Sensors

Advancements in Modeling, Design Issues, Fabrication and Practical Applications
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This special issue titled “Sensors: Advancements in Modeling, Design Issues, Fabrication and Practical Applications” in the book series of “Lecture Notes in Electrical Engineering” contains the invited chapters from experts working on different sensors related research in different parts of the world. A total of 19 chapters are presented in this book.

The first group of six chapters are on electromagnetic sensors. In the first chapter, Christian Schott and Samuel Huber have described modern CMOS Hall sensors with integrated magnetic concentrators which have dramatically enhanced magnetic field measurement performance. Michael Haji-Sheikh has described commercial magnetic sensors both Hall and anisotropic magneto-resistors in the second chapter. Pavel Ripka in the third chapter has described techniques for improvement of the accuracy of magnetic sensors. Many of these ideas can be used for other types of sensors and measurement systems in general. Sensors may use the attenuation, velocity and electrical dispersion of electromagnetic waves as a direct or intermediate step in the transduction process. Ian Woodhead is his chapter has discussed the modelling of the sensor response which provides the means to predict its spatial and temporal sensitivity and accuracy. In his chapter, Mustapha Nadi has briefly reviewed and discussed metrological aspects relating to electrical characterization of biological tissues. Experimental results obtained on different kinds of biological tissues (blood and bone) are presented and discussed as examples according to the influencing constraints specific to their physiological nature. V. Kasturi and S. C. Mukhopadhyay have reported a sensing system to improve the tanning process of sheep skin to produce better quality leather. The dielectric properties of the sheep skin are measured using a sensor system based on an interdigital sensor. Once the skin is converted into leather the process cannot be reversed. Over-treatment of the sheep skin can damage the quality of leather or inadequate tanning may not yield the desired level of quality, so it is important to know the appropriate tanning process required for the skin.

The second group contains three papers on fibre optic/optical fibre sensors. Andrea Cusano and his group has overviewed the most relevant milestones of the
technological evolution of Fiber Bragg Gratings Evanescent Wave Sensors in thirty years from the discovery of Kenneth Hill in 1978. They have also reviewed the advancement in the area of FBGs evanescent wave sensors as valuable technological platforms for chemical and biological applications. The emphasis have been placed on principles of operation, technological developments and overall performances discussing perspectives and challenges lying ahead. In the next chapter Jesus M. Corres and his colleagues have attempted to approach the fibre optic humidity sensing technology to scientists unfamiliar with the field. They have presented a general review of this type of sensors with emphasis in the techniques based on nanostructured coatings. These devices have been classified according to the sensing mechanism and taking also into account the different methods of fabrication and the sensing materials they are based on. Elfed Lewis and his group have reported the development an optical fibre based system capable of monitoring the presence of exhaust gas emissions and measuring their temperature on line in the exhaust system of a modern vehicle. There exists at present no commercial sensor, which is capable of providing online measurements of these exhaust gases as required by European legislation. The design of this sensor using low cost and compact optical components, which make it suitable for operation on board a vehicle, has been discussed.

The next two chapters are in the category of wireless sensors. Ray Huang and his group have reviewed some of the fundamental mechanisms of wireless sensor networks including their architecture, topology, data integration, routing techniques, and applications. Sensor network applications include both military and civilian monitoring in both rural and urban environments. Wireless sensor networks hold great potential for improving control, conservation, convenience, efficiency, reliability flexibility, and safety in network environments. In the next chapter Md Abdur Rahman and his colleagues have described the essence of a generic transport layer of a MultihopWireless Sensor Network (WSN). The transport layer of the Internet handles the congestion generated due to the network traffic and the end-to-end reliability of individual packets. Similar to the Internet, many WSN applications require a congestion control mechanism to regulate the amount of traffic injected within the WSN to avoid packet loss and to guarantee end-to-end reliable packet/event delivery. WSN researchers thus argue the presence of a transport layer for WSN similar to the Internet.

