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Modern Sensing Technologies

This special issue on **Modern Sensing Technologies** of the Sensors and Transducer JOURNAL is primarily focused on the different aspects of design, theoretical analysis, fabrication, characterization and experimentation of different sensing technologies. This special issue comprises 30 papers carefully selected from the extended versions of the reviewed papers which were presented in the 2nd International Conference on Sensing Technology (ICST 2007), November 26-28, 2007, Palmerston North, New Zealand, and published in the conference proceedings.

Of all the papers, four papers are grouped in the category of sensors for medical and biological applications. In the first paper, Chen et. al., have reported a tactile/proximity sensor made from carbon microcoils and elastic polymer, polysilicone YE-103, to detect load by the change of electrical parameters with a response time of 0.3 to 0.5 S. The reported sensitivity of 1 mgf is 3 to 4 times higher than that achieved using conventional capacitive sensors. In the next paper, T. Mohammad Brahim et. al., have presented a review of the large possibilities of sub-micron gap Suspended-Gate FETs, namely SGFET, to detect chemical and biologic species with high sensitivity. C. Gooneratne and his group have reported a novel needle sensor, based on giant magnetoresistive element, to measure the volume density of magnetic fluid inside an artificial medium. This type of sensor has the potential to be used in many medical procedures such as hyperthermia based treatment of cancer. S.M. Rezaul Hasan and S.N. Ibrahim have presented an improved CMOS Electric-Field Sensor circuit which can be used in a Lab-on-a-chip micro-array that uses dielectrophoretic actuation for detecting bio-cells. The improved circuit utilizes the current in both branches of the DeFET to provide a much larger output sensed voltage for the same input electric field intensity compared to the previously published designs.

The next group of four papers is in the wireless sensors and networks cluster. Paolo Ferrari et. al., have dealt with an issue of coexistence problems of installation of several wireless sensor systems in the same industrial plant. The authors have proposed a methodology based on a central arbiter that assigns medium resources according to requests coming from WSN coordinators. An infrastructure which is a wired Real-Time Ethernet (RTE) network assures synchronization and distributes resources. Nomura et. al., have proposed a wireless sensing system for effective operation of a strain sensor. The authors have designed a novel SAW strain sensor that employs SAW delay lines to measure the two-dimensional strain. In the next paper Vasanth et. al., have proposed Control Radio Flooding (CRF) protocol for self organizing sensor networks. The proposed stack, which is fully power-aware, is referred to as CRF-STACK. It integrates the hierarchical space partitioning tree with a data transaction model that allows seamless exchanges between data collecting sensors and its parent nodes in the hierarchy and could be compatible with emerging IEEE standards. The heart of the model is a scalable real-time OS which provides a programming interface to develop sensor applications and the underlying radio communication. S. Bhardwaj et. al., have reported a ubiquitous computing technology to provide better solutions for healthcare of elderly people at home or in a hospital. The healthcare parameters are derived from ECG and accelerometer. Data of vital signs, accumulated through long-term monitoring and fusion of multiple data, is a valuable resource to assess the status of personal health and predict potential risk factors. The hardware allows data to be transmitted wirelessly from on-body sensors to a base station attached to a server PC using IEEE 802.15.4.

The next three papers are in the category of capacitive sensors. Winncy Y. Du and Scott W. Yelich have reviewed resistive and capacitive sensing technologies. The physical principles of resistive sensors are governed by several important laws and phenomena such as Ohm's Law, Wiedemann-Franz Law; photoconductive-, piezoresistive-, and thermoresistive effects. The capacitive sensors are described through three different configurations: parallel (flat), cylindrical (coaxial), and spherical (concentric). The authors have described different configurations with respect to geometric structure, function and application in various sensor designs. In the next paper Daniel Hrach et. al., have presented a multi-purpose and easy to handle rapid prototyping platform that has been designed for capacitive measurement systems. The core of the prototype platform is a Digital Signal Processor board that allows for data acquisition, data (pre-) processing and storage, and communication with any host computer. The platform runs on uCLinux operating system and features the possibility of a fast design and evaluation of capacitive sensor developments. John Christie and Ian Woodhead have, in the next paper, described the physical basis of dielectric moisture sensing.

