Workshop Agenda

2nd Annual workshop of IEEE Sensors Council NSW Chapter

April 16, 2021, 9WW, 116, Macquarie University, Sydney, NSW, Australia, 2109

Time	Details	Affiliation	Title of the Talk
08.45 – 09.00	Registration and Morning Tea		
09.00 – 09.30	Opening Remarks		
09.15 – 09.30	Prof. Subhas Mukhopadhyay	Macquarie University – Chair of Sensor Council Chapter	Welcome to all Presenters
Session – I (09.30 – 10.50) In-Person (Chair – Dr Noushin Nasiri)			
09.30 – 09.40	Sumedha Prabhu	Macquarie University	Molecularly Imprinted Polymer-Coated Impedimetric Smart Creatinine-MEMS Sensor for Determining Creatinine Levels from Samples for IoT Enabled PoC Diagnostics
09.40 – 09.50	Samta Sapra	Macquarie University	Printed, Wearable E-skin Force Sensor Arrays
09.50 – 10.00	Vivek Ramakrishna	UNSW/Macquarie University	Towards the development of "smart" implants in orthopaedic spinal applications
10.00 – 10.10	Ollencio D'Souza	Macquarie University	Edge Analytics - essential to create smart sensors
10.10 – 10.20	Brady Shearan	Macquarie University	Development of an IoT-Enabled Sulphur Sensor with an rGO-AgNP Composite
10.20 – 10.30	Fowzia Akhter	Macquarie University	Design and development of a pedestrian counting and environmental system for a smart city
10.30 – 10.40	Jayden Chen	Macquarie University	UV photodetectors based on Ultraporous Nanoparticle Networked Metal Oxide Semiconductors
10.40 – 10.50	Danial Bavi	Macquarie University	Wearable and Smart UV Photodetector to Prevent Skin Cancer
10.50 – 11.10	Tea Break		
Session – II (11.10 – 12.20) In-Person (Chair: Prof. Subhas Mukhopadhyay)			
11.10 – 11.20	Rohan Ibn Azad	Macquarie University	AI-enabled surgery: Enabling da Vinci Xi Robot with Live Cancerous Tumour Detection

11.20 – 11.30	Sakura Mukhopadhyay	Macquarie University	Smart sensor for early detection of damage in pavements
11.30 – 11.40	Mahsa Asadniaye Fardjahromi	Macquarie University	Enhancing Osteoinductivity and Osteoconductivity of alloplastic scaffolds using Metal-Organic Framework modification
11.40 – 11.50	Hadi Ahmadi	Macquarie University	Monovalent Ultra selective Heterogeneous 2D Layered Graphene Oxide Nanochannels Functionalized with Sulfonated Groups for Highly Efficient Lithium Sieving
11:50 – 12:00	Elham Shirani Faradonbeh	Macquarie University	Specific Cell Enrichment via a Cleavable Antibody Binding Surface
12:00 – 12:10	Alice James/ Avishkar Seth	Macquarie University	Estimation of Grip Pattern Using Reinforcement Learning for Prosthetic Arm/ AI-Enabled Wearable Sensing System to perform conformity test in healthcare
12:10 – 12:20	Available		
12.20 – 12.00	Lunch (all attendees will go to have lunch together and ccommittee meeting)		
Session – III (02.00 – 03.00) Via Zoom (Online, International) Chair: Prof. Boby George			
02.00 – 02.12	J.M. Garcia-Briones	Instituto Tecnológico y de Estudios Superiores de Monterrey	Advanced Learner Assistance System (ALAS) for engineering education using wearable sensors
02.12 – 02.24	Diego Mauricio Botín Sanabria	Instituto Tecnológico y de Estudios Superiores de Monterrey	Digital Twins for Smart Communities: Mobility
02.24 – 02.36	Prakash Rewatkar	Birla Institute of Technology and Science (BITS)	Power on Paper: Microfluidic Rapid Prototype Enzymatic Biofuel Cell Based on a Nanocomposite Bucky Paper Bioelectrodes
02.36 – 02.48	Waqas Afridi	Macquarie University	IoT based Smart Water Management in Process Industries
02.48 – 03.00	Anil Kumar A. S.	Indian Institute of Technology Madras	An Eddy Current Based Non-contact Displacement Sensor
03.00 – 03.20	Afternoon Tea Break		
Session – IV (03.20 – 04.20) Via Zoom (Online, National) Chair: Dr Mohsen Asadnia			
03.20 – 03.30	Dr Karthick Thiyagarajan	University of Technology Sydney	Smart Ultrasonic Sensing Suite for Inspecting Pipe Linings
03.30 – 03.40	Nuwan Munasinghe	University of Technology Sydney	Temperature Compensated 3D Printed Strain Sensor for Advanced Manufacturing Applications
03.40 – 03.50	Bahare Mohamadzade	Macquarie University	Conformal, Pattern-Reconfigurable Antennas
03.50 – 04.00	Available		

