Guest editorial

Comprehensive sensor technologies in non-destructive testing and monitoring

The digitisation of the global economy requires quick decision-making by non-destructive testing (NDT) and/or non-destructive evaluation (NDE) experts, to maintain their position in the development of new, unique technologies and materials. In the context of fourth industrial revolution, characterised by increasing intensification of the use of information technology, the development of more advanced integrated sensor systems and technologies is required.

In this special issue, the main trends for the development of sensors for control and monitoring of complex systems, including biomedical objects are considered. It consists of 11 papers selected from 23 submitted.

The focus of the special issue is mainly on the following three topics:

1 innovative methods of NDT and NDE, sensor arrays and multi-sensors;
2 biomedical sensors for health monitoring; and
3 artificial intelligence (AI) and machine-learning technologies in sensor data processing.

Five papers are devoted to the first topic. One of them describes a portable infrared (IR) thermographic detector for detecting hidden corrosion in metallic objects, such as above-ground tanks, pipes and containers. The authors show that the IR thermographic techniques are convenient for detecting material losses up to 15%–20% in uniformly painted steel shells with thickness up to 8 mm. The next paper investigates spectral sensitivity characteristics of newly proposed pyroelectric sensors based on tetraaminodiphenyl film for wavelengths from 0.4–10 μm to 300–3,000 μm. The pyroelectric sensor can be used in visible, IR and terahertz spectral ranges in spectrometers in industry for operational control of terahertz radiation sources, as well as in terahertz security systems. The third paper gives a solution to the urgent problem for developers of MEM gyroscopes and accelerometers regarding the critical dependence of the Eigen frequencies of elastic suspensions on temperature when using substrates for sensors made of dielectric materials, such as borosilicate glass. The fourth paper is about displacement measurement in large-scale structures (such as excavation walls) as one of the most important applications of close-range photogrammetry, in which achieving high precision requires extracting and accurately matching local features from convergent images. The fifth paper, the last on this topic, proposes a new design of a microwave radiometer as part of mobile sensor systems with self-contained power supplies. The instrument can be used to improve radio-thermal images of earth's surface and high-resolution sensing of ice-sheet structures.

The topic on biomedical sensors for health monitoring includes four papers. The first one provides an analysis of electrophysiological signals recorded by specially designed nanosensors. Data are simultaneously obtained from electrocardiogram (ECG), electroencephalogram and galvanic skin response during tests on volunteers using neutral questions and questions that cause excitement. As a result, the reliability of psychophysiological studies can be improved. The second paper is devoted to capacitive coupling electrodes with the ability to monitor the quality of skin–electrode contact in ECG diagnosis. Experimental identification of distortions contributing to the recorded ECG signals for various disturbances of the skin–electrode contact is investigated. These sensors can be used in both personalised medical devices and tele-ECG devices. The third paper studies the effect of size, material and shape of metal nanoparticle on performance of fibre surface plasma resonance sensor. Metal nanoparticles are used to enhance sensitivity of refractive index sensing, which is important for the evaluation of liquid materials, optical components and biosensing. The fourth paper discusses the possibility of ultrasonic intensification of drug dissolution of cholesterol calculi of the gallbladder using conventional ultrasound frequency and intensity from 0.1 to 0.5 W/cm^2.

Finally, the third topic includes two papers. The first of them considers monitoring of friction temperature rise of mechanical brakes using the fusion of multi-source information and AI technology. The authors show that fusion-monitoring model based on support vector machine is more accurate than that of artificial neural network. The second paper provides a method for improving the accuracy of smart sensors (deemed digital measuring instruments) by organising combined measurements and processing their results using the parametric adjustment method at heterogeneous dispersion of the random error of the applied regression model.

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