The following two chapters are on sensors for tracking and navigation. In his chapter Maki Habib has reported the development of a real time 3D sensor system and a new concept based on space decomposition by encoding its operational space using limited number of laser spots. The sensor system uses the richness and the strength of the vision while reducing the data-load and computational cost. The chapter presents the development and implementation of an intelligent 3D Fiber Grating (FG) based vision-system that can monitor and track human being status in real time for monitoring purposes to support wide range of applications. The 3D visual sensor is able to measure three-dimensional information with respect to human, objects and surrounding environment. The sensor system consists of a
CCD camera, a laser spot array generator (constitutes: laser diode and driver, lens, fiber gratings and holder), and a processing unit with alarm facilities and interfacing capabilities to a higher-level controller and decision-making along with a user-friendly interface. The system works by projecting a two-dimensional matrix of laser spots generated through two perpendicularly overlaid layers of FGs. In the next chapter W.Y. Chung and his group have developed a three Dimensional Navigation Viewer (3DNV), a convergence of location-aware application and three-dimensional (3D) graphics technology for a 3D visualization of location-aware information. The system allows visualization of situational information in a complete, 3D model of indoor environments equipped with instantly updated route results, synchronized with physical world. The approach is validated via indoor context-aware technologies, Cricket and Received Signal Strength Indication (RSSI). The overall results provide a valuable insight into the novel integration approach between 3D graphics standard, Virtual Reality Modeling language (VRML) and indoor location-aware systems.

In his chapter Ikuo Ihara has discussed the fundamentals of ultrasonic sensing techniques that can be used in the various fields of engineering and science. He has also included some advanced techniques used for non-destructive evaluations. At first, basic characteristics of ultrasonic waves propagating in media are described briefly. Secondly, basic concepts for measuring ultrasonic waves are described with introductory subjects of ultrasonic transducers that generate and receive ultrasonic waves. Finally, specialized results demonstrating the capabilities of using a buffer rod sensor for ultrasonic monitoring at high temperatures are presented.

In their chapter Nedeljko Cvejic and his group have presented a novel multi-modal image fusion algorithm using the Independent Component Analysis (ICA). Region-based fusion of ICA coefficients is implemented, in which the mean absolute value of ICA coefficients is used as an activity indicator for the given region. The ICA coefficients from given regions are consequently weighted using the Piella fusion metric in order to maximise the quality of the fused image. The proposed method exhibits significantly higher performance than the basic ICA algorithm and improvement over the other state-of-the-art algorithms.

In the next chapter G. Sen Gupta and his colleague have described a technique to significantly increase the speed of image processing for robot identification in a global-vision based system, targeted at real-time applications. Of major significance are the proposed discrete and small look-up tables for Y, U and V color thresholds. A new YUV color space has been proposed which significantly improves the speed of color classification. The look-up tables can be easily updated in real-time and are thus suitable for adaptive thresholding. The experimental results confirm that the proposed algorithm greatly improves the performance of the image processing system. The results are compared with other commonly used methods such as a composite look-up table which is indexed using RGB pixel values.
In their chapter Sajal Chandra Banik and his group have proposed approaches to multi-robot task allocation and cooperation in a chronological way such that they can be studied and compared for future development with affection based augmentation. In respect of some drawbacks (like high communication overhead, dead lock, etc.) with the existing approaches, they have presented the affection based task allocation and cooperation that has been used for a very few cases. They have also presented the complexity of the affective method and give some hints to compensate the complexity problems.

H. Wakiwaka has described a displacement sensor using magnetostrictive wire. It is a sensor which estimates the displacement from propagation time of an elastic wave that is caused and detected by using the magnetostrictive effect and the inverse-magnetostrictive effect. This sensor can be used for measurement up to 60 meters in simple structure, therefore it is appropriate for industry applications. Various methods for reducing the hysteresis error has been proposed.

In the last chapter G. Chattopadhyay has provided an overview of the state-of-the-art of submillimeter-wave sensors for a variety of space-borne applications and their performance and capabilities. Most of the radiation in the Universe is emitted at wavelengths longer than 10 m (30 THz), and this peaks at about 100 m (3 THz), excluding the contributions from the cosmic microwave background (CMB). Radiation in these wavelengths highlights warm phenomena, processes of change such as star formation, formation of planetary systems, and galaxy evolution; atmospheric constituents and dynamics of the planets and comets and tracers for global monitoring and the ultimate health of the earth. Sensors at far-infrared and submillimeter wavelengths provide unprecedented sensitivity for astrophysical, planetary, earth observing, and ground-based imaging instruments. Very often, for a spaced based platforms where the instruments are not limited by atmospheric losses and absorption, the overall instrument sensitivity is dictated by the sensitivity of the sensors themselves.

We do hope that the readers will find this issue interesting and useful in their research as well as in practical engineering work in the area of modern sensors and sensing technology. We are very happy to be able to offer the readers such a diverse special issue, both in terms of its topical coverage and geographic representation.

Finally, we would like to whole-heartedly thank all the authors for their contribution to this issue.

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