04.00 – 04.15	Certificate distribution, Closing Remarks and Vote of Thanks

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Dr Dimitrios Georgakopoulos dimitrios.georgakopoulos@measurement.gov.au

List of Abstracts:

Session – I

1) Sumedha Prabhu – Macquarie University

Title: Molecularly Imprinted Polymer-Coated Impedimetric Smart Creatinine-MEMS Sensor for Determining Creatinine Levels from Samples for IoT Enabled PoC Diagnostics

Abstract: Creatinine is biological waste. Low-cost creatinine smart sensing systems are necessary to develop a distributed network to monitor creatinine's blood content in real-time. The existing sensing systems are costly and have system limitations. They are significantly challenging to use in a continuous real-time health monitoring program. Molecularly Imprinted Polymer (MIP) is a valuable technique that allows the development of a low-cost sensor with selective recognition elemental polymer coating. Current research has confirmed that MIPs are functionalized over microelectromechanical systems (MEMS) interdigital (ID) sensor platforms for creatinine detection in heat-inactivated serum samples. The sensing method is based on Electrochemical Impedance Spectroscopy (EIS) with MIP functionalized material on the MEMS ID sensor, permitting creatinine's accurate detection range of 0.1 – 50 parts per million (ppm). Unknown samples are measured to validate the sensing method. This paper presents the MEMS ID sensor's fabrication process and the advantage of using a functionalized MEMS ID sensor to measure creatinine concentration in serum samples. The sensor is characterised at laboratory temperatures and humidity levels for detecting different creatinine concentrations. Ultra High-Performance Liquid Chromatography is used to validate all the results. The sensing system is developed based on a single frequency-dependent EIS technique. It has LoRaWAN connectivity to transfer the creatinine level data to a cloud server for monitoring real-time data. The developed sensing system has excellent potential to be a part of a distributed sensing network to monitor the data in real-time. This is an extension of our earlier work by including LoRaWAN-based Internet of Things (IoT) as an additional capacity within the sensing system, making it a connected Point-of-Care diagnostic. The system sends data directly to an IoT-based web server, which will help develop further distributed healthcare monitoring systems for directly analysing patient blood samples. Thus, this PoC diagnostic helps control creatinine associated blood toxicity.

2) Samta Sapra – Macquarie University

Title: Printed, Wearable E-skin Force Sensor Arrays

Abstract: The need to develop E-skin for robotics is essential to provide a sense of touch on a large area, same as human skin. In this paper, the design, fabrication and development of a flexible, printed E-skin force sensor array is reported. The performance of the capacitive force sensor array is analysed. A resolution of 2.5 sq. mm is achieved, with a localization accuracy of 99%. The sensor operates in shunt mode of capacitive coupling. The proposed E-skin sensor patch provides significant force sensitivity and stable loading, unloading for static and dynamic forces. The characterization of the sensor is done by the EIS technique. The methodology and operating principle of the capacitance matrix are discussed. The dependence of localization accuracy on touch angle and contact area estimation is discussed. This E-skin sensor patch is low-cost, scalable, modular and customisable.

Additionally, for a user-friendly and interactive approach, GUI is developed in open-source python software. Unsupervised machine learning algorithm trains the tactile E-skin system for different user style to distinguish the cluster of lower and higher touch angle for improving accuracy. The proposed E-skin sensor finds application in

large area robotics, gripper pad for prosthetics in biomedical devices where the sense of touch and high resolution is needed.

