling of Heated Materials***

Ikuo Ihara (Nagaoka University of Technology, Japan)

In the fields of materials science and engineering, there are growing demands for monitoring temperature and its distribution of heated materials. This is basically because temperature is one of the most important factors that dominate the material properties and behavior. Such temperature monitoring is required for not only the surface but also the inside of heated materials. In this work, a new ultrasonic method for monitoring temperature gradients of

materials during heating or cooling is presented. The method consists of ultrasonic pulse-echo measurements and an inverse analysis for determining one-dimensional temperature distributions along the direction of ultrasound propagation in or on the material. To demonstrate the practical feasibility of the method, several experiments with heated materials have been made and successful results of internal temperature profiling are obtained. In addition, laser ultrasonic techniques that provide non-contact monitoring of surface temperature distributions of heated materials are proposed and their potentials are demonstrated. Thus, it is highly expected that the ultrasonic thermometry is a promising means for on-line temperature profiling of industrial materials processed at high temperatures.

14:05 – 14:35 ***MOS Gas Sensors: What determines our choice?***

Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Numerous researches have shown that a characteristic of solid-state gas sensors is the reversible interaction of the gas with the surface of Metal Oxide Semiconductor (MOS) materials. In addition to the conductivity change of gas-sensing material, the detection of this reaction can be performed by measuring the change of capacitance, work function, mass, optical characteristics or reaction energy released by the gas/solid interaction. Various materials, synthesized in the form of porous ceramics, and deposited in the form of thick or thin films, are used as active layers in such gas-sensing devices. However, in spite of so big variety of approaches to MOS gas sensor design the basic operation principles of all gas sensors above mentioned are similar for all the devices. As a rule, chemical processes, which detect the gas by means of selective chemical reaction with a reagent, mainly utilize MOS chemical detection principles. The analysis of various parameters of metal oxides and the search of criteria, which could be used during material selection for MOS gas sensor applications, were the main objectives of this review. For these purposes the correlation between electro-physical (band gap, electroconductivity, type of conductivity, oxygen diffusion), thermodynamic, surface, electronic, structural properties, catalytic activity and gas-sensing characteristics of metal oxides designed for solid-state sensors was established. It has been discussed the role of metal oxide manufacturability, chemical activity, and parameter's stability in sensing material choice as well.

14:35 – 15:05 ***Prediction and Validation of Outcomes from Air Monitoring Sensors and Networks of Sensors***

Aime' Lay-Ekuakille (University of Salento, Italy)

Air monitoring plays a key role in measuring atmospheric pollutant concentrations in different locations of the same region or of distinct ones. This paper describes results of processing volatile organic compounds (VOCs) using an interesting genetic algorithm and also processing benzo(a)pyrene(BaP) data. Both pollutants are collected from a network of sensors located in an industrial area and in a city respectively.

15:05 – 15:35 ***Cooperative Spectrum Sensing for Primary User Detection in Cognitive Radio***

Ramanarayanan Viswanathan (Department of Electrical & Computer Engineering, Southern Illinois University Carbondale, Carbondale, USA)

In order to utilize the available spectrum more efficiently, cognitive radio systems have been proposed. Spectrum sharing in cognitive radios allows unlicensed users to share the licensed spectrum during the absence of primary users. For achieving best spectral efficiency and non-interference with primary users, it is important to accurately detect the presence/absence of primary users. For this purpose, the solutions learned within the framework of decentralized detection in sensor networks have been considered. In this talk, we survey various approaches and the results obtained for primary user detection in cognitive radio networks.

15:35 – 15:55 - Tea Break

15:55 - 17:55

S4: S4A: Magnetic Sensors

Chair: Prof. Hartmut Ewald (University of Rostock, Germany)

15:55 – 16:15 ***Electrical Interference with Pickup Coil in Induction Magnetometer***

K. Tashiro (Shinshu University, Japan); Hiroyuki Wakiwaka (Shinshu University, Japan); Shin-ichiro Inoue (Shinsh University, Japan)

In this paper, we consider electrical interference to pickup coil in an induction magnetometer. By using a dummy load in place the pickup coil, we confirm that there is no significant electrical interference in a differential-input type current-to-voltage converter. In order to reveal electrical interference with the pickup coil, we investigate the output voltage of the magnetometer as grounding condition parameters. From the number of experimental considerations, we formulate a suitable condition to solve the electrical interference problem.

16:15 – 16:35 *All-oxide magnetic field sensor*

Aurélie Solignac (CEA Saclay, France); Ruben Guerrero (CEA Saclay, France); Philippe Lecoeur (IEF-Université Paris Sud, France); Myriam Pannetier-Lecoeur (CEA Saclay, France); Guillaume Agnus (IEF-Université Paris Sud, France)

Spin electronics sensors can be used as magnetic field sensors in various applications such as current sensing, non-destructive testing or compasses. If metallic layers are used for most of the room temperature applications, oxide materials exhibit very good performances for low temperature applications. Here we present the principle of an all-oxide field sensor, which could offer field sensitivity in the sub-femtotesla range. We present the magnetic tunnel junction developed for this purpose and give the performances in term of magnetoresistance and noise.

16:35 – 16:55 *Metal Detector Head Analysis*

Zhuoran Tang (University of Auckland, New Zealand); Lawrence Carter (The University of Auckland, New Zealand)

Metal-detector performance depends heavily on the sensor head. Errors in coil placement within the head can lead to degradation in detector performance. Electromagnetic modelling of typical very-low-frequency detector heads shows the effect of coil placement errors on detector sensitivity. Provided the bucking coil 'tracks' the receive coil, required error corrections can remain small.

16:55 – 17:15 *Micro Elements for Interrogating Magnetoelastic Sensors*

Cai Liang (King Abdullah University of Science and Technology, Saudi Arabia); Chinthaka Gooneratne (King Abdullah University of Science and Technology, Saudi Arabia); Leslie Mathison (Auburn University, USA); Bryan Chin (Auburn University, USA); Jürgen Kosel (King Abdullah University of Science and Technology, Saudi Arabia)

This paper reports a new approach for interrogating a magnetoelastic sensor's resonant frequency. Previously, the frequency of a magnetoelastic sensor was measured by using a large-scale coil of at least some millimeters both in diameter and length. Planar structures of ladder and spiral type are designed, fabricated and tested to interrogate the resonant frequency of a magnetoelastic sensor. A sensor of 8 mm length is measured to have a resonant frequency of 269 kHz in air. The ability to interrogate a magnetoelastic sensor with such microscale elements is a step towards the miniaturization of a magnetoelastic sensor system and integration of such a system in a microfluidics device.

17:15 – 17:35 *GMR based integrated non-contact voltage sensor for fuel cells monitoring*

Myriam Pannetier-Lecoeur (CEA Saclay, France); Claude Fermon (CEA Saclay, France); Alain Giraud (CEA Saclay, France)

We present an integrated voltage sensor dedicated to fuel cells monitoring. This sensor is based on Giant Magneto Resistances (GMR) as sensitive elements coupled to a micron size integrated metallic line which creates a field on the GMR elements when a current flows in it. Complete module containing eight channels with the associated electronics have been developed and successfully tested on fuel cells batteries for automotive.

17:35 – 17:55 *A Half-Ring GMR Sensor for Detection of Magnetic Beads Immobilized On a Circular Micro-Trap*

Chinthaka Gooneratne (King Abdullah University of Science and Technology, Saudi Arabia); Cai Liang (King Abdullah University of Science and Technology, Saudi Arabia); Arthur Useinov (Integrated NanoTechnology Fab, KAUST, Saudi Arabia); Ioanna Giouroudi (Vienna

University of Technology, Austria); Jürgen Kosel (King Abdullah University of Science and Technology, Saudi Arabia)

Utilizing magnetic principles in biological immunoassays is an attractive option given its ability to remotely and non-invasively manipulate and detect cells tagged with micro/nano size superparamagnetic type beads and due to the fact that even the most complex biological immunoassays will have very little magnetic effect. The presence of magnetic beads can be detected by a magnetic sensor which quantifies the amount of target cells present in the immunoassay. In order to increase the detection rate a circular conducting micro-trap is employed to attract, trap and transport the magnetic beads to the sensing area. In this research we propose a half-ring spin valve type giant magnetoresistance (GMR) sensor for the measurement of stray fields produced by 2 micro meter magnetic beads which are around the circular micro-trap. A couple of half-ring GMR sensors can be used to cover the entire circular border width, in order to detect the majority of the immobilized magnetic beads. Analytical and numerical analysis leading towards the fabrication of the half-ring GMR sensor are presented. DC characterization of the fabricated sensor showed a magnetoresistance of 5.9 %. Experimental results showed that the half-ring GMR sensor detected the presence of 2 micro meter magnetic beads. Hence, half-ring GMR sensors integrated with a circular micro-trap have great potential to be used as an effective disease diagnostic device.

S4: S4B: Gas Sensors

Chair: Prof. Elfed Lewis (University of Limerick, Ireland)

15:55 – 16:15 *Oxygen Detection Using Nanoporous Anodized Aluminum Oxide Sensors*

Michael J. Haji-Sheikh (Northern Illinois University, USA)

The objective of this work has been the analysis of the impedance variation of nanostructured sensors in the presence of several gases at different temperatures. This sensor employs platinum nanowires grown in anodic aluminum oxide to detect the gases. Silicon wafers were oxidized to form silicon dioxide and were sputter deposited with titanium tungstide and aluminum metal. The aluminum film was subsequently anodized to form nonporous anodic aluminum oxide. Platinum metal was filled in these pores by the process of electropolymerization to form encapsulated nanowires. Surface morphology characteristics were determined using atomic force microscopy and scanning electron microscopy. A subsequent metallization process using evaporation deposited gold metal to form electrical contacts. Variations in the electrical response of the sensor in the presence of hydrogen, nitrogen and oxygen at 5oC, 25oC and 40oC are presented in this work.

16:15 – 16:35 *Study of nano Fe2O3 MOS thick films as ethanol gas sensor*

Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India); Nitin Pawar (K A A N S Arts, Commerce and Science College, India)

Thick films of AR Grade nano Fe2O3 material with n type semiconducting properties were prepared and tested for their gas sensing performances. Thick films of the materials were prepared by screen printing technique. The gas sensing performance was studied using static gas sensing system. The material was tested for various gases such as CO, CO2, NH3, Cl2, H2, LPG, ethanol and H2S. The nano Fe2O3 film showed maximum sensitivity to Ethanol gas at 350oC temperature and at 250 ppm concentration with short response time and large recovery time. Physical and structural properties of the films material were studied by TEM, XRD.

16:35 – 16:55 *Preparation and characterization of nanostructured Zirconia for gas sensing application*

Pratap Patil (Department of Physics, Ruia College, Matunga, Mumbai India & Department fo Physics, Arts Science and Commerce College, Nandgaon, District Nasik India, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Nanocrystalline ZrO2 (Zirconia) has been synthesized by a conventional precipitation method. The structural, morphological, microstructural, optical and gas-sensing properties of ZrO2 were investigated by using X-ray diffraction analysis (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), UV-vis spectroscopy and static gas sensing unit, respectively. X-ray diffraction pattern and TEM of the synthesized product reveal their nano-crystalline nature with grain size 18 nm and 20 nm, respectively. Gas sensing properties of their thick films, which were fabricated by screen-printing to various gases (O2, NO2, C2H5OH, CO, CO2, NH3, LPG, H2S and H2) were tested in ambient air. The ZrO2 thick films showed a high response and selectivity to H2S gas. The effect of operating temperature, gas concentration on the sensing characteristics of these films towards H2S was discussed.

16:55 – 17:15 *A novel optical fiber sensor for gas temperature monitoring in chemically pollutted environments*

Giovanna Saviano (SAPIENZA - Rome University, Italy); Ferdinando Felli (SAPIENZA- Rome University, Italy); Stefano Bianco (Laboratori INFN Frascati, Italy); Carla Lupi (SAPIENZA - Rome University, Italy); Michele Arturo Caponero (ENEA Frascati Research Centre, Italy); Luigi Benussi (INFN - Laboratori Nazionali di Frascati & CERN, Italy); Davide Piccolo (INFN Frascati, Italy); Cristian Vendittozzi (SAPIENZA- Rome University, Italy)

A novel optical fiber sensor for the monitoring of gas temperature is presented. Test results in controlled environment are presented and applications in both industrial and research environments are discussed. The sensor will be proposed for implementation in the real time monitoring of temperature and environmental variables for the improvement of the gas system knowledge and optimization of the muon detector based on Resistive Plate Counters (RPC) of the Compact Muon Solenoid (CMS) collaboration at the Large Hadron Collider (LHC) accelerator of CERN, Geneva (Switzerland).

17:15 – 17:35 *Advanced oxygen sensor with oxide electrode materials*

Pavel Shuk (Emerson, USA)

Calcium doped lanthanum and yttrium manganite electrode materials with oxygen deficiency and low polarization resistance (<30Ωcm2 at 600°C) were tested in new advanced electrochemical sensor for the oxygen measurements. Oxygen sensor with oxide electrodes was showing fast response (t95~5s at 600°), good reproducibility (±0.04% O2) and long term stability at different oxygen concentration

17:35 – 17:55 *Gas Sensing Characteristics of Pure and Fe-Doped Tungsten Oxide Thin Films*

Tuquabo Tesfamichael (Queensland University of Technology, Australia)

In this study gas sensing characteristics of pure and 10at% Fe-doped nanostructured tungsten oxide thin films of various thicknesses (100-500 nm) prepared by electron beam evaporation are reported. The sensing performances of the films towards various gasses (H2, NH3, NO2, N2O) at different operating temperatures (150-280oC) have been investigated. Very high sensing response of both types of films towards NO2 compared to the other target gasses was observed. This indicated that the WO3 based sensors are highly selective to NO2 exhibiting much lower response to the other target gasses. The pure WO3 sensor of 300 nm film thickness has shown the highest response amplitude at lower temperature (150oC). Doping of the tungsten oxide film with Fe significantly increases the base conductance of the pure film but also decreases the gas sensing response. The amount of Fe additives (10 at%) has not been optimized which can be one factor for the decrease of sensing response. A film thickness of 400 nm has shown the optimum sensing responses among the WO3:Fe films. However, change of operating temperature between 200-250oC has shown little variation to the sensing response of the different films (100-500 nm). The high sensing performance of the WO3 based sensors to NO2 can be attributed due to the nanostructural nature of the films obtained through e-beam evaporation and subsequent annealing of the films at 300oC for 1 hour in air.

S4: S4C: Special Session on Autonomous Sensors and Sensors Systems

Chair: Dr. Stoyan Nihtianov (Technical University - Delft, The Netherlands)

15:55 – 16:15 *Highly Stable Capacitance-to-Digital Converter with Improved Dynamic Range*

Stoyan Nihtianov (Technical University - Delft, The Netherlands); Roumen Nojdelov (Velista - Roumen Nojdelov, Bulgaria); Ruimin Yang (Technical University Delft, The Netherlands); Xiaodong Guo (TU Delft, The Netherlands)

This paper presents the design, implementation and verification of a highly stable capacitance-to-digital converter (CDC). This converter is based on a multi-slope type of converter which utilizes stable resistors as reference components. Based on the previous works, a so-called "zoom-in" technique is applied in this design which significantly improves the dynamic range of the converter. The measurement range is up to 100pF if the zoom-in is enabled. Depending on the measurement mode, the measurement time varies from 51us to 75us. The experimental results

show that the converter achieves up to 18.5-bit dynamic range when enabling the zoom-in and 3.6 ppm/oC temperature stability. The 1/f noise corner of the converter is around 20mHz which indicates good long-term stability.

