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Special Issue on Measurement Systems, Sensors and Energy Harvesting

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I. INTRODUCTION AND SCOPE

The increasing demand for efficient, reliable, and sustainable monitoring systems has driven research in the areas of measurement systems, sensors and energy harvesting. New sensors enable real-time monitoring of physical and environmental conditions with efficient measurement systems. The integration of these technologies has the potential to enhance system performance, reduce operating costs, and improve maintenance processes. This special issue is devoted to state-of-the-art modelling, data processing and condition monitoring methods for applications ranging from Industry 4.0 to environment monitoring, enabled by the Internet of Things (IoT). The guest editorial would like to thank all the contributing authors for making their research outputs publicly available via this special issue. Thanks are also extended to reviewers for their valuable comments for improving the quality of the submitted articles. We also would like to thank the journal's production teams and editorial board for their assistance with the special issue.

II. REVIEW OF TOPICS ADDRESSED

A summary of the topics and papers included in this special issue is presented in this section.

A. MAPOD ANALYSIS IN EDDY CURRENT TESTING OF FLAWS CONSIDERING MULTIPLE RESPONSE SIGNALS AND MULTIPLE FLAW PARAMETERS

This paper considers multiple response signals and multiple flaw parameters to perform probability of detection (POD) for eddy current testing (ECT). The flaw length, the flaw depth, the coil impedance and the magnetic flux density are comprehensively studied under various lift-off distances. A finite element model (FEM) of ECT is established and verified with experiments to obtain sufficient simulation data for discrete POD modelling. The continuous POD function is then fitted based on the discrete values to show the superiority of integrating multiple factors. A comparison with conventional POD analysis further demonstrates the higher reliability of ECT flaw detection considering multiple flaw parameters and multiple response signals, especially for small flaws.issue.

B. DEVELOPMENT OF LONG-RANGE, LOW-POWERED AND SMART IoT DEVICE FOR DETECTING ILLEGAL LOGGING IN FORESTS

This paper proposes the use of long-range, low-powered, and smart Internet of Things (IoT) nodes for detecting illegal logging in forests. The research framework involves developing IoT devices for forest sound classification and transmitting each node's status to a cloud server. The key issues addressed in this work include sensor and board selection, an ensemble network consisting of Long Short-Term Memory (LSTM) and Convolutional Neural Network (CNN) model development for audio classification, TinyML implementation on a microcontroller, choice of communication protocol, gateway selection, and power consumption optimization. The model outperforms LSTM and CNN models when used independently and also gave 88% accuracy after quantization. Notably, this solution demonstrates cost efficiency and high potential for scalability.

C. STRAIN-INSENSITIVE FIBER BRAGG GRATING COMPOSITE STRUCTURE FOR WIDE-RANGE TEMPERATURE SENSING

This paper reports on the design, fabrication, and temperature strain sensing performance of a fiber Bragg grating composite structure for surface mounted temperature measurements over a wide temperature range, with highly reduced strain cross-sensitivity. The fiber Bragg grating sensor is encapsulated in a polyimide tube filled with epoxy resin, forming an arc-shaped cavity. This assembly is then placed between two layers of glass fiber prepreg with a flexible pad in between and cured into shape. Experimental results, supported by finite element simulations, demonstrate an enhanced temperature sensitivity is 26.3 pm/°C over a wide temperature range of –30 °C to 70 °C, and high strain transfer isolation of about 99.65%.

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D. ATTRIBUTE-DRIVEN FUZZY FAULT TREE MODEL FOR ADAPTIVE LUBRICANT FAILURE DIAGNOSIS

This paper develops an attribute-driven adaptive lubricant diagnosis method for equipment condition monitoring. A fuzzy fault tree (termed FFT) based model is constructed to correlate monitoring indicators to attributes including physic-chemical, contamination, and wear. Inference rules are integrated to mitigate conflicts arising from the reverse degradation of multiple indicators. The model is dynamically optimized with lubricant analysis knowledge and monitoring data. For verification, the developed model is tested with lubricant samples from both the fatigue experiment and actual aero-engines. Fatigue experiments reveal that the proposed model can improve the lubricant diagnosis accuracy from 73.4% to 92.6% compared with the existing methods. While for the engine lubricant test, a high accuracy of 90% was achieved.

E. VISION-BASED DYNAMICS MONITORING (VDM) FOR DIAGNOSING THE VARIATIONS OF WIND TURBINE TOWER FOUNDATION CONDITIONS

This paper aims to investigate wind turbine tower foundation variation dynamic monitoring based on machine vision. Machine vision monitoring is a kind of non-contact measurement, which help to realize comprehensive diagnosis of early foundation uneven settlement and loose faults. The finite element model is firstly investigated as the theoretical foundation to investigate the dynamics of the tower foundation. Secondly, the Gaussian-based vibration detection is adopted by tracking the tower edge points. Finally, a tower structure with distributed foundation support is tested. The modal parameters obtained from the visual measurement are compared with those from the accelerometer, proving the vision method can effectively monitor the issues with tower foundation changes.

F. IDENTIFICATION OF STABILITY DOMAINS FOR FLOW PARAMETERS IN FUSED FILAMENT FABRICATION USING ACOUSTIC EMISSION

This study proposes a method to process the acoustic emission signal for monitoring the flow state in fused filament fabrication. Fast Kurtogram is applied upon the selected short impact signals to identify the frequency with the highest kurtosis for signal filtration. The results indicate that this approach significantly enhances processing speed and improves feature extraction capabilities. By correlating AE characteristics under various parameters with the quality of extruded raster beads, AE can monitor the real-time state of material flow. This study offers a concise and efficient method for monitoring the state of raster beads and demonstrates the potential of online monitoring of the flow states.