3) Vivek Ramakrishna – Macquarie University

Title: Towards the development of “smart” implants in orthopaedic spinal applications

Abstract: Structural health monitoring is a term that was originally adapted from medicine, which is now applied to large engineering structures for damage detection. Real-time, continuous monitoring is now becoming increasingly popular in medicine. However, orthopaedics is yet to adapt to the trend instead of relying on intermittent imaging, often with high radiation doses.

In orthopaedics, there is a clinical need for load-sensing implants that address biomechanical, postoperative monitoring. Spinal interbody cages demonstrate a clear pathway towards achieving this. Load-sensing interbody cages may be able to guide clinical decision making regarding the need for extra stabilisation, revision surgery, and postoperative rehabilitation. Furthermore, using sensor measurements from the implant, early indicators of mechanical or clinical failure may be detected.

Finite element modelling has been conducted to obtain a clear mapping of stress regions and to determine the impact of bone growth on the loads experienced by the implant. While choosing mechanically and clinically suitable piezoresistive sensors have proved to challenge, experimentation is ongoing into the integration of these sensors in the implant for sensitive detection of bone growth. As an alternative, further research has also gone into the development of capacitive flexible sensors for pressure mapping of the interbody cage, which is currently showing positive results.

In order to take ‘smart’ implants to actualisation, further work is required to demonstrate the sensitivity, resolution, and durability of the integrated sensors. In future research, incorporating telemetric technology for wireless powering and data transfer will ensure that ‘smart’ implants reach the market and allow for effective postoperative monitoring that leads to truly personalised healthcare.

4) Ollencio D'Souza – Macquarie University

Title: Edge Analytics - essential to create smart sensors

Abstract: We assume that developing sensors for single or multiple sensing purpose, however complex, might be an appropriate objective in sensor research. In this presentation, I would like to show why analytics at the edge, tying in different sensors and operational analytic logic, would optimise functionality and opportunity to deliver much better outcomes from already deployed sensor (nets). We will also investigate one "product" case where "sensor fusion" with built-in analytic logic has delivered the health, safety and security industry a very effective tool.

5) Brady Shearan – Macquarie University

Title: Development of an IoT-Enabled Sulphur Sensor with an rGO-AgNP Composite

Abstract: The research proposed is in relation to real-time detection of Sulphur ions within aqueous mediums, with the future potential of detection of Hydrogen Sulfide (H_2S) in wastewater systems. Electrochemical Impedance Spectroscopy (EIS) is utilized alongside a novel interdigital capacitive sensor. The synthesis of graphene-based polymer composite coatings for Sulphur ion absorption is detailed. Sampled Sulphur measurements are conducted by using the presented coatings. The sensitivity curve obtained for a range of Sulphur concentrations from 0.5 ppm to 50 ppm highlights the promising initial results and strong potential for use within the detection of H_2S. The coating of Reduced Graphene Oxide (rGO) with silver nanoparticles (AgNPs) exhibits an enhanced sensitivity and selectivity towards Sulphur ions. A portable IoT-based system is also presented for the detection of Sulphur irrespective of time and place.

6) Fowzia Akhter – Macquarie University

Title: Design and development of a pedestrian counting and environmental system for a smart city

Abstract: An Internet of Things (IoT) enabled intelligent sensor node has been designed and developed for smart city applications. The fabricated sensor nodes count the number of pedestrians, their direction of travel,

along some ambient parameters. The Field of View (FoV) of Fresnel lens of commercially available passive infrared (PIR) sensors has been specially tuned to monitor the movements of only humans and no other domestic animals such as dogs, cats etc. The ambient parameters include temperature, humidity, pressure, Carbon di Oxide (CO2) and a total volatile organic component (TVOC). The monitored data are uploaded to the Internet server through the Long Range Wide Area Network (LoRaWAN) communication system. An intelligent algorithm has been developed to achieve an accuracy of 95% for the pedestrian count. There are a total of 74 sensor nodes that have been installed around Macquarie University and continued working for the last six months.