16:15 – 16:35 *LED Based Spectroscopy - a Low Cost Solution for High Resolution Concentration Measurements e.g. for Gas Monitoring Applications*

Martin Degner (University of Rostock, Germany); Elfed Lewis (University of Limerick, Ireland); Hartmut Ewald (University of Rostock, Germany)

Reliable online sensor measurement data are the foundation of autonomous controlled processes. One important issue for a high quality production (closed loop control) as well as for environmental protection (emission reduction) is the in-situ concentration measurement of substances. Especially the selective and high resolved detection of individual substances is a complex issue for low cost sensor solutions. Optical spectroscopy is a valuable method according the selectivity and resolution but appropriate setups are quite complex thus they are cost intensive and almost not autonomous. This paper presents a low cost and high resolution (parts per million (ppm) and parts per billion (ppb) range) spectrometric sensor system for gas detection in harsh environment. Novel LEDs are utilized as wavelength selective light sources in combination with standard photodiodes and optical fibres to realize robust in-situ gas measurements. Referenced measurement results for different applications are shown and discussed.

16:35 – 16:55 *Integration of hybrid sensing networks in indoor intelligent homes*

Juan Antonio Nazabal (Universidad Pública de Navarra, Spain); Francisco Falcone (Universidad Publica de Navarra, Spain); Carlos Fernández (Universidad Publica de Navarra, Spain); Ignacio R. Matias (Public University of Navarra, Spain); Subhas Mukhopadhyay (Massey University, New Zealand)

In this work we present a system based on the integration of different type of sensor technologies at laboratory level. A ZigBee temperature sensor prototype has been integrated with a fiber optic sensor network and a KNX sensor network. The system also has the capability of remote monitoring in real-time all the different sensor presented in the system.

16:55 – 17:15 *Automatic breathing segmentation from wearable respiration sensors*

Paulo Lopez-Meyer (The University of Alabama, USA); Edward Sazonov (The University of Alabama, USA)

Respiratory Inductance Plethysmography (RIP) allows studying the physiology of the breathing process and provides ability to characterize it in an automated manner. An efficient and robust automatic breath segmentation technique that can be applied to sensor signals acquired in free living conditions is of interest due to the significant variability in the breathing patterns of different activities. The gold standard for breath segmentation has been visual recognition of breath cycles based on respiratory signals interpreted by an expert. This process is impractical for long term monitoring of respiration, especially when intended to be performed by wearable sensors. In this work a feasibility study is presented using a technique for automatic breath segmentation based on peak and valley detection to determine beginning and end of a breath segment. The proposed segmentation method is applied to breathing recordings collected from four different activities: resting, reading aloud, food intake and smoking, acquired by a wearable RIP sensor. Significant differences in the breathing waveforms patterns are easily observed for each one of these activities. Results suggest that the breath segmentation technique studied in this paper has enough robustness to be used under different activities, with up to 96.6% accuracy for resting, 89.9% for reading, 91.1% for food intake and 89.2% for smoking.

17:15 – 17:35 *A simulation based comparative study of two broadband probes for NMR of magnetically ordered materials*

José Mariano (University of Algarve and ICEMS, Portugal); Mircea Rogalski (Instituto Superior Tecnico and ICEMS, Portugal); Octavian Adrian Postolache (Institute of Telecomunication - IT/IST & Escola Superior de Tecnologia de Setubal, Portugal)

Nuclear Magnetic Resonance is a valuable technique for the investigation of magnetically ordered materials. This paper presents a simulation-based comparative study between the two most used broadband NMR probes: the delay-line probe, introduced by Lowe, Engelsberg and Whitson, and the high-pass, proposed by Panissod. A practical approach concerning the probe characteristics was done using SPICE.

Wednesday, November 30

08:30 - 09:30

S5: S5A: Sensors for Novel Applications – I

Chair: Dr. Carlos Fernández (Universidad Publica de Navarra, Spain)

8:30 – 8:50 *Sensing Technologies for Homeland Security in Cloud Environments*
Maria Fazio (University of Messina, Italy); Massimo Villari (University of Messina, Italy); Antonio Puliafito (University of Messina & Engineering Faculty, Italy)

World Wide Governments are trying to increase the level of security deploying on the territory many monitoring cameras and sensors able to capture new physical parameters. Internet is becoming the common communication method, hence international Police employers are looking and analyzing the overall Internet traffic for reconstruct communications. Cloud Computing may help Homeland Security needs especially for processing and storing a huge amount of data. In this work we introduce a new Cloud architecture able to deal with different types of virtual elements, logically belonging to Cooperating Clouds, treated and manipulates in the same way. The description of a Use-Case related to the Homeland Security, that is the Transportation of Dangerous Goods, helps us to present the Cloud architecture we introduced, highlighting its features and peculiarities.

8:50 – 9:10 *External Smart Microphone for Mobile Phones*
Peter Volgyesi (Vanderbilt University, USA); Sandor Szilvasi (Vanderbilt University, USA); Janos Sallai (Vanderbilt University, USA); Akos Ledeczi (Vanderbilt University, USA)

Mobile phones are gaining popularity as sensing platforms. They already come with a set of built-in sensors, such as GPS, accelerometer, microphone and radio, enabling interesting applications. Several systems exist where external sensors are interfaced with mobile phones to monitor medical conditions or support environmental sensing among others. In this paper, we present an external acoustic sensor that interfaces with a mobile phone to support continuous monitoring of sounds in the environment. The on-board electronics samples the microphone, performs signal processing and detection tasks and sends the events of interest to the mobile phone via Bluetooth. The main reasons the built-in microphone is not able to support such an application is the high power usage of continuous sampling and processing the acoustic signal on the phone and the fact that the typical phone is carried in a pocket or bag shielding the microphone from the environment. Our particular motivating application is a mobile phone-based countersniper system.

9:10– 9:30 *Intensity control of a phase-shift based laser scanner for reducing distance errors caused by different surface reflectivity*
Junhwan Jang (Gwangju Institute of Science and Technology, Korea); Kyihwan Park (Gwangju Institute of Science and Technology, South Korea, Korea)
In the phase-shift measurement method, the distance light travels can be obtained based on the phase difference between the reference signal and the measured signal. When the object having various colors is measured, the intensity of the measured signal much varies even at the same distance, and it causes different phase delay due to wide dynamic range input to a signal processing circuit. In this work, an intensity control method is proposed to solve this phase delay problem.

S5: S5B: Sensors for Health and Biomedical Applications

Chair: Dr. Poul F Nielsen (University of Auckland, New Zealand)

8:30 – 8:50 *Characterizations and Performance Evaluations of Thin Film Interdigital Sensors for Gram-Negative Bacteria Detection*

Abdul Rahman Mohd Syaifudin (Massey University, New Zealand), S.C. Mukhopadhyay and Pak Lam Yu

Thin film interdigital sensors have been designed and fabricated. The sensors were fabricated using different substrates and using different fabrication technology. The initial design was fabricated on glass slide and fabricated using IDT (Intergrated Device Technology). The new sensors were fabricated on silicon/silicon dioxide wafer. All sensors were coated with APTES, a cross-linker bind to certain bio-molecules and then were immobilized with Polymyxin B, a specific bio-molecules that bind to endotoxin (Lipopolysaccharide, LPS). Sensors were tested for different concentration of LPS. Their characteristics were presented using Impedance Spectroscopy method.

8:50 – 9:10 ***Social Media, Mobile Devices and Sensors: Categorizing New Techniques for Health Communication***

Robert Steele (The University of Sydney, Australia)

The advent of social media and online social networking is still relatively new, a rapid penetration of these technologies is being seen and their impact in relation to health communications is more recently also being considered. In relation to health in particular, these social media communications systems can also be considered to gain extended capabilities and impact when used atop and interacting with mobile devices and sensors. In this paper we introduce a framework to categorize and analyse the emerging types of health-related social media interactions and communications and consider how the techniques fit within this broader framework for healthcare applications of social media.

9:10 – 9:30 ***Towards Non-invasive and Continuous Monitoring of Blood Glucose Level based on CW Photoacoustics: New Concept for Selective and Sensitive Measurements of Aqueous Glucose***

Serge Camou (NTT Corporation, Japan)

This paper describes the concept of combining two protocols based on the continuous-wave photoacoustic technique for selective and sensitive measurement of glucose compounds. The first protocol, equivalent to an acoustic velocity measurement, provides a highly sensitive measurement of glucose as well as other parameters. The second protocol exhibits sensitivity to compounds depending on the optical wavelength used for the generation of acoustic waves. By multiplying the number of optical wavelengths used, it is then possible to obtain a system of M independent equations with N unknown parameters, including glucose concentration. Solving the system combining the results from the two protocols should then provide selective and sensitive measurement of diluted glucose non-invasively and continuously.

S5: S5C: Sensors for Dielectric Measurement

Chair: Dr. Kailash P. Thakur (LANDCARE RESEARCH, New Zealand)

8:30 – 8:50 ***The Use of Dielectric Models to Determine Moisture Content in Aggregate Material***

Ian G Platt (Lincoln Ventures Ltd, New Zealand)

This paper provides a preliminary study on the properties of dielectric modeling when applied to composite aggregate materials under the action of Time Domain Reflectometry (TDR). While only the bounds of the values are determined, results indicate that models that take account of ionic exchange processes can come close to representing composite aggregate material. For high precision work however these existing models are not be accurate enough and a new mixing model is required.

8:50 – 9:10 ***Dielectric Measurement of Logs for Improved Internal Imaging***

Wayne Holmes (Unitec Institute of Technology, New Zealand)

This paper describes the measurement of the dielectric properties of the typical log features of Heartwood, Sapwood and internal Branches. Measurements were made using the waveguide cell technique covering the frequency range of 2.3 to 6.5GHz. This has shown that for the desired contrast between heartwood and Sapwood to be achieved the imaging system must operate above 4GHz. Additional work was undertaken to establish a method to correct these

measurements for variations in basic density and Earlywood\Latewood banding, giving rise to a potential moisture content estimation error of 0.63%. This will lead to improved spatial location of features of interest

9:10 – 9:30 ***Dielectric characteristics of lipid droplets suspended in YEPD media***
Richard Blakey (Liverpool John Moores University, United Kingdom); Alex Mason (Liverpool John Moores University, United Kingdom); Carole Rolph (University of Central Lancashire, United Kingdom); Gray Bond (University of Central Lancashire, United Kingdom); Ahmed I Al-Shamma'a (Liverpool John Moores University, United Kingdom)

Currently, there are no point-of-care diagnosis strategies available to indicate the presence of neoplasmic growth. This research aims to develop a novel diagnostic strategy based on detecting lipid accumulation in various cells. This element of the research is a preliminary experiment to prove the concept of detecting TAG lipid droplets in YEPD media. This method calculated the relative dielectric constant of vegetable oils at 2.991 to 3.014 for groundnut and grapeseed oil respectively. The results indicate a decrease in relative dielectric constant and dielectric loss as the proportion of lipid droplet increases.

9.30 – 9.50 - Tea Break

09:50 - 11:20

S6: Keynote Address - 2

Chair: Dr. Amal Punchihewa (Massey University, New Zealand)

9:50 – 10:35 #3: Falling Detection and Motion Reconstruction of Elderly People: Sensors Based Approach, Professor Yueh-Min Huang, National Cheng-Kung University, Taiwan

At present, there are many studies of falling accident detection, while most employed image detection or used single acceleration sensors for identification. Recognition by image detection has very high operational complexities, and infringe on privacy. Single acceleration sensors have very high accuracy in falling detection, however, the accuracy of judging body posture requires highly complex operations, and thus, cannot provide real-time notice for accidental falling detection. This study explored the collaborative detection of body behavior modes and accidental falling incidents by using multiple tri-axis acceleration sensors. Information is provided by sensors distributed over the body that transmit positions, by radio transmission devices to a computer, in order to analyze and recognize current body behavior status, which create a warning when a falling accident happens. After a falling accident occurs, more information of the sudden incident, such as body posture and impact of crucial position, can be provided to medical personnel for more accurate diagnosis.

10:35 – 11:20 #4: Lossy mode resonances - based fiber optic sensors, Professor Ignacio R. Matías, Public University of Navarra, Spain.

During the last decades, much research has been done in the field of semiconductor and metal clad optical waveguides. In both cases, the clad introduces losses to the propagation of light in the optical waveguide. Depending on the properties of the cladding or the thin-film, three main cases can be distinguished. The first case, occurs when the real part of the thin-film permittivity is negative and higher in magnitude than both its own imaginary part and the permittivity of the material surrounding the thin-film (i.e. the optical waveguide and the surrounding medium in contact with the thin-film). In this case, coupling occurs between light propagating through the waveguide and a surface plasmon, which is called surface plasmon polariton or surface plasmon resonance (SPR). The second case occurs when the real part of the thin-film permittivity is positive and higher in magnitude than both its own imaginary part and the material surrounding the thin-film. Some authors consider these modes as long-range guided modes [3], whereas others call them lossy modes. The third case, occurs when the real part of the thin-film permittivity is close to zero, while the imaginary part is large. This case is known as long-range surface exciton polariton.

During the last years, hundreds of publications have been devoted to the SPR, whereas the number of publications devoted to lossy modes resonances (LMR) is quite low. In fact, all of them correspond to theoretical works. Moreover, in our knowledge, the utilization of LMR for sensing purposes has been used very recently in our group for the first time. For the sake of truth, some works using LMR had been previously published, but authors misunderstood these resonances with others, mainly with SPR.

11:30 - 12:50

S7: S7A: Temperature and Humidity Sensors

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

11:30 – 11:50 ***Flexible pH Sensor with Polyaniline Layer based on Impedance Measurement***

Hsun-Pei Wu (Department of Mechanical Engineering & Institute of Nanotechnology & Southern Taiwan University, Taiwan); Cheng-Hsin Chuang (Southern Taiwan University, Taiwan); Cheng-Ho Chen (Department of Chemical and Materials Engineering, Taiwan)

A flexible sensor with conducting polyaniline layer for detection of the pH value based on impedance measurement has been fabricated and demonstrated in this paper. The pH sensor consists of an interdigital electrode array on flexible printed circuit and a thin-film polyaniline as the sensing layer. Due to the conductivity of polyaniline depends on the redox state; the impedance change of polyaniline after reacted with different pH value solution can be as the sensing mechanism. In order to obtain a reliable and stable impedance measurement result we also developed a standard procedure for pH value detection in this study. As the experimental results, the impedance variation of pH sensor was less than 1% in the ambient environment, and the measured impedances were increased with pH values varying from 2 to 12. In addition, the impedance change between unreacted sensor and reacted sensor exhibited 3 orders difference, thus, the resolution of pH value detection can be very high and it is possible to detect by simple electronic device. Consequently, a low-cost, disposable, flexible IDT-electrode sensor with polyaniline layer has demonstrated the feasibility of pH value detection; moreover, the sensor also can be applied to other applications such as gas detection, humidity and glucose, etc.

11:50 – 12:10 ***Temperature Sensors for use in Muscle Microcalorimetry***

Callum Johnston (University of Auckland, New Zealand); Poul F Nielsen (University of Auckland, New Zealand); Andrew Taberner (University of Auckland, New Zealand); Ian Hunter (MIT, USA)

In order to measure the heat production of small samples of heart muscle, very sensitive temperature sensors are required. In this paper, we survey a range of candidate temperature sensors for use in a microcalorimeter for studying cardiac muscle tissue. The key metrics (noise equivalent temperature, thermal mass and noise equivalent heat) of eight different temperature and heat sensors are compared. The sensor that would potentially allow the greatest heat resolution utilises the phenomenon of vapour pressure. An initial prototype of this thermometer has been constructed, and the design of a new sensor is outlined.

