Special Issue on Information Management in Structural Health Monitoring

The future of aircraft and vehicle safety lies in the ability to effectively process all pertinent measured information and accurately predict the residual useful life of the structural components. Structural health monitoring (SHM) encompasses the process of integrating four critical steps: (a) physics-based model of the structure; (b) sensor technology and *in-situ*, non-destructive sensing methodologies; (c) information management techniques including damage detection, analysis, localization, and classification; and (d) residual useful life estimation algorithms. This process involves identification of potential damage scenarios for a structure, periodic observations of the structure using appropriate sensors, extraction of information-rich damage features from the measurements and analysis of the features to determine the health of the structure, and prediction of the health state of the structure at future critical times. As a result of this integrated process, SHM for damage detection has emerged into a necessity for the design and implementation of any new aircraft structural component as SHM can lead to reduced service intervals, low safety factors, and efficient designs. SHM applications are also not limited to aircraft and vehicles; they include systems from diverse areas such as circuit boards, water pipes, bridges, and biomechanical components.

It is envisioned that the future will allow for real-time updating and instantaneous feedback on the damaged state of a structure. As sensors and management of information from data collected from the sensors are critical parts of SHM, the development, modeling, and management of new smart materials that can be used as sensors will lead the path to the future of SHM. The success and efficacy of SHM for aircraft and space vehicles hinges on the smart use of advanced methods for processing massive amounts of heterogeneous data from multiple sources. Although massive amounts of data may be available, one of the key challenges is how to only employ the most appropriate data sources with relevant features. As a result, source and feature selection are challenging problems that require extensive research that can lead to efficient solutions.

Despite recent advances, there are still many challenges to overcome before SHM can be widely employed. A multidisciplinary research initiative (MURI) project, sponsored by the Air Force Office of Scientific Research, is currently underway at Arizona State University. The project is focused on SHM and prognosis of metallic aerospace structures, and the partner institutions are Virginia Polytechnic Institute, Johns Hopkins University, and University of Southern California. The MURI program has a diverse advisory board including members from the Air Force, Army, Navy, NASA, and industry; one member of the advisory board is Dr Charles Farrar from Los Alamos National Laboratories, who is serving as one of the guest editors for this issue.

This special issue is aimed to emphasize the importance of information management in SHM. Information management is a fundamental process during which sensor data, collected over the life of the structure, is used to determine the current physical condition of the structure. Information management spans several advanced topics, including data compression, data mining, feature extraction, and feature analysis for damage identification, localization, classification, and prognosis. Improvements in information management will lead to faster and more accurate diagnoses from which well informed cost and potentially lifesaving decisions can be made. There are eight papers published in this special issue. The work for two papers was supported by the MURI program, while the other papers were selected due to their relevance on the topic. Three papers present damage classification using data driven approaches; four papers present damage detection methods for different structures; and one paper presents a strategy for improving signal quality by removing environmental influences.

1045-389X/09/11 1269–2 $10.00/0 DOI: 10.1177/1045389X09337575

We hope that this special issue will enlighten the community on the latest advances and current needs of information management for SHM and broaden its applications, and that it will serve as the foundation for further advancement in this area of research.

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