7) Jayden Chen – Macquarie University

Jayden Chen[1], Darren Bagnall[2], Noushin Nasiri[1]

[1]NanoTech Laboratory, School of Engineering, Faculty of Science and Engineering, Macquarie University, Sydney, Australia.

[2]School of Engineering, Faculty of Science and Engineering, Macquarie University, Sydney, Australia.

Title: UV photodetectors based on Ultraporous Nanoparticle Networked Metal Oxide Semiconductors

Abstract: ZnO nanostructures have attracted significant interest for UV detection due to their high sensitivity, long-term stability, and low fabrication cost. Ultraporous Nanoparticle Network (UNN) is a novel hierarchical morphology for UV photodetectors resulting in excellent sensitivity and record-high UV response. Herein, a rapid (≤100 s) one-step synthesis and self-assembly method, Flame Spray Pyrolysis (FSP), is introduced to fabricate ultraporous films composed of electron-depleted crystalline metal oxide nanoparticles on low-cost glass featuring interdigitated electrodes. The performances of UV detecting based on UNN structured ZnO in comparison with the state-of-the-art technologies is investigated.

8) Danial Bavi – Macquarie University

Danial Bavi[1], Jayden Chen[1], Subhas C. Mukhopadhyay[2], Noushin Nasiri[1]

[1]NanoTech Laboratory, School of Engineering, Faculty of Science and Engineering, Macquarie University, Sydney, Australia.

[2]School of Engineering, Faculty of Science and Engineering, Macquarie University, Sydney, Australia.

Title: Wearable and Smart UV Photodetector to Prevent Skin Cancer

Abstract: Accurate detection of ultraviolet radiation is critical to many technologies including wearable devices for skin cancer prevention, optical communication systems, and missile launch detection. Here, n smart UV detector system to measure the UV index using a nanoscale ultrasensitive UV sensor. The device is equipped with Bluetooth Low Energy (BLE) communication that consumes low energy and lasts at least one day with fully charge. This wearable UV detector is the first personalised UV monitoring system which can perform based on real-time data measurements at different weather types and has a potential to be calibrated based on end-user skin type.

Session – II

9) Rohan Ibn Azad – Macquarie University

Title: AI-enabled surgery: Enabling da Vinci Xi Robot with Live Cancerous Tumour Detection

Abstract: Stage 4 cancer leaves the patient with options limited to chemotherapy, hormone therapy and as a last resort, partial or radical surgery. Surgeons use their experience to distinguish between cancerous tissue and non-cancerous tissue, taking assistance from ultrasound scan, Indocyanine Green (ICG). The method is not reliable as an overdose or underdoes of ICG renders the technique ineffective. Ultrasound is done 1 week before the surgery, and stage 4 cancer is prone to spread by the time of the surgery. Intraoperative ultrasound is another option, but the surgeon has to concentrate on controlling the ultrasound and the pickup probe during the surgery and also has to switch between console and ultrasound image.

This project proposes a novel technique of using trained Computer Vision algorithms to provide intra-operative malignant tumour detection during surgery, helping the surgeons operate more efficiently and save time.

10) Sakura Mukhopadhyay - Macquarie University

Title: Smart sensor for early detection of damage in pavements

Abstract: Civil structures are a vital role in society, existing in various forms such as roads, railways, and bridges. Failure of these structures can have catastrophic consequences affecting both the public and economic growth. Early detection of the damage can avoid failure, safety hazards and need to further repair and maintain. Methods that can assess the health of the structures are required and is known as Structural Health Monitoring (SHM). SHM has grown both in the research and development field in recent years for the use of conducting surveys and undertaking analysis for security, safety, and post-disaster surveys. It also allows assessing the external factors that affect the structure, such as ageing, natural disasters, collisions. The application of SHM consists of the selection and allocation of a suitable sensor to measure the critical parameters not only affecting the damage but further the health and performance of the structure.