12:10 – 12:30 ***A Smart Conductivity Sensor with Temperature and Water Tide Level Compensation Capabilities***

Jose Costa Pereira (ESTSetúbal, Portugal); Pedro Girão (Instituto de Telecomunicações, Portugal); Octavian Adrian Postolache (Institute of Telecomunication - IT/IST & Escola Superior de Tecnologia de Setubal, Portugal)

This paper presents a smart conductivity sensor with capabilities to compensate measurement errors caused by temperature variations and, particularly, to compensate measurement errors caused by water tide levels variations in estuarine zones. A low-cost smart conductivity sensor (SCS) is presented and a mathematical model to compensate measurement errors is proposed. The last part of the paper includes several experimental results that are used to validate theoretical expectations, namely, to confirm the dependence of the conductivity measurements on water tide level and to evaluate the performance of the compensation algorithm that is proposed.

12:30 -12:50 *Characterisation of a Fibre Bragg Grating System for Strain and Temperature Sensing*

Kevin Stevens (Quest Reliability Ltd, New Zealand)

We have characterised a strain and temperature sensing system being developed by Southern Photonics that uses a new Optical Interrogator and fibre Bragg gratings. We have determined the key strain and temperature coefficients and shown that strain and temperature can simultaneously be measured. The experimental uncertainty is 5.2 pm when using the 1540 nm fibre Bragg grating, which corresponds to an experimental uncertainty in measuring the temperature of 0.54 ºC and in measuring the strain of 3.4 με .

S7: S7B: Thick and Thin Film Sensors

Chair: Dr. Nabarun Bhattacharyya (C-DAC, Kolkata, India)

11:30 – 11:50 *LPG Gas Sensing Properties of CuO Loaded ZnO Thick Film Resistors*

Madhavrao Keshavrao Deore (Arts, Science and Commerce College, Ozar (Mig), India); Vishwas Gaikwad (K.T.H.M. College, Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

A gas sensing performance of pure and CuO-loaded ZnO thick films was studied by preparing thick films using the screen printing technique. The pure AR grade powder of the Copper Chloride was loaded at the various concentrations (1 wt. %, 3 wt. %, 5 wt. % and 7wt. %) into the pure AR grade powder of the Zinc oxide. The powders of different compositions were heated at "1000 oC" for "12 hrs". The copper chloride transforms into copper oxide upon heating. These films of different compositions were fired at 550 oC for 30 min. The electrical, structural and morphological properties of the films were investigated. The X-ray diffraction analysis of pure and loaded films shows the polycrystalline nature. The surface morphology of the films was studied by SEM. The final composition of each film was determined by EDAX analysis. The gas response, selectivity, response and recovery time of the sensor were measured and presented. The sensing performance was tested for various gases at different operating temperatures. The ZnO sensor loaded with 5 wt. % of CuO is found to be sensitive to LPG gas than pure ZnO and other loading concentrations with fast response and recovery time.

11:50 – 12:10 *Sol-gel synthesis of TiO2 nano powder and study of their gas sensing performance using thick film resistors*

Vishwas Gaikwad (K.T.H.M. College, Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Nano size TiO2 powder with anatase and rutile structure was prepaired by a sol-gel method using TiCl4 ethanol solution. The TiCl4 acts as precursor in this reaction. The obtained product with grain size 2.80 nm. The obtained product consist of both rutile and anatase phases. These phase formed after drying of gel at 800C.The proportion of anatase to rutile was 6:8.The high proportion of rutile phase responsible for higher gas sensitivity. The thermal stability of nano product tested using TGA-DTA technique. The nano size structure of TiO2 was confirmed by X-Ray Diffraction Spectroscopy (XRD), Field Emission Scanning Electron Microscopy (FESEM). The gas sensitivity of material tested by preparing thick film by screen printing technique for this the thixotropic paste of material was prepared by using ethyl cellulose and butyl cellulose. The gas sensing performance of this thick film was tested for gases like ethanol, CO2, H2S, NH3, CO, Cl2, gases and observed maximum sensitivity for H2S gas at 3500C.

12:10 – 12:30 *Synthesis of nano barium zirconate (BaZrO3) and its gas sensing performance using thick films*

Ramnath Choudhari (KTHM College, Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Nano powder of pure Barium Zirconate was prepared by wet-chemistry synthesis method, using Barium Stearate and Tetra-n-Butyl Zirconate as Ba, Zr sources and Stearic acid as complexing reagent. The gel was calcined at 1100 °C in air. X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Selected Area Electron Diffraction (SAED) and UV Visible spectrograph were used to characterize the crystallization process, to study the particle size and morphology of the calcined powder. The results indicated that Barium Zirconate nanopowder with particle size between 19 nm to 79 nm obtained after calcinations of the dried gel at 1100 °C for 1h. Gas sensing performance of this Nano powder using thick films showed maximum sensitivity to NH3 gas at 200oC for 100 ppm gas concentration as compared to other gases like H2S, CO, CO2, Cl2, Ethanol, H2 etc.

12:30 -12:50 *Nanocrystalline CdSnO3 thin film as highly sensitive ethanol sensor*
Ganesh E. Patil (Arts, Commerce & Science College, Nandgaon, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Well-defined nanocrystalline CdSnO3 thin films were prepared by spray pyrolysis technique at a substrate temperature of 350oC. The structural, surface morphological and microstructural properties were investigated using different techniques such as X-ray diffraction, FESEM, AFM and TEM. X-ray diffraction studies revealed that film is nanocrystalline with orthorhombic crystal structure. A gas sensor based on thin film was applied to ethanol sensing test as well as some other gases. Obtained results show that the sensitivity of nanocrystalline CdSnO3 thin film sensor reaches 576.2 to 100 ppm ethanol with a response time less than 12 s.

S7: S7C: Optical, Fibre Optic Sensors and Smart Grid

Chair: Prof. Tong Sun (City University of London, United Kingdom)

11:30 – 11:50 *Non-invasive measurement of blood components*
Jens Kraitl (University of Rostock, Germany); Hartmut Ewald (University of Rostock, Germany); Ulrich Timm (University of Rostock, Germany); Elfed Lewis (University of Limerick, Ireland)

NIR-spectroscopy and Photoplethysmography (PPG) is used for a measurement of blood components. The absorption-coefficient of blood differs at different wavelengths. This fact is used to calculate the optical absorbability characteristics of blood which is yielding information about blood components like hemoglobin (Hb) and arterial oxygen saturation (SpO2). The measured PPG time signals and the ratio between the peak to peak pulse amplitudes are used for a calculation of these parameters. The newly developed optical sensor system uses up to five wavelengths in the range of 600nm to 1400nm for a measurement of the hemoglobin concentration, oxygen saturation and pulse. This noninvasive multi-spectral measurement method was tested with prototype-devices based on radiation of monochromatic light emitted by laser diodes and by using light emitting diodes (LED) through an area of skin on the finger. The sensors assembled in this investigation are fully integrated into wearable finger clips.

11:50 – 12:10 *A Signal Correction Technique for Raman-Scattering Based Temperature Sensing Using Optical Fibers*
Takeo Kasajima (Fujitsu Laboratories Ltd., Japan); Kazushi Uno (Fujitsu Laboratories Ltd., Japan); Fumio Takei (Fujitsu Laboratories Ltd., Japan)

For better visualization of temperature distribution in data centers, a new signal correction technique was investigated in the temperature measurement based on Raman scattering light analysis in optical fibers. In a typical raised-floor data center, the temperature of the free access floor is almost constant and lower than the server rack area. Using this characteristic of the data centers and the impulse response of the measurement system, a correction technique was developed to improve the spatial resolution of the temperature measurement. As a result, the relative error for the temperature difference on the door of the server-rack became less than 1/10 of the original distributed temperature sensing (DTS) measurement. The new technique made us possible to visualize the temperature distribution in data centers more thoroughly and accurately.

12:10 – 12:30 *Optical Sensing: A New Approach to Measurements with Fiber Bragg Grating*
Sayuj Nath (National Instruments, New Zealand); Mark Phillips (National Instruments, New Zealand)

Optical sensors have emerged during the telecom boom in the late 1900's, due to the availability of low-cost telecom-grade optical components. It's only after the telecom bubble in early 2000 that optical sensors became sufficiently developed to become a viable technology for real-world applications. Optical sensing systems are nonconductive and use light to perform measurements of various phenomena. There several optical sensing technologies available, each with different strengths and weaknesses. FBG-based optical sensing provides distinct advantages for civil measurements because of their multiplexing capability and wavelength-encoded measurement information. In other words, with their ability to serve both as sensing element and signal transmission medium, FBG technology can have a significant impact on structural and physical measurement systems. This paper will present a holistic view of stress/strain measurements, including conventional strain gages and vibrating wires. It will then introduce optical

sensing, presenting the different optical sensor technologies. Finally, more details on FBG optical sensing will be provided, including the benefits that make FBG a compelling technology for structural and physical measurement applications.

12:30 – 12:50 ***Interconnecting ZigBee and 6LoWPAN Wireless Sensor Networks for Smart Grid Applications***

Chia-Wen Lu (National Chi Nan University, Taiwan); Shu-Cheng Li (National Chi Nan University, Taiwan); Quincy Wu (National Chi Nan University, Taiwan)

Although the ZigBee communication protocol is popularly adopted in wireless sensor networks (WSNs), it is rather immature compared with Internet Protocol (IP) which has been developed over the past 40 years. ZigBee networks can not directly communicate with current Internet. It always needs a gateway to collect required data from a ZigBee network and to convert the ZigBee protocol to IP. Moreover, it scales poorly on routing and network management. On the contrary, Internet Protocol, especially the new Internet Protocol version 6 (IPv6), is a more promising alternative as scalability is concerned. If a wireless sensor network is developed based on the IP protocol, it does not need an application-layer translator which is mandatory for ZigBee networks. This can greatly save developing time and improve the efficiency for end-to-end communications. Many existing IP-based services can thus be re-used to monitor WSNs status in real time. From a perspective on network management service, this paper compares the advantages and disadvantages of ZigBee and IP. Since ZigBee is only appropriate for small-scale networks and suffers from the scope expansion of a sensor network, our suggestion is that future deployment of wireless sensor network devices should be IP-based, so that they can be easily managed remotely. To allow legacy ZigBee networks to co-exist with IP networks, translators may be required during this migration phase.

12:50 - 14:00

S8: Poster Session – I Lunch cum Poster Session

Chairs: Dr. Azam Ali (Agresearch Ltd, New Zealand), Dr. Michael J. Haji-Sheikh (Northern Illinois University, USA)

Synthesis, characterizations and gas sensing properties of nanocrystalline In2O3 thick film sensor

Ramesh Bari (GMD Arts, KRN Commerce and MD Science College, Jamner, India); Dnyaneshwar Chavan (Arts, Commerce and Science College, Lasalgaon, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

The nanocrystalline powder of In2O3 with cubic structure prepared by a simple hydrothermal decomposition route. The structure and crystal phase of the powder was characterized by X-ray diffraction (XRD), microstructure by Transmission Electron Microscopy (TEM). The results indicated that the indium oxide was cubic with range size 28.5-65.8 nm. Gas sensing properties of the nanocrystalline In2O3 thick film sensor were tested for various gases in air at static state. The tested results showed that the sensor based on In2O3 nanocrystals exhibited high response towards H2S gas (40 ppm) at an operating temperature 100oC. The selectivity of the sensor elements for H2S gas against different gases was studied. The results on response and recovery time were also discussed.

Studies on gas sensing performance of pure and surface modified ZrO2 thick film resistors

Sudhakar Deshmukh (Arts Science and Commerce College, Manmad, India); Ramesh Bari (GMD Arts, KRN Commerce and MD Science College, Jamner, India); Ganesh E. Patil (Arts, Commerce & Science College, Nandgaon, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India); Lalchand Patil (Nanomaterials Research Lab., Pratap College, Amalner, India)

In this present work thick films of pure ZrO2 powder were prepared by screen printing technique. The material was characterized by XRD, SEM, EDAX and UV Techniques. X-Ray diffraction studies confirm that combinations of tetragonal and monoclinic structure. The gas sensing performances of various gases were tested. The thick films showed highest response to NH3 (100 ppm) at 300 oC.The film was modified by dipping in 0.1 M CdCl2 solution for 5, 10, 20 and 30 minutes and surface morphology was observed by SEM technique. The gas sensing performance of

various gases were tested and first time it was investigated that film showed highest response to H2S gas at operating temperature 300oC by dipping technique. The quick response and fast recovery time was reported.

Gas sensing studies of thick and thin films of WO3

Krishnakumar Thakur (KTHM College, Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

The effect of type of sensor (thick and thin film) on its gas sensing performances was studied in this paper. Screen-printing technique and spray pyrolysis method were used to prepare thick and thin films of WO3 (Tungsten Oxide).The gas sensing performance of the both films were tested for various gases at different temperatures and results are correlated. The WO3 thick film showed good response (S=191.31) to H2S at 3500C and WO3 thin film showed poor response (S=6.48) at 350oC for 400 ppm. The gas response, selectivity and thermal stability of the sensor were measured and presented

Synthesis of SnO2 nanoparticles for gas sensing applications

Varsha Patil (BHAVAN's College, Mumbai, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

SnO2 nanoparticles were synthesized using a hydrothermal method in the presence of the surfactant hydrazine at 100oC for 12 h. X-ray diffraction, field emission scanning electron microscopy (FESEM), transmission electron microscopy (TEM) and UV-vis diffuse reflectance spectroscopy (DRS) were employed to characterize the product. The X-ray diffraction (XRD) pattern of the as-prepared sample is indexed to the tetragonal structure of SnO2 and the particle size is 22.4 nm, which is further confirmed by TEM. Analysis of the DRS spectrum showed the band gap of the synthesized SnO2 to be 3.6 eV. The anionic surfactant hydrazine plays a key role in the formation of the SnO2 nanostructures. A probable reaction for the formation of SnO2 nanoparticles is proposed. Gas-sensing properties of the sensor element were tested to various gases, as a function of operating temperature and concentrations of the test gases. The nanocrystalline SnO2 exhibited high response towards H2S gas at an operating temperature 150oC. The selectivity of the sensor elements for H2S against different reducing gases was studied. The results on response and recovery time were also discussed.

Synthesis,characterization of WO3 nanopowder and its gas sensing properties

Suresh Nahire (G. M. D. Arts, B. W. Commerce and Science College, Sinnar, India); Ramesh Patil (K T H M College Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

Nanosized WO3 powders were synthesized from WCl6 using chemical co-precipitation method. The WO3 single crystal with mean particle size 68 nm was observed. Thick film resistors were prepared using screen printing technique for building ultra sensitive and selective gas sensors. The response at different temperature ranging from 100oC to 450oC were studied and presented for various gases. High sensitivity has been obtained towards H2S, revealing the capability of the material to detect concentration as low as 10 ppm, upto the Threshold Limit Value (TLV). The results highlight that the nano-material can be adopted for the development of gas sensors with performances suitable for practical applications.

High precision fiber-optic inclinometer based on abrupt-tapered Mach-Zehnder interferometers

Nan-Kuang Chen (National United University, Taiwan); Zhi-Zheng Feng (Department of Electro-Optical Engineering, National United University, Taiwan)

We demonstrate all-fiber inclinometer using tunable Mach-Zehnder interferometers with an extinction ratio of above 30.4 dB by introducing two points of abruptly tapering in a short length (< 1.4 cm) of highly Er/Yb co-doped fiber (EYDF). The abrupt tapers can transfer partial core mode into cladding modes and the interference occurs when the phase difference between core and cladding modes are accumulated to "pi" after a certain propagation length. The wavelength shift can reach 40.8 nm (from 1607.2 to 1648 nm) when the inclination angle θ varying from 0° to 32°. The wavelength shift can reach 26 nm (from 1404.4 to 1430.4 nm) when the inward compression displacement D is 260 μm.