The next two articles are on Sensors signal processing. Carlos Braga et. al., have reported the development of a Kalman filter tuning model based on QR duality principle. They have designed the filter in an orientation to measure the most important state variable of the electrolytic bath. The technical solution encompasses on-line evaluation of the *Kalman* filter working with a real production pot. The main goal is to compute a set of filter gains that represents the behavior of the alumina inside the cell. In the next paper El-Hassane Aglzim et. al., have presented an electronic measurement instrumentation developed to measure and plot the impedance of a loaded electrochemical generator like batteries and fuel cells. Impedance measurements were done with variations of the frequency in a larger band than what is usually used.

In the next two papers sensors related to gas sensing have been presented. G. H. Jain et. al., have prepared Barium Strontium Titanate (BST-(Ba_{0.87}Sr_{0.13})TiO₃) ceramic powder for sensing different gases such as ammonia and H₂S. Pavel Shuk et. al., have discussed different aspects of industrial zirconia oxygen sensors especially application limits and stability. Special consideration has been given to the practical aspects of the oxygen sensor design and operation. Two articles have discussed image sensors. The digital image sensors are very important for their ubiquitous use in many industrial and consumer applications. In their paper, Kenji Irie et. al., have presented an overview of image noise and described a method for measuring noise quantity for use in image-based applications. In their paper S.H. Lim and T. Furukawa have presented a calibration-free approach to modeling image sensors using mechanistic deconvolution, whereby the model is derived using mechanical and electrical properties of the sensor.

Jagadish Patra et. al., have proposed a novel computationally-efficient functional link neural network (FLNN) that effectively linearizes the response characteristics, compensates for the non-idealities, and automatically calibrates sensors to make them intelligent. Jaspreet and his colleagues have described the various nonlinearities (NL) encountered in the Si-based Piezoresistive pressure sensors. They have analyzed the effects of various factors like diaphragm thickness, diaphragm curvature, position of the piezoresistors etc. taking anisotropy into account. Jeng Yen has presented a novel technique to validate and predict the Rover slips on Martian surface for NASA's Mars Exploration Rover mission (MER). Different from the traditional approach, the proposed method uses the actual velocity profile of the wheels and the digital elevation map (DEM) from the stereo images of the terrain to formulate the equations of motion. Ibrahim in his paper has presented two methods for obtaining sensorless rotor position information by monitoring the actual excitation signals of the phases of a switched reluctance motor. This is done without the injection of diagnostic current pulses and has the advantages that the measured current is large and mutual effects from other phases are negligible. R. Dykstra et. al., have presented some development works towards a portable NMR system for the non-destructive testing of materials such as polymer composites, rubber, timber and concrete. Hong Wei et. al., have introduced

a novel silicon micro-machined gyroscope which is driven by the rotating carrier's angular velocity. S.M. Rezaul Hasan and S.M. Ibrahim in their paper have presented an improved integrated circuit sensor for emulating and monitoring the quality of perishable goods based on the surrounding temperature. The sensor is attached to the container of fresh or preserved farm or marine produce and passes on the monitored quality information from manufacturer/producer to the consumers. In their paper Satoshi Ikezawa et. al., have described laser-induced breakdown spectroscopy (LIBS) using micro-droplet NaCl solution. In their study, micro-droplet ejection systems for sampling are designed. These micro-droplet ejection systems enable a constant volume of the sample liquid to be obtained and they take advantage of the liquid's physical state; the density of the solution can be controlled accurately. The methods presented in their report generate small droplets (diameter 30 or 50 μm) by confining the entire volume of the sample material in the laser beam spot area (minimum beam spot diameter: 53.2 μm) and separating it from its surroundings. Ian Woodhead and his colleagues have developed integral equation and differential equation methods to enable modeling of current and hence impedance of wood. It provides the forward solution for impedance tomography that in turn provides a measure of internal moisture distribution. S.M.Cho and et. al., have reported the design and fabrication of a micromachined infrared sensor for an infrared focal plane array. Amorphous silicon was used as a sensing material, and silicon nitride was used as a membrane material. To get a good absorption in infrared range, the sensor structure was designed as a $\lambda/4$ cavity structure. A Ni-Cr film was selected as an electrode material and mixed etching scheme was applied in the patterning process of the Ni-Cr electrode. Somrak Petchartee and Gareth Monkman have introduced a new way to predict contact slip using a resistive tactile sensor. The prototype sensor can be used to provide intrinsic information relating to geometrical features situated on the surface of grasped objects. Information along the gripper finger surface is obtained with a measurement resolution dependant on the number of discrete tactile elements. S. Palit has reported the development of a new broadband microstrip antenna. A significant breakthrough in bandwidth enhancement has been achieved by optimizing the antenna's dimensions, substrate materials, substrate thickness, aperture dimensions and by positioning a thin conductor at a particular angle as a reflector to stop the back radiation. Ian Platt and Ian Woodhead have introduced a new configuration of Bragg gratings within an optical fibre to improve strain measurement resolution and accuracy. They have described the geometry, together with the research direction currently being undertaken to produce a commercially viable micro-displacement sensor suitable for a number of architectural and engineering application.