11) Alice James – Macquarie University

Title: Estimation of Grip Pattern Using Reinforcement Learning for Prosthetic Arm

Abstract: Prosthesis has a vital role in an amputee's life; it aids and provides rehabilitation to resume daily activities with ease. Along with the significant emotional and physical trauma, the prominent long-term effects are lack of independence and loss of major physical functionality. Soft electronics are used to gauge measurements in the body that will map various parameters such as physical strains (e.g. mechanical), temperature and electrophysiological recordings. This project introduces a measuring system implementing a neural network to enhance the detection of dynamic motions of the five fingers in real-time. The development of this project will aid the design of a prosthetic arm that can process and predict hand gestures as naturally as a biological arm. The project will use reinforcement learning to accurately predict and estimate the grip pattern. The solution designed in this project is aimed to be robust that can also be transferred to various assistive domains in robotics as well. The current prosthetic designs that are commercially available are limited to perform only on the user's direct commands. The aim has been to bridge the gap in control, as the existing systems developed in human-machine interfaces, in general, have a large number of controllable functions that a human can attend to at a given time. The prosthetics design technology will ameliorate the lives of people and restore their independence and social life.

11) Avishkar Seth – Macquarie University

Title: AI-Enabled Wearable Sensing System to perform conformity test in healthcare

Abstract: Wearable technology is a broad term that encompasses a wide range of electronic devices that are usually worn on the body of a human. These portable devices can be in the form of an accessory, electronic skin, an implanted device or even a gaming VR headset. Wearables are believed to be first originated in the early 1300s when the 'eyeglasses' were first developed. Sensors are a key component in wearable devices, enabling effective monitoring of human activity for healthcare and biomedical purposes. With the advancement in computational capabilities of systems, the application of AI and deep learning concepts in biotechnology have skyrocketed. This project aims to demonstrate the development of an AI-based wearable sensor device to allow conformity test in the healthcare domain. Some of the objectives of this project are as follows: To investigate the current types of sensor technologies used in wearable sensors with a comprehensive literature review of the research. To evaluate the different processes involved in the fabrication of a sensor and printing techniques. To understand the role of Artificial Intelligence and IoT in wearable sensor systems and to identify the challenges faced. To simulate the system implementation using novel design algorithms and deep learning techniques for better prediction models and assistance in health monitoring and conformity tests.

12) Mahsa Asadniaye Fardjahromi – Macquarie University, Australia.

Mahsa Asadniaye Fardjahromi [a, b], Amir Razmjou [c], Graham Vesey [d], Subhas Chandra Mukhopadhyay [a], Majid Ebrahimi Warkiani [e]

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Title: Enhancing Osteoinductivity and Osteoconductivity of alloplastic scaffolds using Metal-Organic Framework modification

Abstract: One of the biggest challenges in orthopaedic procedures is providing enough autologous bone grafts to stimulate bone growth. In this procedure, the bone harvested from a donor site transport to another part of the patient's body and assist in bone regeneration. However, this approach suffers from a limited amount of bone supply and sophistication in grafting surgery. The aim of this study is the surface modification of synthetic bone grafts such as polymers and ceramics using nano metal-organic frameworks for enhancing their cell adhesion and bone defect healing. The nano topography of the scaffold was tailored by coating Zeolitic imidazolate frame work-8 (ZIF-8)/ polydopamine, and the morphology and functionality of modification were confirmed with different techniques such as FTIR XRD, SEM, and EDX. To measure the osteogenic differentiation potential of stem cells in bone scaffolds, different techniques such as Real-PCR, immunofluorescence staining, and Alizarin red-based assay of mineralization have been utilized. In conclusion, the nano-ZIFs coating can contribute to developing a new generation of bone grafts with higher osteoinductivity and osteoinductivity potential in bone defect healing.