Biquaternion Beamspace for Polarization Estimation and Direction Finding

Jingfei Jiang (Fudan University, P.R. China); Dan Li (Fudan University, P.R. China); JianQiu Zhang (Fudan University, P.R. China); Bo Hu (Fudan University, Shanghai, P.R. China); Qiyong Lu (Fudan University, P.R. China)

A biquaternion beamspace, constructed by passing the original array data through a quaternion beamformer, is proposed in this paper. Based on our biquaternion beamspace theory, the reason why the existing biquaternion MUSIC (BQ-MUSIC) estimator is not able to estimate the sources' polarization information is theoretically analyzed. From the analytical results, a new version of biquaternion beamspace MUSIC (BB-MUSIC) estimator is introduced to retrieve the sources' polarization information as well as their direction angles. Simulation results are presented to verify the correctness and efficacy of the proposed method.

A Micro Gas Sensor Based on a WO3 thin Film for Aromatic Hydrocarbon Detection

Chia-Yen Lee (National Pingtung University, Taiwan)

In the study, a novel gas sensor is presented for detection of aromatic hydrocarbons (benzene, toluene and xylene), consisting of a quartz substrate, Pt electrodes and a WO3 thin film. Oxidation occurs on the heated WO3 sensing layer as an aromatic hydrocarbon is present in the atmosphere, which causes a resistance variation of the WO3 thin film. From the measured resistance change, the aromatic hydrocarbon concentration is then computed. It is found that the crystalline structure is more perfect as the as-sputtering substrate temperature is 300°C, the WO3 thin film is annealed and the sputtering time is more than 6 hrs. At the optimal working temperature of 300°C, the experimental results show that the sensor has a rapid response time and a high degree of sensitivity for detection of benzene, toluene and xylene.

Application of Biometrics in Process control

Rajesh Singla (Dr BR Ambedkar NIT, India); Anil Sekharmantri (Dr BR AMBEDKAR NIT, India)

Biometric, where science and technology of measuring biological data go in a proper manner. Biometrics, refers to the automatic identification of a person based on his/her anatomical like fingerprint, iris or behavioral like signature, typing rhythm, gait characteristics or traits. The Biometric syndicate serves as a focal point for research, development, testing, evaluation, and application of biometric-based personal identification/verification technology. The biometric that we have considered here is speech recognition which means speaker verification and identification based on unique feature of the speaker like Mel Frequency Cepstrum Coefficient's. Vector quantization is used as clustering technology in feature matching. This speaker verification / identification is interfaced with a virtual process as a security purpose.

A Tracking Technique Incorporating Partial Regions utilized the Particle Filter Algorithm with Hierarchical Structure

Toyohiro Hayashi (Kyushu Institute of Technology, Japan)

Object tracking is a key objective of research in image engineering and considerable research has been directed toward developing tracking techniques based on particle filtering, which generally utilizes similarities in color, shape, texture, and other attributes of a target in likelihood calculations. However, partial occlusion of the target tends to reduce the accuracy of target recognition and is thus a significant obstacle to effective tracking. We therefore propose a technique for robust object tracking even when the target is partially occluded. It employs hierarchical likelihood calculations in particle filtering.

Development of a Performance Test System for Evaluation of Automatic Tank Gauging System

Sangil Lee (Korea Research Institute of Standards and Science, Korea); Hyon Ho Kim (Korea Research Institute of Standards and Science, Korea); Hae Choi (Korea Research Institute of Standards and Science, Korea)

A performance test system was developed to evaluate automatic tank gauging system (ATGS) that detects leakage from underground storage tanks. The performance test system consists of assessments of the accuracy and repeatability and the leak detection capability of the ATGS. The target accuracy, repeatability, and leak detection capability is 0.04, 0.01, and 0.04 mm, respectively. After the development of the performance test system, a newly designed ATGS was evaluated using the system.

Optoelectronic Applications of MOS Capacitors Fabricated on High Resistivity Silicon

Oleksandr Malik (Institute National for Astrophysics, Optics and Electronics, INAOE, Mexico)

Optoelectronic applications of MOS capacitors, fabricated on high resistivity silicon substrate, and operating in non-equilibrium mode under a triangular voltage sweep are analyzed. It is found that those MOS capacitors behave as sensitive optical sensors with direct (without analog-digital conversion) quasi-digital output in the form of a pulse-width-modulated signal, duty of which depends on the light intensity. Capacitor-based optical sensors are promising for automatic control, robotic, and metrological applications.

Fiber Bragg GratingTemperature Sensing SystemforLarge Air Cooled Hydrogenerators

Marcelo Werneck (Coppe/Ufrj, Brazil); Regina Allil (Brazilian Army, Brazil)

This paper describes the research, project, construction, calibration, installation and operation of a fiber Bragg grating based fiber-optic system applied to a hydro-electric generator to perform a continuous monitoring of temperature. After being deployed for two and a half years, the system has proved itself to be capable of reliably and accurately measuring and monitoring temperatures inside the generator, even taking into consideration the harsh environment of the stator. The results were considered satisfactory, demonstrating the usefulness of the fiber-optic system in power generation equipment.

Load Distribution Scheme for Power Saving Efficiency in Wireless Sensor Networks

Tsukasa Goto (Kanagawa University, Japan); Masato Noto (Kanagawa University, Japan)

Wireless sensor networks have drawn enormous interest as the ubiquitous network society has evolved. One drawback associated with wireless sensor networks is the concentration of network traffic on nodes and bottleneck nodes near sink nodes. Studies have explored multi-sink wireless sensor networks as a way of balancing loads across nodes near sinks, but traffic load concentration nodes are not only found around sinks. Here we propose a scheme for reducing the energy consumption of data gathering wireless sensor networks with unevenly distributed nodes, and thereby prolong the service life of networks. The proposed scheme selects multi-sink destinations based on the residual power reduction rate of nearby nodes, and curtails routing via the load-concentrated nodes after detecting these nodes based on their packet reception state. Energy consumption on the high traffic load nodes is reduced by this load balancing among relay nodes, which balances loads on load-concentrated nodes and nodes near sinks. Comparing our proposed scheme with a conventional approach by computer simulation, we prove that our method uses less energy to run topologies where load-concentrated nodes are present, and thus prolongs the service life of the network.

Adaptive Model Based Predictive Networked Control over WSAN with Tolerance to Transmission Faults on the Forward Channel

Paulo Gil (New University of Lisbon, Portugal); Alberto Cardoso (University of Coimbra, Portugal); Amâncio Santos (ISEC, Portugal); Gonçalo Brito Nunes (CISUC, Portugal); Luis Palma (FCTUNL, Portugal)

Remote control based on an adaptive predictive control scheme over wireless sensor and actuator networks is considered. To cope with possible faults on the forward channel linking the base station and actuator nodes a fault tolerant mechanism relying on a hierarchical multi-agent framework is implemented locally on each actuator node. Experimental results using a testbed show the effectiveness of the proposed scheme in accommodating transmission faults on the forward channel.

Minutiae based Fingerprint Recognition

Sujitkumar Chaudhary (Pune University, India)

Most automatic systems for fingerprint comparison are based on minutiae matching. Minutiae are essentially terminations and bifurcations of the ridge lines that constitute a fingerprint pattern. Automatic minutiae detection is an extremely critical process, especially in low-quality fingerprints where noise and contrast deficiency can originate pixel configurations similar to minutiae or hide real minutiae. Several approaches have been proposed in the literature; although rather different from each other, all these methods transform fingerprint images into binary images. In this work we propose an original technique, based on ridge line following, where the minutiae are extracted directly from gray scale images. The results achieved are compared with those obtained through some methods based on image binarization.

Non-Contact Vibration Sensor Using Bifurcated Bundle Fiber

Putha Kishore (National Institute of Technology Warangal, India); Dantala Dinakar (National Institute of Technology Warangal, India)

A fiber optic vibration sensor is demonstrated using bifurcated bundle fiber based on the principle of extrinsic displacement sensor. The light from an IR-LED is coupled into the transmitting fibers and allowed to fall on the surface of the vibrating object. The reflected light from the surface is received by the receiving fibers. The received light is detected by a photo diode and is converted into its equivalent voltage signal by the transimpedance amplifier. The Frequency and amplitude of vibration is monitored using the digital storage oscilloscope. The IR source is used along with glass fibers to avoid the effect of stray light in sensing. The encapsulation of the sensor enables easy alignment, flexible handling and usage in harsh environments. The sensor is capable of measuring the frequencies up to 650Hz with vibration amplitude resolution of 10µm, enough to monitor the vibrations generated in heavy machines.

Building a Sensor Network with PSoC

Manoj Kumar (BITS, Pilani- Hyderabad, India); Sai Phaneendra P (BITS-Pilani, Hyderabad Campus, India); Mb Srinivas (Birla Institute of Technology and Science – Pilani, Hyderabad, India); Surabhi Bothra (BITS-Pilani, Hyderabad Campus, India); Shashi Kumar Palakurty (BITS-Pilani, Hyderabad Campus, India); Rakhee Mohiddin (BITS-Pilani, Hyderabad Campus, India); Narayana Pidugu (Cypress Semiconductors, India); Patrick Kane (Cypress Semiconductors, India); Karthikeyan Mahalingam (Cypress Semiconductors, India)

Sensor networks have found widespread use in a variety of applications such as structure monitoring, environment monitoring, etc... Commercially available sensor nodes (that integrate sensors, micro processor/controller, memory and peripherals) are often used to design and deploy sensor networks. In this paper, authors describe a sensor network built using PSoC (Programmable System-on-Chip) from Cypress Semiconductor. The advantage of PSoC is that it integrates analog, digital and controller components (all required to process sensor data) on a single chip, thus resulting in a smaller footprint for sensor nodes. Communication with other nodes is achieved through CyFi low power RF module operating in the 2.4GHz ISM band. Operation of the network has been tested by implementing the SPIN (Sensor Protocol for Information via Negotiation), a well-known data-centric protocol for sensor networks

A real time fiber optic micro displacement level sensor

Dipankar Sengupta (National Institute of Technology, India)

Detection of micro change in liquid level using PMMA fiber in real time is demonstrated in this article. This sensor operates on light intensity modulation and such modulation results due to displacement of the floating reflector. The sensor system consists of light source, encapsulated PMMA fiber, floating reflector, photo detector, transimpedence amplifier, multimeter and a data acquisition system for the static and dynamic measurement. A change of 0.0073V at the output of the transimpedence amplifier was observed for 1 µm change in level. The temperature variation of the liquid (0 to 70C) has negligible effect on the sensitivity of the sensor. High sensitivity, good linearity, simple design and low cost make this sensor suitable in industry.

Wireless Network for Health Monitoring

Amir Kioumars (SEAT, New Zealand); Liqiong Tang (Massey University, New Zealand)

In the field of human health, collecting real-time data is vital. A system that can remotely monitor heart rate and body temperature is presented in this paper. The data is collected using an Arduino based wireless sensor. The Arduino micro-controller is programmed to transmit the data securely to a remote PC station using an XBee wireless network for display and storage. Power consumption by the system was minimized by activating the sensor when a command from a remote PC is received.

Refractive Index Measurement Using Laser Diffractometer

Chih-Chieh Hsu (National Chiao Tung University, Taiwan); T. Liu (National Chiao Tung University, Taiwan)

For refractive index measurement, this paper presents a new method based on a laser diffractometer, in which a reflective diffraction beam coincides with an incident beam. Calculation by using the angle of a reentry beam, grating pitch, and laser wavelength yields the refractive index. Based on a Littrow configuration, grating pitch measurement and immersion diffractometry are implemented to determine the refractive index of transparent liquids such as water,

oil, and translucent liquids mixed with particles. Experimental results are presented to demonstrate variation in solution composition and the refractive index.

Humidity sensor based on silver nanoparticles embedded in a polymeric coating
Pedro Rivero (Universidad Publica de Navarra, Spain); Aitor Urrutia (Public University of Navarre, Spain); Javier Goicoechea (Public University of Navarre, Spain); Francisco J Arregui (Universidad Publica de Navarra, Spain); Ignacio R. Matias (Public University of Navarra, Spain)

In this work, a new humidity sensor based on the deposition of silver nanoparticles embedded in a polymeric coating on an optical fiber core is presented. The silver nanoparticles inside the coating were characterized by transmission electron microscopy (TEM) in order to get additional information about their size and shape. An increase of the Surface Plasmon Resonance (SPR) peak intensity is observed when the coating is built up by using the Layer-by-Layer (LbL) deposition technique. Changes in Relative Humidity from 20% to 80% are detected by a shift of the SPR wavelength.

Optical sensor based on polymer electrospun nanofibers for sensing humidity
Aitor Urrutia (Public University of Navarre, Spain); Pedro Rivero (Universidad Publica de Navarra, Spain); Javier Goicoechea (Public University of Navarre, Spain); Francisco J Arregui (Universidad Publica de Navarra, Spain); Ignacio R. Matias (Public University of Navarra, Spain)

A novel humidity sensor based on polymer electrospun nanofibers coating onto an optical fiber is proposed in this work. The coating is composed of poly(acrylic acid), and its fabrication was performed by the electrospinning technique using an optical fiber core as substrate. This technique allows the fabrication of sensitive films with high surface area in a fast and simple way compared to other overlay fabrication techniques. The sensor was tested in a programmable temperature and humidity climatic chamber. Relative Humidity (RH) was varied in the range from 20%RH to 80%RH at room temperature. The results showed a monotonic variation of the absorbance spectra to RH changes, thus obtaining a successful humidity sensor.

14:00 - 16:00

S9: Invited Session - II

Chair: Prof. Ikuo Ihara (Nagaoka University of Technology, Japan)

14:00 – 14:30 ***Artificial Olfaction - The Emerging Frontier of Electronic Perception,*** Nabarun Bhattacharyya, Centre for Development of Advanced Computing (C-DAC), India

14:30 – 15:00 Optical Non-Invasive Monitoring of Total Haemoglobin Concentration Monitoring in Real-Time - From Research Project to Clinical Testing, Professor Elfed Lewis, University of Limerick, Ireland

15:00 – 15:30 Acoustic sensor for loosening detection of hip implantate, Prof. Hartmut Ewald Department of Electrical Engineering and Information Technology, University of Rostock, Germany

15:30 – 16:00 Force and Stiffness Sensing During Robot Assisted Surgical Interventions, Prof. Lakmal Seneviratne, Faculty of Engineering, Khalifa University, Abu Dhabi, UAE and Division of Engineering, King's College London, UK

16:00 - 16:20 Tea Break

16:20 - 17:20

S10: S10A: Sensors Interfacing and Signal Analysis

Chair: Dr. Satoshi Ikezawa (Waseda University, Japan)

16:20 – 16:40 *Universal Low Power Smart Sensor Interface using Two-Wires for Data Transmission and Supply*

Hendrik Krüger (University of Rostock, Germany); Frank Lebahn (University of Rostock, Germany); Hartmut Ewald (University of Rostock, Germany)

In many industrial applications different sensors (magnetic, acoustic, optical) have to work under rough conditions. Smart sensors with integrated signal conditioning and processing avoid cable influences and are capable to reject further disturbance influences by signal processing of multi parameter measurements. This article describes a low-power interface for two-wire sensors. The sensor interface was developed for an intelligent eddy current sensor but the concept is not restricted to inductive sensors only.

16:40 – 17:00 *IMU based Onboard-Unit to measure the driveability of transport buses*

Fabian Hoeflinger (University of Freiburg, Germany); Abhishek Ojha (University of Freiburg, Germany); Leonhard M Reindl (University of Freiburg, Germany)

In this work we present an Onboard-Unit for sensing critical and uneconomical driveability of buses. Especially old buses can be upgraded with the Onboard-Unit to monitor and inform the bus driver about his driveability. The driver can adapt his driveability to improve the vehicle safety and reduce the fuel consumption. Since CAN-Bus access is often not available in old buses wireless measurement unit such as GPS and the rotational measurement unit are used to measure the bus velocity and the rotational speed of the engine respectively. Furthermore a laser scanner measures the distance to the vehicle ahead. The sensor peripheries and the components for the Onboard-Unit are analyzed and selected for easy installation. The Onboard-Unit logs the sensor data and creates a driver profile. The bus operator can monitor the real time driveability of the bus on a web interface connected to the Onboard-Unit through a GSM-Module.