We are very happy to be able to offer the readers of the SENSORS & TRANSDUCER JOURNAL such a diverse Special Issue both in terms of its topical coverage and geographic representation. We do hope that the journal readers will find it interesting, thought provoking, and useful in their research and practical engineering work.

We would like to extend our wholehearted thanks to all the authors who have contributed their work to this Special Issue.

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Subhas Chandra Mukhopadhyay graduated from the Department of Electrical Engineering, Jadavpur University, Calcutta, India, in 1987 with a Gold Medal and received the Master of Electrical Engineering degree from the Indian Institute of Science, Bangalore, in 1989, the Ph.D. (Eng.) degree from Jadavpur University, in 1994, and the Doctor of Engineering degree from Kanazawa University, Kanazawa, Japan, in 2000.

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He was with Kanazawa University as a Researcher and an Assistant Professor until September 2000. In September 2000, he joined the School of Engineering and Advanced Technology (SEAT), Massey University, Palmerston North, New Zealand, as a Senior Lecturer, where he is currently working as an Associate Professor. He has published 180 papers in different international journals and conferences, co-authored a book and a book chapter, and edited 11 conference proceedings, books and journal special issues. His fields of interest include electromagnetics, control, electrical machines, and numerical field calculation. Dr. Mukhopadhyay is a Fellow of IEE (U.K.). He is an Associate Editor of the IEEE SENSORS JOURNAL. He is on the Editorial Board of the *e-Journal on Non-Destructive Testing, Sensors and Transducers* and *Transactions on Systems, Signals and Devices* (TSSD). He is on the Technical Program Committee of the IEEE Sensors Conference, the IEEE IMTC Conference, and the IEEE DELTA Conference. He was the Technical Program Chair of ICARA 2004 and ICARA 2006. He was the General Chair of ICST 2005 and ICST 2007 Conference (icst.massey.ac.nz).



Gourab Sen Gupta received the Bachelor of Engineering degree in electronics from the University of Indore, Indore, India, in 1982 with a Gold medal and the Master of Electronic Engineering degree from the University of Eindhoven, Eindhoven, The Netherlands, in 1984. From 1984 to 1989, he was a Software Engineer with Philips India in the Consumer Electronics Division. He is a Senior Lecturer in the School of Engineering and Advanced Technology (SEAT), Massey University, New Zealand. He has 5 years of industrial and 19 years of teaching and research experience. He has published over 70 papers in international journals and conference proceedings, co-authored two books on programming, and edited eight conference proceedings and journal special issues. His areas of interest include robotics, vision processing for real-time applications, sensor integration, embedded systems, and programming.

He has been on the Technical Program Committee of several international conferences.

Mr. Sen Gupta was the General Chair of ICARA 2004 and ICARA 2006 (icara.massey.ac.nz). He was the Technical Program Chair of ICST 2005 and ICST 2007 Conferences (icst.massey.ac.nz).

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In addition, some special sponsored and conference issues published annually.

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- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

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