13) Hadi Ahmadi – Macquarie University

Title: Monovalent Ultra selective Heterogeneous 2D Layered Graphene Oxide Nanochannels Functionalized with Sulfonated Groups for Highly Efficient Lithium Sieving

Abstract: Massive investment in harvesting energy from renewable sources has profoundly increased industries' demand for advanced storage systems such as lithium-ion batteries. Although several 2D material-based methods have been developed lately to extract Li+ from chemically similar metal ions such as K+ and Na+ in low-concentrated unconventional resources (e.g. seawater), their Li+ extraction capacity is limited by an upper bound, which is impossible to cross with current symmetrical morphologies. On the other side, it has been theoretically proven that achieving higher selectivity performance will be only possible through shifting from symmetric to asymmetric 2D nanochannels' architectures. To experimentally uphold this idea, for the first time, a new generation of GO-based membrane containing heterogeneous morphology and surface chemistry is introduced in this study to reach the maximum Li+ capture. Here, we constructed tunable asymmetric interfacial regions embracing nano-confined cavities possessing lithiophilic elements by spatial functionalisation of GO nanochannels with sulfonated groups, resulting in the formation of lithium-rich feed. The results demonstrate that the assemble of 2D Asy-nano-confined channels provides the GO-based membrane with the highest K+/Li+ and Na+/Li+ selectivity ratio of 5.7 and 4.1, respectively, which classifies it as a top-ranked monovalent selective GO-based membrane with an average of 260% improvement. Molecular dynamic (MD) and density functional theory (DFT) simulations discovered a new design for the transportation of ions which creates heterogeneous steric confinement for sieving the ions by providing nucleophilic sites at interfacial region. It has also been theoretically approved that Li+ experiences higher trapping and hydration energy than other monovalent ions to pass through the asymmetric cavities indicating high capability for Li+ exclusion. These findings pave the way for researchers to develop the next generation of industry-scaled up Li+ selective GO-based membranes with high efficiency in advanced technologies.

14) Elham Shirani Faradonbeh – Macquarie University, Australia.

Elham Shirani [1,2], Fatemeh Karimi [2], David Inglis [1], Robert Nordon [2]

[1] School of Engineering, Macquarie University, Sydney, NSW, 2109, Australia.

[2] Graduate School of Biomedical Engineering, University of New South Wales, Sydney, NSW, 2052, Australia.

Title: Specific Cell Enrichment via a Cleavable Antibody Binding Surface

Abstract: Obtaining an enriched, phenotypically-pure cell sub-population from heterogeneous cell mixtures like blood is important for diagnostics and biosensing. Existing techniques such as fluorescent activated cell sorting (FACS) and magnetic-activated cell sorting (MACS) require pre-incubation with antibodies (Ab) and time-consuming preparations. Cell affinity chromatography (CAC) removes the need for pre-incubation and shows high resolution and specificity of separation. The majority of the available antibody-mediated analyte capturing techniques require a modification on Abs (e.g. oxidation, biotinylated, and protein modification) to make them attachable to a surface's cross-linker. In this work, no antibody modification is needed because we take advantage of the carbohydrate chain in the Fc region. In one step Ab creates a cleavable complex with boronic acid on the modified surface. Oriented Ab immobilization using boronic acid has appeared in several comparative highest antigen detection sensitivity studies. This study delivers a cleavable Ab binding surface with low non-specific binding of biomolecules to provide an enriched population of a specific cell type or analytes. The specific surface chemistry modification of this biosensor gives us the advantage of specifically captured cells or analytes with the option of chemical detachment. Detached cells or analytes can be used for further research.

Session – III

15) J.M. Garcia-Briones, M.A. Ramírez-Moreno, J.J. Lozoya-Santos, D.M. Botín-Sanabria G. Olivas-Martínez, J.F. Pacheco-Quintana, K.L. Rodríguez-Hernández, M.O. Candela-Leal, R. Abrego-Ramos, S. Sampogna-Montemayor, G.J. Álvarez-Espinoza – Instituto Tecnológico y de Estudios Superiores de Monterrey

Title: Advanced Learner Assistance System (ALAS) for engineering education using wearable sensors

Abstract: This work presents neuro-engineering tools used to assess students' cognitive performance under different learning modalities. By using a Raspberry Pi for IoT, it is possible to use EEG helmets, other physiological signals, and vehicle signals to be analyzed using ML algorithms and give biofeedback on a web platform for augmented learning and make simulations for automotive engineering purposes. In a preliminary study, a correlation between cognitive performance and EEG analysis found the most relevant features to predict students' performance with an 85% precision at predicting and identifying the best learning modality.