17:00 – 17:20 *Experimental Validation of a Leakage and Fill-level Estimation Method for Vented Tanks*

Rudolf Brunnader (Graz University of Technology, Austria); Gert Holler (Graz University of Technology, Austria)

Commonly used pneumatic fill-level sensing methods are typically limited by the requirement of a perfectly sealed tank system. In the paper, we present first experimental results for a model-based approach that is capable of distinguishing between the influences of varying free volume inside the tank and of small ventilation holes and leakages in the tank hull. The results are obtained by considering the estimated values of the lossless parameters in the equivalent circuit model that correspond to the actual free volume and leakage magnitude.

S10: S10B: Sensors for Aquaculture and Agricultural Applications

Chair: Dr. Ian G Platt (Lincoln Ventures Ltd, New Zealand)

16:20 – 16:40 *Beyond logistic growth model for nitrous oxide emission factors from agricultural soils*

Kailash P. Thakur (LANDCARE RESEARCH, New Zealand)

Measurement of nitrous oxide emission in the dairy farm is a time-consuming process. The alternative approach is to run a realistic process-based model. The NZ-DNDC model is capable of generating reasonable results in a short time.

The model is driven by weather and soil parameters that have a high degree of temporal (weather) and spatial (soil properties) variability. This variability in soil and weather parameters leads to uncertainty in the predicted nitrous oxide emissions. This paper examines the possibility of developing a simplified model to investigate the effects of variation in individual weather or soil parameters on nitrous oxide emission. The S-shaped logistic growth model has been extensively studied and applied to a wide range of biological and socio-technical systems. A model is presented for the analysis of systems that experience a secondary phase of growth or decay, either overlapping or sequentially. This study undertakes to apply the logistic model with secondary growth effects to model the growth of the nitrous oxide emission factor with environmental variables. The generalized model considered here allows for the inclusion of secondary growth with the addition of only one extra parameter, unlike many bi-logistic growth models which double the number of parameters. The model has the capability to generate the generalized logistic behavior as well as a number of different realistic growth and decay behaviours. A nonlinear least-squares algorithm is described that provides parameter estimates from time-series growth data. This is an iterative process that starts with an initial realistic guess of the parameters. The conventional technique evaluates the correction term that is added to the old parameter to generate new one. The modified technique presented here computes the correction term which is multiplied to the old parameter to get the new value. This is a more robust technique that allows for a little non-linearity around the solution. Model sensitivity and robustness are discussed in relation to error structure in the data. Taxonomy and examples of systems of greenhouse gas emission that exhibit secondary growth or decay are presented. The model is shown to be superior to the simple logistic model for representing many growth processes.

16:40 – 17:00 ***A WiFi based Smart Wireless Sensor Network for an Agricultural Environment***

Gerard Mendez (Massey University, New Zealand); Mohd Amri Md Yunus (Massey University, New Zealand); Subhas Mukhopadhyay (Massey University, New Zealand)

The main objective of the present work is to develop a smart wireless sensor network (WSN) for an agricultural environment. Monitoring of environmental factors have increased in importance over the last decade. In particular monitoring agricultural environments for various factors such as temperature and humidity along with other factors can be of significance. A traditional approach to measuring these factors in an agricultural environment meant manually taking measurements and checking them at various times by individuals. The ability to document and detail changes in the parameters that are of interest has become increasingly valuable to such an extent that unattended monitoring systems have been investigated for this function. A remote monitoring system using WiFi for the wireless sensor nodes based on WSN802G modules is investigated for use in the study. These nodes send data wirelessly to a central server, which collects the data, stores it and will allow it to be analyzed then displayed as needed.

17:00 – 17:20 ***Development of an Opto-chemical Carbon Dioxide Sensor for Aquaculture and Oceanography Applications***

Merima Cajlakovic (Joanneum Research, Austria)

In this paper an optical carbon dioxide (CO2) life-time-based sensor designed for the continuous monitoring of low CO2 levels in aqueous solution in fields of fish farming and in oceanography is described. The presented optical measurement unit consists of a CO2 sensitive layer mounted onto the end of sensing probe and an optoelectronic interrogation unit in order to convert the measurement signal into detectable signal. The measurement technique is the phase modulation fluorometry using Resonance Energy Transfer (RET) as sensing scheme. RET measurements were made by incorporation of ruthenium-(II)-tis-4,7-diphenyl-1,10-phennathroline (Rudpp)32- together with pH indicator ion-paired with tetraoctylammonium (TOA-OH) as the cunterion in a highly gas-permeable matrix. As a protective coating a high gas permeable Teflon with added graphite particles was used to eliminate interferences by ionic species. The performance of the whole sensor system is present-ed with respect to spectral characteristics, dynamic range (0 - 60 mg/l of dissolved CO2), required sensor system specifications, temperature behavior and long term stability. First field tests performed in real fish farming conditions are presented as well.

S10: S10C: Capacitive Sensors - I

Chair: Dr. K. Tashiro (Shinshu University, Japan)

16:20 – 16:40 ***Sensitivity of Capacitance Sensors for Quality Control in Blade Production***

Norbert Eidenberger (Johannes Kepler University of Linz, Austria); Bernhard G. Zagar (University of Linz, Austria)

In this paper we analyze the electric field in a measurement setup used for determining the shape of a blade. Conformal mapping is utilized to obtain a mathematical representation of the electric field. This representation permits a sensitivity analysis with respect to the distinct geometrical properties of the measurement setup. The result of the analysis enables the optimization of the position and the layout of the measurement electrodes.

16:40 – 17:00 ***Capacitive sensor arrays for the real time detection of volatile organic compounds***

Evangelos Valamontes (TEI of Athens, Greece); Nikolaos Pantazis (Technological Educational Institution of Athens, Greece); Georgios Patsis (Technological Educational Institution of Athens, Greece); Ioannis Raptis (NCSR Demokritos, Greece); Dimitrios Goustouridis (NCSR Demokritos, Greece); Merope Sanopoulou (NCSR Demokritos, Greece)

Capacitive-type gas sensors rely on changes in the dielectric properties of the sensing polymeric layer due to absorption of Volatile Organic Compounds (VOCs) or moisture. They are promising devices in terms of ease and low cost of fabrication, reversibility and the wide range of sensing material choice. In the present work, the aim is to explore the fabrication issues of the InterDigitated Electrodes (IDE) through a generic simulation model for the prediction of the capacitance of various IDE structures. Based on the simulation results, an IDE layout was selected for the realization and evaluation of chemcapacitor arrays in the presence of different humidity levels and low concentrations of VOCs with dielectric constant close to those of polymers. The extracted results will be further exploited for the fabrication optimization of an InterDigitated Capacitor (IDC) layout with increased selectivity and sensitivity in specific applications.

17:00 – 17:20 ***Error in capacitive sensing due to egde effect:A mathematical analysis***

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

This paper gives mathematical analysis of the contribution of edge effect in electrostrictive capacitive sensors. It has been observed that error due to edge effect is of the order of 1e-5 which is negligible particularly for area greater than 5e-4 sqm as in case of electric double layer capacitive sensors having separation between plates in nanometric range and area in centimetric range. However in case of nanometric capacitive sensors considering both area of plates and separation between them in nanometric range, the percentage error due to edge effect has been found to be upto 8.53% which cannot be ignored for sensitivity consideration of capacitive sensors. It has also been observed that error contribution due to edge effect, in case of capacitive sensors with area 0.25e-8 sqm at separation between plates in micrometric range is significantly high up to 7.47% and for sensor with area 0.225e-3 sqm at separation in millimetric range is also quite high upto 8.58%. In this paper few of capacitive sensors exhibiting minimum contribution from edge effect have been suggested for constructional design.

Banquet Dinner: Wednesday, 30th November at 6.30pm

Venue: Travelodge Hotel, 175-185 Cuba Street, Palmerston North

Tel: 06- 355 5895

Thursday, December 1

09:00 - 10:00

S11: S11A: Sensors for Special Applications - I

Chair: Prof. Aime' Lay-Ekuakille (University of Salento, Italy)

9:00 – 9:20 *RF Hand Gesture Sensor for Monitoring of Cigarette Smoking*

Edward Sazonov (The University of Alabama, USA); Kristopher Metcalfe (The University of Alabama, USA); Paulo Lopez-Meyer (The University of Alabama, USA); Stephen Tiffany (The State University of New York at Buffalo, USA)

Today, over a billion people in the world are smokers. Smoking is associated with increased risk of cardiovascular disease, chronic obstructive pulmonary disease, emphysema, and various cancers, causing approximately 6 million premature deaths per year. Current methods of assessing smoking behavior (e.g., self-report, portable puff-topography instruments) do not permit the collection of accurate, non-reactive measures that capture real-time smoking frequency and comprehensive within-cigarette puff topography. Our goal is development of a non-invasive wearable sensor system (Personal Automatic Cigarette Tracker - PACT) that is completely transparent to the end user and does not require any conscience effort to achieve reliable monitoring of smoking behavior in free living individuals. A key component of PACT is a sensor that captures a characteristic hand-to-mouth gesture preceding cigarette smoke inhalations. This paper details design and validation of a wearable radio-frequency proximity sensor that measures the distance between an individual's wrist and chest in real-time. Hand-to-mouth gestures detected with this device provide quantitative data that can be used for analysis of behavioral patterns during smoking and other activities.

9:20 – 9:40 *Tunneling Magneto-Resistor based Angle Transducer*

Chandrika Sreekantan Anoop (Indian Institute of Technology, Madras, India); Boby George (Indian Institute of Technology Madras, India); Jagadeesh V Kumar (Indian Institute of Technology Madras, India)

An angle transducer that provides a linear output for full-circle angular range (0-360 degrees) of operation is presented in this paper. The sensor part of the transducer is made of two pairs of Tunneling Magneto-Resistors (TMR) and the signal conditioning part consists of a couple of sinusoids having same frequency but differing in phase by 90 degrees and a phase detector. The novel signal conditioning circuit proposed here operates on the sine/cosine outputs of the TMRs and provides a voltage that is linear to the angle being sensed. The output of the proposed transducer depends only on, other than the sensing angle, a dc reference voltage, and is independent of the magnitude of the magnetic flux density acting on the sensor; thereby providing an accurate and robust angle transducer. Simulation studies conducted using SPICE demonstrate the efficacy of the transducer for linear operation across the entire full-scale range. Results obtained from a prototype signal conditioner built and tested establish the practicality of the proposed transducer. The prototype provided a linear characteristic between the output voltage and angle being sensed for a full 360 degrees range with the worst case error less than ± 0.15 %.

9:40 – 10:00 *Lactate Detection Using a Microwave Cavity Sensor for Biomedical Applications*

Jung Hean Goh (Liverpool John Moores University, United Kingdom); Alex Mason (Liverpool John Moores University, United Kingdom); Ahmed I Al-Shamma'a (Liverpool John Moores University, United Kingdom); Stephen Wylie (Liverpool John Moores University, United Kingdom)

This research is an investigation of the use of a low power microwave sensor for detecting lactate, which holds key indicators relating to a patient's future health. The hospital will benefit hugely from this research through better quality of care and more efficient use of resources. A multipurpose sensor platform has been developed which is capable of detecting the concentration of the materials in volumes less than 1ml. The sensor platform will eventually use a low cost electronic device in order to reduce the cost and size of the system, replacing the need for wideband vector network analyser (VNA) equipment. This system will also provide a simple interface for users so that the results of microwave analysis are clear; this interface will have a visual and wireless element. The former will promote direct user interaction and the later will allow for remote data logging, monitoring and analysis. This paper presents initial work using a VNA to detect the lactate in water for small volumes.

S11: S11B: Electronic Nose / Tongue and Ultrasonic Sensors

Chair: Dr. Gert Holler (Graz University of Technology, Austria)

9:00 – 9:20 ***Recognition of dried apples by hybrid electronic tongue system***
Patrycja Ciosek (Warsaw University of Technology, Poland); Anna Kutyla-Olesiuk (Warsaw University of Technology, Poland)

The paper presents the application of hybrid electronic tongue for the classification of extracts prepared from dried apples. The hybrid system was formed on the basis of potentiometric sensor array and voltammetric sensors. The hybrid system allowed for a better characterization of the investigated samples comparing to measuring techniques used separately.

9:20 – 9:40 ***Handheld Electronic Nose (HEN) for applications in Tea Industry***
Alokesh Ghosh (Centre for Development of Advanced Computing, India)

Miniaturization, portability, low power and convenience of use are the key factors that govern a product to be acceptable to the industry and people. Electronic Nose has been successfully implemented for quality evaluation of finished tea as well as end-point detection of tea fermentation process. However, the size, weight and complexity restrict it from online field usage. This paper describes a handheld Electronic Nose developed on simple 16-bit Microcontroller platform with low-power sniffing unit for usage in the tea industry.

9:40 – 10:00 ***Detection of Surface Cracks in Fibre Reinforced Composites using Ultrasonic Rayleigh Waves***
Matthew Thomson (Victoria University of Wellington, New Zealand); Paul Harris (IRL, New Zealand); Gideon Gouws (Victoria University of Wellington, New Zealand)

Detecting defects in fibre reinforced composites (FRCs) is challenging due to the conflicting need to use high frequencies for adequate resolution, but simultaneously ensure adequate wave propagation in the material despite scattering from the fibres. This paper explores the use of Rayleigh surface waves in order to detect exterior cracks in a glass FRC rod. These surface waves are excellent at detecting surface cracks and are conveniently identified when immersed via energy leakage. Finite Element Analysis (FEA) models are used to simulate the propagation of a Rayleigh wave and the effect of surface cracks on this propagation. Experimental studies on glass and a composite are then used to confirm the applicability of Rayleigh waves to detecting surface cracks.

S11: S11C: Sensors for Novel Applications - II

Chair: Prof. Massimo Villari (University of Messina, Italy)

9:00 – 9:20 ***Measurements of Metal Hydride Hydrogen Tank used for Hybrid Electrical Chair with Photovoltaic and Fuel Cell***
Yoshihiko Takahashi (Kanagawa Institute of Technology, Japan)

This paper discusses the temperature related hydrogen input and output characteristics of a metal hydride tank to be used for a hybrid electrical wheelchair with photovoltaic panels and fuel cells. The temperature of a metal hydride tank increases when it is filled with hydrogen and decreases as the hydrogen is ejected. A metal hydride tank is unable to eject hydrogen at low temperatures, therefore it is very important to understand the relations between tank temperature and hydrogen admission and ejection characteristics. The experimental results of these processes are evaluated, and an improved scheme to increase the distance the hybrid wheelchair will travel is proposed.

9:20 – 9:40 ***An approach to estimating protein networks of cell cycle based on least-squares methods for periodic signals***
Takehito Azuma (Utsuminiya University, Japan)

This paper considers a least-squares method for state space models by using periodic signals and two theoretical properties of the least-squares method are shown. Moreover the least-squares method considered in this paper is applied to an estimation problem of protein networks for cell cycle in budding yeast. The derived properties of the least-squares method are verified in the estimation problem and the approach to estimate protein networks for cell cycle is demonstrated.