16) Diego Mauricio Botín Sanabria, José Francisco Pacheco Quintana, Jorge de Jesús Lozoya Santos, Juan Manuel García Briones, Lucas Ortiz Duhart, Mauricio Adolfo Ramírez Moreno – Instituto Tecnológico y de Estudios Superiores de Monterrey

Title: Digital Twins for Smart Communities: Mobility

Abstract: A Digital Twin is a virtual representation of a real-life environment that can simulate current conditions, predict future behavior, and log valuable information about the subject. This project's objective is to create this virtual platform with a real-time simulation that allows the manufacturer to visualize a 3D virtual representation and analyze the vehicle´s dynamic behavior and predictive maintenance models to make appropriate design and maintenance decisions. To do this, a network of inertial and ranging sensors and devices in the vehicle will interact with smart street sensors, process real-life data through Digital Twin edge technology, and transmit it to a cloud database where it can be accessed by an external user for visualization of the virtual environment, real GPS positioning and relevant alerts.

17) Anil Kumar A. S. – Indian Institute of Technology Madras

Title: An Eddy Current Based Non-Contact Displacement Sensor

Abstract: This work presents a novel, non-contact displacement sensor based on the eddy current sensing technique. The moving part of the sensor is a conductive sheet with a simple surface groove. This part is easy to fabricate as the machining process required is simple. The moving part is not electrically connected to the measurement system, like the eddy current proximity sensor. The displacement of the moving part is determined by the change in the inductance of four identical stationary planar coils kept underneath the moving part. A signal

conditioning circuit is presented in this paper, which measures the difference in inductance between two coils. A suitable algorithm has been developed to calculate the displacement using the corresponding inductance values. A prototype has been fabricated in the laboratory to evaluate the performance. The test result shows that the maximum error is less than 1.65%. The output of the prototype sensor was linear for the full range, as expected. It is well suited for application where the vertical space available for the installation is limited. The overall thickness of the developed sensor is less than 5 mm.

18) Prakash Rewatkar - Birla Institute of Technology and Science (BITS), Hyderabad Campus, Hyderabad, India.

Prakash Rewatkar [a], Subhas Mukhopadhyay [b] and Sanket Goel [*a] – MEMS, Microfluidics and Nanoelectronics Lab, Department of Electrical and Electronics Engineering, Birla Institute of Technology and Science (BITS), Hyderabad Campus, Hyderabad, India.

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Title: Power on Paper: Microfluidic Rapid Prototype Enzymatic Biofuel Cell Based on a Nanocomposite Bucky Paper Bioelectrodes

Abstract: Today, sustainable and qualitative electrical power is a crucial factor in all electronic devices. In portable and implantable devices, such requirement is even more essential, which can be provided by the Enzymatic Biofuel Cell (EBFC) as well. In EBFC, glucose is oxidized at the anode side, and an oxidant, such as oxygen, is reduced at the cathode side, leading to the generation of potential between the electrodes. Due to its inherent natural characteristics, EBFC can be implanted in small-powered medical devices such as a pacemaker, insulin pump, and brain stimulator. However, to integrate with the existing micro-electronics devices, EBFC needs to be miniaturized without compromising on its power output. Membraneless Microfluidics Enzymatic Biofuel Cell (M-MEBFC) is not only prone to be miniaturized but also provides multiple advantages, such as the possibility to avoid membrane, the requirement of sufficiently less electrolyte, material compatibility and higher power densities. In this context, Bucky paper (BP) based bioanode and biocathode were used in conjunction with the improved (Mediated electron transfer) MET electrochemistry. The BP, commercially available in the sheet form, is made up of Multi-walled carbon nanotubes (MWCNTs). Furthermore, the surface morphological (SEM and EDX) and electrochemical (LSV, CV and EIS) analysis were accomplished to evaluate the catalytic activity of enzymes. With such promising performance, further studies were carried out by incorporating these optimized BPs into a microfluidic device with a Y-shaped microchannel to make a miniaturized microfluidic paper-based EBFC (µP-EBFC). Developed µP-EBFC has shown excellent power density and stability and generates power over prolonged periods of time. Thereafter, various commercial beverages have been tested as alternative feedstock in the µP-EBFC platform to determine their overall power generation capacity. In order to further boost the power generation potential, the updated shelf-stacked configuration has been demonstrated using the µP-EBFC platform with improved mediator and enzyme immobilized electrochemistry. Due to their fabrication technology and improved performance, these devices have a significant research and development potential to power a range of portable low-power devices.

19) Waqas Afridi – Macquarie University

Title: IoT based Smart Water Management in Process Industries

Abstract: In the current competitive business environment, process industries, mainly water-reliant manufacturing companies, heavily depend on the availability of freshwater for the production of their final goods. However, their in-house current water infrastructure is not fully capable of providing fundamental solutions to sustainable water management, such that it gives rise to extra water consumptions in production processes with minimum quality standards, the higher operational cost in the form of poor asset maintenance and labour dependency. On the contrary, applications of advanced ICTs such as smart sensing network in an IoT environment offers a wide range of development opportunities for the improvement of water infrastructure that leads to efficient and optimized water operations, lower operating costs, and increased productivity.

Session – IV

20) Dr Karthick Thiyagarajan – iPipes Lab, UTS Robotics Institute, University of Technology Sydney

Title: Smart Ultrasonic Sensing Suite for Inspecting Pipe Linings

Abstract: Drinking water and wastewater pipelines stretch more than 200,000 kilometres in Australia. Internal deterioration of such pipelines occurs over time due to a variety of causes, including corrosion. Protective pipe linings are applied to the internal surface of pipelines to mitigate pipe deterioration and extend their service life. In my presentation, I will talk about the latest research developments and findings in ultrasonic sensing technology for inspecting the thickness of the applied linings in water and wastewater pipe infrastructures as part of the post-application quality assurance exercise.

21) Nuwan Munasinghe – University of Technology Sydney

Title: Temperature Compensated 3D Printed Strain Sensor for Advanced Manufacturing Applications

Abstract: Additive Manufacturing has evolved beyond prototyping to manufacturing end-products. The authors are involved in developing a large-scale extrusion-based 3D printer to print mining equipment - a Gravity Separation Spiral, and embedding sensors to monitor the operational conditions remotely. This paper presents a temperature-compensated strain sensor that can be 3D printed inline within large-scale 3D printed equipment. The sensor is printed using conductive carbon filament and embedded in a Polylactic acid (PLA) base. A half-bridge setup is proposed to reduce the impact of temperature variations. Temperature-controlled tests have been conducted with the proposed half-bridge and compared with a non-temperature compensated quarter-bridge setup. Results show that the half-bridge configuration reduces the temperature impact on the strain measurement significantly (68%) compared to the quarter-bridge, in the range of 25-40 Â°C. Deflection testing conducted on the printed sensor shows a near-linear relationship between bending strain and voltage. Multiple bending cycles have shown that there is no significant hysteresis. ANSYS simulations are used to accurately estimate the internal temperature since embedding a temperature sensor would affect the structural integrity. Although carbon black material is naturally brittle, steps have been taken in the design to avoid undesirable cracking. Results from laser microscopy analysis of the printed traces showed no crack defects.

22) Bahare Mohamadzade – Macquarie University

Title: Conformal, Pattern-Reconfigurable Antennas

Abstract: Reconfigurable antennas have attracted attention due to their multifunctional capabilities in modern communication systems. An increase in demand for flexible and conformal antennas in modern electronic systems has led to the development of flexible and conformal reconfigurable antennas. Flexible and conformal antennas rely on non-conventional materials. Therefore, there are notable challenges associated with the integration of the required elements such as switches, diodes, etc., with the antenna, the mechanical stability of the structure, and the electronic robustness of the antenna when exposed to the folding of sustained bending operations. In this presentation, a conformal antenna with electronically tuning capability of its radiation pattern between broadside and monopole-like patterns at 5.2 GHz is shown. The design is a planar structure without any use of rigid shorting pins or a complex feeding network. The antenna is fabricated using a highly flexible PDMS-conductive fabric composite. All the antenna parts, including the RF switches, wires, and dc biasing circuit, are fully encapsulated by PDMS to provide resilience against deformations.