9:40 – 10:00 ***Continuous Monitoring of Physiological Parameters using Smart Sensors***
Tauseef Quazi (Massey University, New Zealand); Subhas Mukhopadhyay (Massey University, New Zealand)

A smart sensing system, which would help in detecting human emotions based on information from physiological sensors, is designed and developed. Heart rate sensor, galvanic skin response sensor and temperature sensor will continuously monitor the physiological parameters. The amplified and filtered signals from the sensors are then processed by a microcontroller and the results are displayed on a computer screen. The partial developed system has shown good results in monitoring the physiological parameters.

10:00 – 10:20 **Tea Break**

10:20 - 12:00

S12: S12A: Special session on Ubiquitous Systems for HealthCare

Chair: Dr. Octavian Adrian Postolache (Institute of Telecomunication - IT/IST & Escola Superior de Tecnologia de Setubal, Portugal)

10:20 – 10:40 ***An Online Telemetering System for Mobile Health Parameter Monitoring and Medical Assistance***
Roman Agethen (University of Erlangen-Nuremberg, Germany); Fabian Lurz (University of Erlangen-Nuremberg, Germany); Andre Schwarzmeier (Institute for Electronics Engineering & University of Erlangen-Nuremberg, Germany); Georg Fischer (University of Erlangen-Nuremberg, Germany); Robert Weigel (University of Erlangen-Nuremberg, Germany); Dietmar Kissinger (University of Erlangen-Nuremberg, Germany)

This paper presents a flexible telemetering system based on a mobile medical communication platform for long-term medical data acquisition. The system is able to gather data from multiple medical relevant sensors like electrocardiography. Preprocessing is performed before wireless transmitting the data either via Bluetooth to a local station like a laptop or mobile phone or via GSM / UMTS to a central infrastructure (server). An implemented emergency call function provides an automatic phone call to an assistance hot-line and offers the possibility of transferring online personal vital parameters as well as the patients GPS coordinates via UMTS.

10:40 – 11:00 ***Wellness Determination of Inhabitant based on Daily Activity Behaviour in Real-Time Monitoring using Sensor Networks***
Nagender Suryadevara (Massey University, New Zealand), S.C.Mukhopadhyay, R.K.Rayudu

In this study, we reported a Wireless Sensor Network (WSN) based system for monitoring daily living activities of inhabitant and smart software including novel technique for determining wellness of the inhabitant based on activity usage of household appliances. We defined two new wellness functions to determine the status of the inhabitant in real-time and were able to find out regular character of the inhabitant in a sensor equipped home. Developed intelligent program was tested at four different houses with only single inhabitant. Results of wellness determination are encouraging in deriving habitual behaviour of the inhabitant.

11:00 – 11:20 ***Smart Walker for Pervasive HealthCare***

Octavian Adrian Postolache (Institute of Telecomunication - IT/IST & Escola Superior de Tecnologia de Setubal, Portugal); Pedro Girão (Instituto de Telecomunicações, Portugal); Jose Costa Pereira (ESTSetúbal, Portugal); Cláudia Maia e Moura (Universidade Atlantica, Portugal); Gabriela Postolache (Universidade Atlantica, Portugal)

The article presents the design and implementation of a smart walker based on technologies expressed by microwave Doppler radar, MEMS accelerometers, flexible force sensors and Bluetooth communication. The data provided from the sensor channels are acquired by a microcontroller platform with ADC capabilities, and then are wireless transmitted to an Android OS smart phone that runs specific developed Java software. The software performs different tasks such as data processing and graphical user interface, and can also be used for remotely monitoring of activity/inactivity of the users, upper extremity kinetics and kinematics during walker-assisted gait. Additional synchronization functions are performed between the smart phone and a physiotherapy web server.

11:20 – 11:40 ***Development of Wireless Sensing System Monitoring Physiological Information for Healthcare in Daily Life***

Chika Sugimoto (Yokohama National University, Japan); Ryuji Kohno (Yokohama National University, Japan)

In Japan's fast-aging society with a falling birthrate, it has become necessary to promote prevention of disease and health maintenance. Information on human physiological state and activity in daily life makes it possible to estimate health condition and support predictive diagnosis and treatment. A wireless sensing system for monitoring thermal physiological information in living environment was developed and its functions were evaluated. The system consists of ear-worn temperature sensors, thermo-hygrometers, skin temperature sensors, and an ECG sensor with accelerometer. The level of data loss by wireless communication was low enough to estimate physiological state using more than 10 sensors, even though both the IEEE 802.15.4 radio and the specified low power radio coexist. By using wearable sensors with a long battery life and wireless sensor networks with little data loss, data could be obtained without restraining wearers' movements. The system was applied to the prevention of heat stroke during exercise. A method to detect the change of physiological state and give a warning in the context of activity and surroundings by monitoring thermal physiological information with ambient temperature and humidity was proposed.

11:40 – 12:00 ***Acoustic sensor for loosening detection of hip implantate***

Hartmut Ewald (University of Rostock, Germany)

One of the main reasons for revision of total hip replacements (THR) is the aseptic or septic loosening. The Osseointegration of the uncemented hip stem in the femoral bone has to detect exactly in order to enable early state loosening detection. All present diagnostic methods, e.g. radiographs and arthroscopy, show insufficient sensitivities and specificities between 70% and 80%. Osseointegration can be identified in-vivo by use of acoustic methods. The acoustic waves can be generated by a mechanical hammer or by a piezoelectric transducer placed on the inside the femoral hip stem wall. The process of loosening in the bone interface will affect by the mechanical-acoustics properties of the bone interface. A functional model of the measuring principle shows significant differences in varied phases of fixation. The new sensor system demonstrates its potential as a new acoustic concept to detect aseptic loosening. Moreover, the proposed system could be used in experimental applications to determine the quality of osseo-integrative coatings and new implant materials as well.

S12: S12B: Sensors System for Structural Health Monitoring

Chair: Dr. Alex Mason (Liverpool John Moores University, United Kingdom)

10:20 – 10:40 ***Corrosion Characterisation Using Pulsed Eddy Current Sensor Systems***

Guiyun Tian (Newcastle University, United Kingdom)

Pulsed Eddy Current (PEC) has been applied to characterise atmospheric corrosion on steel samples. Coated and uncoated mild steel (S275) samples with different marine atmospheric corrosion have been supplied by International Paint®. After introduction of pulsed eddy current systems, different measurement on different samples have been undertaken. Experimental results using pulsed eddy current sensor systems and feature extraction on corrosion classification and corrosion progression are reported. In conclusion, PEC testing has potential for corrosion characterisation and monitoring in industrial fields where corrosion is an important problem, e.g. the marine applications.

10:40 – 11:00 ***Unobtrusive packaging of optoelectronic devices for optical tactile and shear sensors***

Erwin Bosman (Ghent University & IMEC, Belgium); Bram Van Hoe (Ghent University - IMEC, Belgium); Jeroen Missinne (Ghent University - IMEC, Belgium); Geert Van Steenberge (Ghent University - IMEC, Belgium); Sandeep Kalathimekkad (Ghent University - IMEC, Belgium); Peter Van Daele (Ghent University, Belgium)

This paper presents the development of two new types of optical sensors that can measure both pressure and shear stresses in an unobtrusive way. Standard packaging technologies for optoelectronic components result in very bulky and rigid sensors. We present an optoelectronic package which is flexible, only 40 µm thick and which can be bent down to a bending radius of 2 mm. This advanced packaging technique enables the flexibility and compactness of the sensors, which are needed to be unobtrusive. The resulting pressure and shear sensors are discussed, characterized and demonstrated.

11:00 – 11:20 ***Condition Monitoring of High-Speed Flywheel using Modal Analysis Method***

Rudolf Brunnader (Graz University of Technology, Austria); Christian Deinhammer (Graz University of Technology, Austria); Bernhard Schweighofer (Graz University of Technology, Austria); Hannes Wegleiter (Graz University of Technology, Austria); Gert Holler (Graz University of Technology, Austria)

Due to the availability of new materials and enhanced production processes, compact flywheel energy storage systems will become a competitive alternative to battery systems in hybrid vehicles. These new high-speed composite flywheels are highly stressed on the rotor side and therefore require condition monitoring for a save and reliable operation. This paper presents a monitoring approach based on modal analysis. A cylindrical test object, representing the simplification of an external flywheel rotor, is analyzed. A numerical simulation of the test object is performed using Comsol Multiphysics software, and practical measurements are carried out to verify the basic assumptions underlying the proposed measurement approach. Simulation and experimental results are used to assess the applicability of the approach for condition monitoring of flywheel rotors.

11:20 – 11:40 ***Design of a Wireless Sensor Network for Structural Health Monitoring of Bridges***

Michael Reyer (Johann-Maus-Strasse, Germany); Stefan Hurlebaus (Texas A&M University, USA); John Mander (Texas A&M University, USA); Osman Ozbulut (Texas A&M University, USA)

Bridges are bottlenecks in the railroad net, because of their limiting characteristics. To achieve a high load of the railroads old bridges especially are being pushed to their physical limit, regarding transfer speed, schedule, axle load and train length. Therefore monitoring of these strategic structures is getting more and more important. Installation costs of conventional sensors are expensive and time intensive. New wireless sensor platforms and distributed processing algorithms, going hand in hand with new or enhanced monitoring methods, promise an early damage detection and damage estimation. This paper designs a wireless sensor network for Structural Health Monitoring using commercially available wireless sensors to measure and extract vibration characteristics of bridges. The functionality of the network is verified in a laboratory experiment.

11:40 – 12:00 ***New magnetic connector for emebedding of optical sensors in composite materials***

Ferdinando Felli (SAPIENZA- Rome University, Italy); Carla Lupi (SAPIENZA - Rome University, Italy); Cristian Vendittozzi (SAPIENZA- Rome University, Italy); Andrea Brotzu (SAPIENZA - Rome University, Italy); Giovanna Saviano (SAPIENZA - Rome University, Italy); Michele Arturo Caponero (ENEA Frascati Research Centre, Italy); Emanuele Basile (Sapienza Rome University, Italy)

Since the early '80s we begun to talk about the possibility of inserting the optical fiber within the next generation (composite) materials. At the time the optical fiber was used primarily to signals transportation, for communications, and therefore were used primarily multi-modal fibers, not suitable for use with fiber optical sensors, particularly FBG sensors. It has been started to develop connectors that would allow the embedding of the fibers themselves, allowing an easier outgoing of the termination pigtails from the material itself, [1-3]. Several patents were developed for this purpose, focusing attention, given the almost complete immunity to magnetic fields of optical fiber, to connectors magnetized to facilitate the operation of plug-in. Over the years we have lost trace of these connectors. Today, given

the enormous development perspective that the FBG sensors play in the field of real time structural health monitoring, we are turning our attention to the need for a connector easy, quick and effective to plug, that size does not interfere with the structure to be monitored, easy to make and assemble, in a word, practical, from all points of view. For this reason we have designed a miniaturized magnetic connector that is optimized for connecting the single-mode optical fiber, typically used for FBG sensors, which allows efficient transport of the signal, minimizing losses and allow seamless integration with the material, and the structure to be monitored, in other words, this connecting system has been designed in order to develop a product which solves the problem shown by commercial available connectors during their embedding inside materials.

S12: S12C: Special Session on Environmental Sensing and Monitoring

Chair: Prof. Jose Costa Pereira (ESTSetúbal, Portugal)

10:20 – 10:40 *A Load Balancing Algorithm Based on Probabilistic Multi-Tree for Wireless Sensor Networks*

Tzu-ping Chung (National Taiwan University, Taiwan); Tzu-Shiang Lin (National Taiwan University, Taiwan); Xiang-Yao Zheng (National Taiwan University, Taiwan); Ping-Lang Yen (National Taiwan University, Taiwan); Joe-Air Jiang (National Taiwan University, Taiwan)

To extend the lifetime of a large wireless sensor network, it is important to spread the inevitable energy consumption (loads) across the network, and thus reduce hot spots. This article introduces a two-step solution to this issue based on the AODV tier allocation with multiple paths to disperse loads from hot spots. After the allocation, paths for nodes to transmit data back to the sink are decided through a probabilistic approach. By computer simulation, it is shown with various indexes that the performance of the proposed algorithm is better than that of deterministic approaches after network deployment, and an appropriate state can be reached in reasonable time.

10:40 – 11:00 *Wireless Sensor Network for Data Center Environmental Monitoring*

Michael Rodriguez (University of Puerto Rico, Mayaguez, USA); Luis Ortiz (University of Puerto Rico, Mayaguez, USA); Yi Jia (University of Puerto Rico, Mayaguez, USA); Kazutomo Yoshii (Argonne National Laboratory, USA); Robert Ross (Argonne National Laboratory, USA); Pete Beckman (Argonne National Lab, USA)

Data centers energy consumption has attracted global attention due to the fast growth of the information technology (IT) industry. Up to 60% of the energy consumed in a data center is used for cooling in wasteful ways due to lack of environmental information and overcompensated cooling system. In this project, a wireless sensor network for data center environmental monitoring has been developed to improve energy efficiency and optimal data center performance. The sensor network consists of a suite of sensor nodes for data sensing, a route nodes to relay sensed data, and a coordinator node to establish a network, receive the data and process the data. The prototype sensor network was built on Arduino open source hardware with seamless integrated XBee RF module and configured to operate within ZigBee mesh network standard. 24 hours test run at Argonne MCS data center has demonstrated that the wireless networked environmental monitoring solution is easy to integrate and manage with the existing IT infrastructure while delivering better visibility into data center's 3D temperature and humidity distribution and substantially improvements in energy efficiency can be achieved.

11:00 – 11:20 *Application of Independent Component Analysis for Estimating Nitrate Contamination in Natural Water Sources Using Planar Electromagnetic Sensor*

Mohd Amri Md Yunus (Massey University, New Zealand), S.C.Mukhopadhyay

A system that measures impedance of a planar electromagnetic sensor is described in this paper. It has been used to estimate the amount of nitrate contamination in water samples with the assistance of a method based on independent component analysis. Nitrates sample in the form of ammonium nitrates (NH4NO3), each of different concentration between 5 mg and 20 mg dissolved in 1 litre of deionized water (mili-q) was used as one of the main references. A model based on independent component analysis was developed to estimate nitrate contamination. The model was tested with eight sets of mixed NH4NO3 and (NH4)2HPO4 water samples. From the results, the model can acceptably detect the presence of nitrate added in distilled water and capable of distinguishing the concentration level in the presence of other type of contamination. The system and approach presented in this paper has the potential to be used as a useful tool for water sources monitoring.

11:20 – 11:40 ***Development of an Embedded System-based Gateway for Environmental Monitoring Using Wireless Sensor Network Technology***

Chun-Yi Liu (National Taiwan University, Taiwan); Cheng-Long Chuang (National Taiwan University, Taiwan); Chia-Pang Chen (National Taiwan University, Taiwan); Wan-Yi Chang (National Taiwan University, Taiwan); Jyh-Cherng Shieh (National Taiwan University, Taiwan); Chen-Han Lin (National Taipei University of Technology, Taiwan); Chwan-Lu Tseng (National Taipei University of Technology, Taiwan); Joe-Air Jiang (National Taiwan University, Taiwan)

To acquire continuous observation results is an essential demand to environmental monitoring. Wireless sensor networks (WSNs), composed of many tiny sensing equipment, give a good solution to collect continuously temporal and spatial data. Due to the limitation of WSNs, such as volume of wireless sensors, cost, energy, processing capability, and transmission distance, we need a solution in charge of collecting sensed data and transmitting it to the backend server. This solution has to handle all data in the network, so the stability and processing capability are a top priority. As a solution, we purpose a gateway with energy-efficiency embedded system that supplies a suitable interface and solve the problem of limited energy source. We employ a touch screen with external devices to provide users the gateway status to deal with the unpredictable situations. We design a power supply set comprising a lead-acid battery and a solar cell. Under adequate exposure to the sun, it can supply sufficient energy for long-term monitoring.

11:40 – 12:00 ***Developed Urban Air Quality Monitoring System Based on Wireless Sensor Networks***

Jen-Hao Liu (National Taiwan University, Taiwan); Yu-Fan Chen (National Taiwan University, Taiwan); Tzu-Shiang Lin (National Taiwan University, Taiwan); Da-Wei Lai (National Taiwan University, Taiwan); Tzai-Hung Wen (National Taiwan University, Taiwan); Chih-Hong Sun (National Taiwan University, Taiwan); Jehn-Yih Juang (National Taiwan University, Taiwan); Joe-Air Jiang (National Taiwan University, Taiwan)

Air pollution is one of environmental issues that have been often discussed. The fast-growing population and urbanization result in the population concentrated in certain areas. Heavy transportation may lead to poor air quality, and inhaling pollutants for a long time also causes damages in human health. A traditional air quality monitoring method is to build air quality monitoring stations, but this method is expensive and provides low resolution sensing data. In addition, monitoring stations are generally less densely deployed. This paper proposed an urban air quality monitoring system based on the wireless sensor network technology and integrated with the global system for mobile communications. The system consists of sensor node, a gateway, and a back-end platform controlled by the LabVIEW program through which sensing data can be stored in a database. This system is deployed to the main roads in the Taipei city to monitor the carbon monoxide (CO) concentration caused by vehicle emissions. The experimental results show that the proposed system can provide micro-scale air quality monitoring in real-time through the WSN technology.

12:00 - 13:40

S13: Poster Session – II Lunch cum Poster Session

Chairs: Dr. Azam Ali (Agresearch Ltd, New Zealand), Dr. Michael J. Haji-Sheikh (Northern Illinois University, USA)

Development of Event Data Recorder for Pedestrians for Analysis of Traffic Accidents

Hitoshi Arakawa (Kyushu Institute of Technology, Japan)

The number of traffic accidents involving cyclists and pedestrians is increasing rapidly in Japan. To clarify the causes of these accidents, it is indispensable to gather information as to what happened in these accidents. This paper introduces the prototype of an Event Data REcorder for a Pedestrian (EDREP) for recording and analyzing traffic accidents similar to the Event Data Recorder (EDR) of a vehicle. The prototype of the EDREP consists of a sensor unit

and a controller unit. The sensor unit consists of image sensors, a motion sensor, and a Global Positioning System (GPS) data receiver. The controller unit consists of a personal computer. The sensor unit and the controller unit are connected through a Universal Serial Bus (USB) link. The video image sequences acquired by the EDREP are transferred to a data server through a wireless internet connection in real time using video streaming technology. In this paper, three video camera systems (Type I, II, III) are implemented and assessed. The main difference among the systems is the type of cameras used in the sensor unit. Type I, II and III are equipped with two or more Web cameras, an omni-directional video camera and two or more NTSC video cameras, respectively. This paper also describes the advantages and disadvantages of the three systems based on results obtained by conducting experiments in a real-road environment.

Quartz Resonator Hydrogen Sensor Using Platinum Black

Hiroshi Oigawa (Waseda University, Japan)

To achieve accurate detection of hydrogen concentration at the range of under 0.1% to 4% in air, we are developing the quartz resonator hydrogen sensor using platinum catalysts. The platinum electrodes of previous model were fabricated by sputtering. To improve its sensitivity, we focused on the platinum black of which structure has the three-dimensional porous. The electrodes of new model were coated by the platinum black through hydrogen reduction of the hexachloroplatinic acid. From experimental results, it was revealed that the sensitivity of a new model was two times bigger than the previous model.

Synthesis, Characterization and electrical conductivity of Gd3+ substituted cobalt ferrite

Vinod Kumar (DCR. University of Science & Technology, Murthal, Haryana, India); Anu Rana (NSIT, India)

Nano particles of CoGdxFe2-xO4, with x = 0.0, 0.1, 0.3, 0.5 have been synthesized by chemical co-precipitation method. The synthesized nano-materials are annealed at 573K for two hours to improve crystallinity. The developed particles are characterized by X-ray diffraction to confirm ferrite phase formation. The average crystallite size as determined from XRD data using Scherrer formula decreases to 7 nm in the Gd3+ ion doped sample (with x = 0.5) compared to 27 nm in case of undoped cobalt ferrite sample. The electrical properties for the different compositions of Gd3+ ion substituted cobalt ferrite material were studied in the frequency range 100 Hz to 10 MHz at room temperature using WK impedance analyzer. It is found that the electrical conductivity of the samples increases with increasing Gd3+ ion concentration. The results of our investigations reveal a strong dependence of material properties on Gd3+ ion doping.

Accelerometer Based Wireless Wheel Rotating Sensor For Navigation Usage

Ji-De Huang (Industrial Technology Research Institute & Information and Communications Research Laboratories, Taiwan); Tong-Wen Wang (Industrial Technology Research Institute, Taiwan)

Accelerometer is an important component in INS. Low cost MEMS accelerometers often provide poor accuracy and make system divergent rapidly. This paper provides another way to use accelerometer. Mounting accelerometer on wheel, one can get accuracy angular velocity and degree of wheel, then vehicle's speed and passing distance can be calculated accurately. A concept system was built and experiment showed this system's error is about 15m over 967m integrated path.

Airborne Antenna Tracking for Sky-Net Mobile Communication

Chin E. Lin (Cheng Kung University, Taiwan); Ying-Chi Huang (National Cheng Kung University, Taiwan)

Sky-Net Project surveys a concept to establish a communication environment for emergency and disaster rescue in remote areas using UAV. An E-Cell is carried airborne to relay mobile communication users to rescue teams. Two directional antennas for horizontal and vertical polarization are installed on airborne to ground receiver. The communication antennas require good alignment from airborne to ground for LOS transmission. To overcome the dynamic flight characteristics, a real time servo control system is developed on a microcontroller-based on GPS and AHRS feedbacks to accomplish high accuracy requirement for 5.8GHz microwave system. The UAV and ground station are exchanging their 10Hz GPS data and linking via 900MHz and 5.8GHz wireless modules as redundancy. By reading the difference of attitude and position data, the ground antenna is tracking the UAV through the servo control system. The airborne system reads AHRS and ground GPS data to control the tracking servo mechanism to align the airborne antenna onto ground antenna. The microcontroller reads UAV real-time data including Euler's angles, GPS and barometric data to determine an appropriate angle to align with ground antenna. The antenna tracking system is

completed as the preliminary technology for further Sky-Net Project in real flight verifications with very stable antenna alignment for LOS microwave transmission.

An Analysis of Sensitivity Distribution Using Two Difference Signal Source in ECT

Elmy Johana Mohamad (Universiti Tun Hussien Onn Malaysia & Faculty Of Electrical & Electronic Engineering, Malaysia); Ruzairi Abdul Rahim (Universiti Teknologi Malaysia, Malaysia); Leow Ling (Universiti Teknologi Malaysia, Malaysia)

The investigation of this work is to analysis the sensitivity distributions using two difference signal source, in order to improve the situation of non-uniform sensitivity distribution, less sensitivity in the central area and non-linear change in ECT (Electrical Capacitance Tomography) system. Simulation using COMSOL Multiphysics is developed in order to obtain the changes in capacitance between inter-electrodes due to increasing the size of permittivity of the dielectric material when two difference voltage sources was injected and MATLAB to obtain the sensitivity distribution inside the closed pipe from the sensor. Generated phantoms and measured values are presented. Simulation is verified using available experimental data through the existing system, portable ECT sensor with 16 segmented portable electrodes plate by PROTOM Research Group UTM, MALAYSIA. Due to the simulation and experiment verification, by using this technique the linear relationship between the capacitances measured inter-electrodes and the permittivity dramatically improved and the sensitivity distribution for an opposing electrode pair was increased thus gives the sensitivity distribution in central area slightly increased. The use of this technique does increase the level of detection signals and thus the SNR(signal noise to ratio) compared to those achieved using standard single-voltage source method.

Biased Kalman Filter

Jiajia Tan (Fudan University, Shanghai, P.R. China); JianQiu Zhang (Fudan University, P.R. China); Bo Hu (Fudan University, Shanghai, P.R. China); Qiyong Lu (Fudan University, P.R. China)

A well-known result on the estimation theory is that biased estimators can outperform unbiased ones in terms of the mean-squared error (MSE). In this paper, we propose a biased Kalman filter (KF) by biasing the minimum-variance unbiased (MVU) output of a traditional KF. The theoretical results show that the proposed biased KF (BKF) provides a tradeoff between the estimation bias and variance, leading to reduce the estimation MSE of the traditional KF. For different applications, two different bias methods, called as the optimal bias and blind bias method respectively, are proposed. Both the analytical and simulated results show that the presented BKF can outperform the traditional KF in terms of MSE.

Optimization of Co-ordinate system for Elliptical Curve Cryptography in Wireless Sensor Network

Pritam Gajkumar Shah (DSI Bangalore, India); Br Lakshmikantha (DSI Bangalore, India)

All standard ECC protocols like Elliptical Curve Diffie Hellman (ECDH), Elliptical Curve Digital Signature Algorithm (ECDSA) used for pair wise key establishment and authentication in WSN requires scalar multiplication operation to calculate public key. Scalar multiplication occupies 80% of the protocol execution time and depends on several factors including choice of coordinate system. One of the crucial decisions, when implementing an efficient ECC on WSN is deciding which coordinate system going to use. The coordinate system determines the efficiency of point addition and point doubling algorithms on the elliptic curve, and hence the efficiency of the basic cryptographic operation of scalar multiplication. This paper has investigated relative performance of various coordinate systems and have suggested appropriate one for WSN. The results have been validated on MIRACL crypto library with real life examples

Optical Fiber Refractometers based on Sputtered Indium Tin Oxide Coatings

Sergio López Lambás (Public University of Navarra, Spain); Carlos Zamarreno (Public University of Navarra, Spain); Miguel Hernaez (Public University of Navarre, Spain)

This work presents the fabrication of optical fiber refractometers based on indium tin oxide (ITO) coatings deposited by sputtering with response in the visible spectral region. ITO thin-films have been sputtered by employing a rotating mechanism that enables the fabrication of smooth and homogeneous coatings onto the optical fiber core. Fabricated ITO coated optical fiber devices present several resonances in the visible and near infrared region. These resonances show high optical power attenuations (more than 10 dB) in the visible spectral region, which produces changes in the colour of the output visible light. Therefore, since these resonances shift as a function of the refractive index (RI) of the surrounding medium it is feasible to determine the RI of the outer medium in contact with the ITO coating by simply monitoring the chromatic coordinates (colour change), x and y, of the visible output light.

Synthesis and gas sensing properties of MoO3 thin films by spray pyrolysis

Daga Ahire (KTHM College, Nashik, India); Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

MoO3 thin films have been prepared by a simple spray pyrolysis technique at substrate temperature 250oC. The structure and morphology of thin films are characterized by X-ray powder diffraction (XRD), scanning electron microscopy and UV-vis spectroscopy. The gas sensing properties of MoO3 thin film is studied at gas concentration 400 ppm and working temperature of 100-400 oC. It was found that the sensitivity depended on the working temperatures and also H2S gas concentration. The results show that the MoO3 thin film can be used to fabricate high performance H2S gas sensors.

Optical probe current sensor module using Kerr effect and its application to IGBT switching current measurement

Keisuke Ogawa (Shinshu University, Japan)

An optical probe current sensor module using Kerr effect has been fabricated and applied to switching current measurement for IGBT used for DC-DC converter and DC-AC inverter of EV/HEV. Since the sensor module using Kerr effect of single domain exchange-coupled magnetic thin film utilizes magnetization rotation only, the Barkhausen noise due to domain wall pinning can be excluded. The current sensor consists of Laser-diode, polarizer, Fe-Si/Mn-Ir exchange-coupled film, quarter-wavelength plate, prism beam splitter, pin Photo-diode and differential amplifier. The optical probe current sensor has a current measurement range of ±60 A and frequency range of DC - 200 kHz. By using it, the switching current of IGBT has been measured.

The Electrical Signals Measurement for Nanowire Field Effect Transistors

Chien-Hung Chen (National Applied Research Laboratories, Taiwan); Yi-Jr Su (National Chiao Tung University, Taiwan); Tai-Shan Liao (Instrument Technology Research Center, Taiwan); Yuh-Shyong Yang (National Chiao Tung University, Taiwan); Chi-Hung Hwang (Instrument Technology Research Center, Taiwan)

This study demonstrates an electrical measurement method that analyses the properties of nanowire field effect transistors (nFETs) for biosensing applications. Detecting electrical signals is critical for all biosensing experiments especially for nFETs that are extremely sensitive to many types of environmental factors. Both direct current (DC) and alternating current (AC) measurements are frequently used. We study the pros and cons of these two methods for measuring electric signals from nFETs. Our results indicate that AC measurement generates less current data than DC measurement. However, the signal-to-noise ratio of AC measurement is higher than DC measurement. These results are important for future biosensing experiments and data analysis using nFETs.

PVDF film micro fabrication for the robotics skin sensor having flexibility and high sensitivety

Hiro Han (Wakayama University, Japan); Yuusaku Nakagawa (ITOKI, Japan); Yasuyuki Takai (Wakayama University, Japan); Kunitomo Kikuchi (Wakayama University, Japan); Shigeki Tsuchitani (Wakayama University, Japan)

This paper provide a novel and potential method to realize a flexible and high sensitive, high resolution skin sensor useful for the application of life-supporting robotic skin. MEMS technology was applied and by etching process 140~300/40-micron of patterns was fabricated easily directly on to the elongated and polarized polyvinylidene fluoride (PVDF) film that will be used as the sensing material in the skin sensor. The effects of PVDF film etching condition, especially the PVDF experienced temperature history to its important sensing parameter of the piezoelectric constant d33 was evaluated by experiment. PVDF film etching characteristics were introduced also. N,N'-dimethyl acetamide (DMA, C4H9NO) solution was used as the wet etching etchant, and O2 RIE for dry etching process. Below the temperature of 55-C, the PVDF film piezoelectric constant was got almost no change, and at the range over 55-C, deteriorated linearly with the temperature rise about 0.3-pC/(N C). At 100-C, there was only 50% of deterioration on the PVDF film piezoelectric constant. Such a strong piezoelectric activity will be useful to the sensitivity in skin sensor. By photomask design and control of process condition, much fine and complex micro structure could be fabricated directly on the PVDF film, and it will be useful to realize the required soft and high sensitive, high-resolution skin sensor.

Effectiveness of model-based motion estimation from an inertial measurement unit

Mark Finch (University of Auckland, New Zealand); Poul F Nielsen (University of Auckland, New Zealand); Andrew Taberner (University of Auckland, New Zealand); Thomas Lintern (The University of Auckland & The Auckland Bioengineering Institute, New Zealand)

This article examines the effectiveness of using a mathematical model improve motion estimates from an inertial measurement unit (IMU). Our custom built IMU (termed WIMOTIONZ) is capable of measuring acceleration, angular rate, and the magnetic field vector in three axes. A magnetometer calibration technique, that removes external magnetic disturbances, is discussed and the objective function used in the optimisation routine is presented. The addition of a model is shown to decrease the RMS error, with respect to a "gold-standard" encoder, by 67% compared with only using a magnetometer. The combined system of model with IMU is shown to predict the position of the sensor to within 1% of its physically measured value.

Optimization of Planar Interdigitated Electrode Array for Bioimpedance Spectroscopy: Restriction of the number of electrodes

Mouhamad Ibrahim (Nancy University, France); Djilali Kourtiche (NANCY Université, France); Mustapha Nadi (Nancy University Henri Poincare & Faculty of Sciences and technology, France); Francois Montaigne (University of Nancy, France); Gwladys Lengaigne (University of Nancy, France)

This paper concerns physical model of interdigitated sensor in the frequency range 102-107 Hz. A theoretical approach is proposed to optimize the use of the sensor for bioimpedance spectroscopy. CoventorWare software was used to modelize in three dimensions the interdigital sensor system for measuring electrical impedance of biological medium. Complete system simulation by Finite element method (FEM) was used for sensor sensitivity optimization. The influence of geometrical parameters (number of fingers, width of the electrodes), on the impedance spectroscopy of biological medium was studied.

Application of an FBG sensors system for structural health monitoring and high performance trimming on racing yacht

Cristian Vendittozzi (SAPIENZA- Rome University, Italy); Giampiero Sindoni (SAPIENZA - Rome University, Italy); Claudio Paris (SAPIENZA - Rome University, Italy); Paolo del Marmo (GiPaC SRL, Italy)

The real time Structures Health Monitoring (SHM) is a requirement that affects all fields of engineering and is aimed at managing the safety of the structures themselves and of the people who use them or move around them . This leads to the need for a monitoring system which allows long term measurement campaigns, even continuous throughout the lifetime of a structure, stable and effective; such a system coexisting with the structure that is being measured in real time must be invisible, durable (more of the structure itself), but this should not interfere with the physical characteristic being measured (strain, acceleration, temperature, etc). The same requirement is also present in many sports motor racing (cars and motorbikes), aerobatics and also yacht racing (regattas), where a monitoring system helps checking the status of the structure (car, bike, airplane, boat), for the safety of people on board, and for improving performance by making real time variation on aerodynamic and mechanical components(such as spoilers, wings, winglets, brakes, suspension), as it is now for over thirty years with the telemetries. Telemetry has been a key factor in modern motor racing: engineers afford to interpret the vast amount of data collected during a test or a race (accelerations, temperature, speed of the wheels and displacement of suspensions) and use them to tune the car for optimizing performance. In this paper is presented a monitoring and trimming system for yachts racing based on FBG fiber optic sensors network embedded inside the structure itself. Here are described several applications where sensing system has been installed on the boat mast , either glued externally or embedded inside the material (carbon fiber reinforced composite, CFRC) during production, and hence the sails, the hull, keel, the rudder, etc. Prevention of serious damage on a racing yacht might be achieved by monitoring the loading conditions and by inspecting the structural integrity, but if it is not easy to estimate loads (generally due to waves and winds) easier could be the structural integrity real time check. The material which is used to build the boat can be internally sensorized.

13:40 - 15:00

S14: S14A: Capacitive Sensors - II

Chair: Dr. Chinthaka Gooneratne (King Abdullah University of Science and Technology, Saudi Arabia)

13:40 – 14:00 ***A Capacitive Array Sensing based Training System for Ophthalmic Anesthesia***

Biswarup Mukherjee (Indian Institute of Technology, Madras, India); Boby George (Indian Institute of Technology Madras, India); Mohanasankar Sivaprakasam (IIT Madras, India); Jagadeesh V Kumar (Indian Institute of Technology Madras, India); Jaichandran Venkatakrishnan (Sankara Nethralaya, India)

A novel capacitive sensing scheme based ophthalmic anesthesia training system for detecting position of syringe needle insertion is presented in this paper. A measurement and excitation scheme is also proposed for the sensor array. Based on this scheme, a 16x8 capacitive sensor matrix PCB structure is proposed and a prototype has been developed to precisely locate the position of the needle of the syringe. Experimental results from the prototype PCB match circuit simulations based on equivalent model, thus validating the proposed scheme. The training system can be developed at low cost without any custom fabrication methods.

14:00 – 14:20 ***A 23ppm/ºC Readout Circuitry Improvement for Capacitive Sensor Acquisition Platforms***

Raúl Aragonés (University & Universitat Autònoma de Barcelona, Spain); Joan Oliver (University & Universitat Autonoma de Barcelona, Spain); Carles Ferrer (Universitat Autònoma de Barcelona, Spain)

This paper presents a high performance analog front-end for conditioning and acquiring raw sensors signals for a frequency based converter platform, with very low power consumption aim.This platform consists of specific circuits designed to interface capacitive sensors with high efficient frequency to code converters. The whole system shapes a readout integrated circuit (ROIC).This ROIC integrates a specific capacitance to frequency converter based on a high performance voltage reference circuit. It presents low power consumption (only 149 µA at full power mode) and the temperature coefficient achieved is 23 ppm/ºC thanks to compensation of the channel length modulation effect and the suppression of mobility dependence.This newly frequency acquisition and conditioning techniques proves to be very precise, versatile and useful for signal sensor acquisition in scalable structures, improving the monitoring system reliability and performance.

14:20 – 14:40 ***Validation of an analytical model for contact mode plate deflection of touch mode capacitive pressure sensors***

Giulio Fragiacomo (Technical University of Demark, DTU, Denmark); Erik Thomsen (Technical University of Denmark, Denmark); Thor Ansbæk (Technical University of Denmark, Denmark)

Design and fabrication of touch mode micro pressure sensors rely on accurate and simple models in order to evaluate the plate deflection profile. This can be used to calculate the capacitance, sensitivity and touch point pressure which are among the key performance parameters of this class of devices. Here we validate a simple analytical model by means of finite element analysis (FEA). An excellent match is shown between the resulting deflection profile and capacitance found by the finite-element and analytical model in both normal mode and touch mode.

14:40 – 15:00 ***Autonomous Sensing for Leakage Detection in Underground Water Pipelines***

Abdullah Kadri (QU Wireless Innovations Center, Qatar); Adnan Abu-Dayya (QUWIC, Qatar); Daniele Trinchero (Politecnico di Torino & iXem Labs, Italy); Riccardo Stefanelli (Politecnico di Torino - iXem Labs, Italy)

This paper presents an advanced architecture for autonomous sensing (AS) within underground water pipelines. This AS architecture consists of a free-moving wireless sensor that communicates wirelessly with a relay stations fixed on the ground. This sensor is equipped with a hydrophone that captures the internal state of the pipe by continuously sensing the noise signal. The data is transmitted wirelessly to the relay nodes and then to a central server on real-time basis for further analysis. Advanced algorithms are applied on the data to get useful information about existing or futuristic leakages. A novel experimental setup has been designed and built for carrying out preliminary experiments. The acquired results have shown both the ability to detect leakages and to identify their magnitude.

S14: S14B: Sensors for Special Applications - II

Chair: Prof. Gui Yun Tian (Newcastle University, United Kingdom)

13:40 – 14:00 *A Sensor-assisted Model for Estimating the Accuracy of Learning Retention in Computer Classroom*

Jan-Pan Hwang (National Cheng Kung University & National Cheng Kung University, Taiwan); Ting-Ting Wu (National Cheng Kung University, Taiwan); Fu-Jou Lai (National Cheng Kung University, Taiwan); Yueh-Min Huang (National Cheng Kung University, Taiwan)

Modern lifestyle is closely associated with information technology, and sensor technology is particularly used, especially in learning and education. This study proposed a sensor-assisted learning system using sensor technology, in order to determine the learning retention of learners in the learning process, and further provide assistance or feedback. The identification rule of this system is constructed based on decision tree algorithm ID3 (C4.5). The system determined the learning retention according to the learners' visual attention recognition, sitting position variability, and physiological signals analysis.

14:00 – 14:20 *Current Based Sensor Signal Processing Technique for Extracting the Feedback Signal*

Tommy Halim (University of Applied Sciences Giessen-Friedberg & CITY University London, Germany); Karsten Leitis (University of Applied Sciences Giessen-Friedberg, Germany)

In a closed loop system, feedback signals are continuously being fed back and compared with the input signal. The difference between the input signal and the feedback signal is being used by the system so as to reduce the error signal and bring the output of the system to a desired value. By knowing the transfer function and measuring the feedback signal, the corresponding input signal can be obtained. Most sensor systems are implementing feedback for several reasons. A common reason is to minimize the large signal linearity problem. This paper presents a circuit architecture that enables the extraction of the feedback current signal without giving significant influence as it is the case for typical shunt resistor solutions. The whole system is being realized in 0.35µm CMOS technology using 1.5 V power supply.

14:20 – 14:40 *Model-Based Wheel Speed Acquistion by Interrupt Capture Method for Integrated Stability Control*

Appalaraju Madeti (Tata Consultancy Services, India); Koustubh Vidyadhar Tilak (Tata Consultancy Services, India); Narasimha Bidi (Tata Consultancy Services, India); Ujjwala Karle (ARAI, India); Prasanna Venkatesan Kannan (The Automotive Research Association of India, India)

A key technological feature of automotive active safety systems is the accurate and instantaneous calculation of the Wheel Speed and Wheel angular Acceleration or Deceleration. Accurate and fast measurements are critical for the functionality of the active safety systems, irrespective of the control logic used to realize the control function. The accurate estimation of critical vehicle dynamic states such as Vehicle Speed, Vehicle Acceleration or Deceleration, Vehicle Longitudinal Force, Wheel Load, Road Friction Coefficient and Vehicle Yaw Rate depend on the accurate acquisition of the Wheel Speed This paper presents a new model-based method for Wheel Speed acquisition based on interrupt capture. This method assures accuracy at high and low speed and the real-time performance at low speed. The hardware interrupts are generated for every rising and falling edges of Hall effect Wheel Speed Sensor, and are used to trigger an Interrupt Service Routine that implements a time capture algorithm. This method ensures that Hall effect sensor pulses are not missed hence provides accurate measured values compared to conventional Input capture methods based on either rising or falling edges. The paper also provides the results of above strategy from MIL and Vehicle tests.

14:40 – 15:00 *A Simple Multiple Loop Sensor Configuration for Vehicle Detection in an Undisciplined Traffic*

Sheik Mohammed Ali (Indian Institute of Technology Madras, India); Boby George (Indian Institute of Technology Madras, India); Lelitha Vanajakshi (IIT Madras, India)

This paper presents an inductive loop vehicle detection system suitable for heterogeneous and less-lane disciplined traffic. Vehicle detection system based on inductive loop principle has been in use but works well only for lane based and homogeneous traffic. A multiple loop system that is suitable for sensing vehicles even in heterogeneous and less-lane disciplined conditions has been reported recently. This paper proposes a new measurement scheme for the multiple loop system. With the new scheme, all the inductive loops are connected in series and only two wires are

required, instead of two per each loop, between the measurement unit and multiple loop system, there by reduces the system complexity. Each loop has a unique resonance frequency and the excitation given to the loops connected in series have frequency components covering all the resonance frequencies of the loops. When a vehicle goes over a loop corresponding inductance and resonance frequency will change. The shift in frequency or its effect for individual loops can be monitored simultaneously and the vehicles can be sensed and segregated as bicycle, motor-cycle, Car, Bus, etc. A prototype multiple loop system has been built and tested based on the proposed measurement scheme. The system sensed, segregated and counted the vehicles accurately.

S14: S14C: Chemical and Biological Sensors

Chair: Prof. Gotan H Jain (Arts, Commerce & Science College, Nandgaon, India)

13:40 – 14:00 *Development of Electrochemical Impedance Spectroscopy Based Sensing System for DEHP Detection*

Asif Iqbal Zia (Massey University & COMSATS Institute of Information Technology, New Zealand), S.C.Mukhopadhyay

This research work presents a real time and noninvasive technique to detect Di(2-ethylhexyl)phthalate (DEHP) content in purified water and quantify its concentration by Electrochemical Impedance Spectroscopy (E.I.S.). Planar Inter-digital capacitive sensors are employed to evaluate conductivity, permeability and dielectric properties of material under test. These sensors, consisting interdigitated microelectrodes, are designed and fabricated on silicon substrate using thin-film Microelectromechanical system (MEMS) based semiconductor device fabrication technology. Impedance spectrums are obtained with various concentrations of DEHP in purified water by using an electric circuit in order to extract sample conductance. Relationship of sample conductance with DEHP concentration is studied in this research work. This relationship enables us to show the ability of E.I.S. to detect DEHP concentration and can be used in water treatment process.

14:00 – 14:20 *Optical sensing of protein adsorption on titanium implants*

Vladimir Vetterl (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Research, Czech Republic); Raimo Silvennoinen (University of Eastern Finland, Department of Physics and Mathematics, Joensuu, Finland); Stanislav Hasoň (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Res, Czech Republic); Sonia Bartáková (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Res, Czech Republic); Vaněk Jiří (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Res, Czech Republic); Niko Penttinen (University of Eastern Finland, Department of Physics and Mathematics, Joensuu, Finland); Martti Silvennoinen (University of Eastern Finland, Department of Physics and Mathematics, Joensuu, Czech Republic); Ladislav Cvrček (HVM Plasma, spol. s r. o., Czech Republic); Vítězslav Březina (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Res, Czech Republic); Jana Šoukalová (Masaryk University, Faculty of Medicine, Centre for Dental and Craniofacial Res, Czech Republic)

Adsorption of the elongated human plasma fibrinogen (HPF) and globular human serum albumin (HSA) molecules on titanium-based surface is monitored by analyzing permittivity and optical roughness of protein-modified surfaces by using a diffractive optical element (DOE) based sensor and a variable angle spectro-ellipsometry (VASE). Both DOE and VASE confirmed that fibrinogen forms a thicker and more packed surface adlayer compared to a more porous and weakly adsorbed albumin adlayer. Linear relation of the permittivity (ε) and dielectric loss (ε´´) was found for some of the dry titanium doped hydrocarbon (TDHC) surfaces with excellent HPF adsorption ability. Aging process of TDHC's influenced the fibrinogen adsorption.

14:20 – 14:40 *Analysis of the Interference of Moisture on Ethylene Hormone Detection with a Palladium Complex*

Azam Ali (Agresearch Ltd, New Zealand)

Ethylene is the simplest plant growth hormone which plays a key role in many physiological processes including ripening of fruit. Therefore, it is important to detect ethylene for regulating the fruit ripening process during storage, transportation and distribution. In this study, a palladium based organic-inorganic complex was synthesized based on a method reported elsewhere [1]. This hybrid complex was processed, formulated and used for detection of ethylene hormone emitted by kiwi fruit. The influences of moisture on detection of ethylene hormone were investigated using

FTIR, 13C-NMR and colorimetric analyses of the palladium complex before and after exposure to ethylene hormone and moisture. This study indicated that the palladium complex interacts both with moisture in high humidity and ethylene hormone.

14:40 – 15:00 ***Novel Electrode Materials for Electrochemical Sensors,*** *by U. Guth, J. Zosel, J. Riedel, N. Tran, M. Berthold, C. Vonau, U. Sasum, P. Shuk, M. Paramasivam, V. Vashook*
Pavel Shuk (Emerson, USA)

Electrode materials are the key components for electrochemical sensors which can be used for determination of gaseous and dissolved species. The sensitivity as well as the selectivity are mainly influenced by the kind and the structure of sensitive electrode material. In this paper two kinds of materials are described. Screen printed carbon electrodes can be modified by thin layers of conducting polymers like Poly(3,4-ethylendioxythiophene) (PEDOT). By means of differential pulse (DPV) and square wave voltammetry (SWV) it is possible to determine biogene amine like dopamine in liquids of human bodies and explosives in ground water in the µM und ppb level, respectively. Polyaniline (PANI) can be used not only at room temperature but also in high temperature sensors. For the first time we could show that zirconia sensors with Nb2O5 or FeCl3 and Co(NO3)2 embedded PANI electrodes are are suitable for hydrogen and hydrocarbons sensing in oxygen containing atmospheres at 450°C. The sensitivities of such electrodes are much higher than those of the usual applied oxide systems like Nb2O5 or La0.75Ca0.25Mn0.5Ni0.5O3-δ. Due to the availibility and compactness of electronic devices electrochemical sensors with modified electrodes can be applied in stationary (potentiometric) and non-stationary (SWV or DPV) mode in field application.

15:30 CLOSING CEREMONY