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Special issue on Structural Health Monitoring of Civil Structures

Structural Health Monitoring, 2014; 13(4):345-346

Published version available via DOI: 10.1177/1475921714542895

Editorial
Special Issue on Structural Health Monitoring of Civil Structures

The ability to monitor structures over their lifetime in order to improve reliability and availability and reduce life-cycle costs is of vital important in many engineering fields. Structural Health Monitoring (SHM) is defined as a process of monitoring the performance and evaluating the state of health of structures based on measurements from on-structure sensing systems. SHM has attracted significant worldwide research efforts because it provides engineers and infrastructure owners a more reliable way to monitor structural conditions for preventing catastrophic failure. SHM also provides quantitative data for designing reliable structures. SHM stakeholders are investing in SHM as a viable technology for economically managing infrastructure assets, and there is a trend to install SHM systems on marquis structures, e.g. cable supported bridges in Hong Kong, Guangzhou TV Tower in Mainland China, Skarnsundet Bridge in Norway, and the new I35W bridge which was built to replace the old bridge that failed catastrophically leading to the tragic loss of life.

Realizing the importance of SHM, a group of researchers in Australia joined together to establish the Australian Network of Structure Health Monitoring (ANSHM) in 2009. The objectives of ANSHM are to promote and advance the field of SHM in Australia. The members of ANSHM include individuals or groups of individuals of Australian academic institutions, universities, industrial or research organizations with a serious interest in SHM. Through June 2014, it has attracted members from more than 20 organizations, including (in alphabetical order) Australia's Information Communications Technology Research Centre of Excellence (NICTA), Australian Road Research Board (ARRB), Commonwealth Scientific and Industrial Research Organization (CSIRO), Curtin University, Deakin University, Griffith University, James Cook University, Monash University, Opus International Consultants, Queensland Department of Transport and Main Roads, Queensland University of Technology, Rockfield Technologies Australia, The Roads and Maritime Services of New South Wales, University of Adelaide, University of Melbourne, University of New England, University of New South Wales, University of Newcastle, University of Southern Queensland, University of Technology Sydney, University of Western Australia, University of Western Sydney, University of Wollongong, Victoria's Highway Department (VicRoads).

On 21 – 22 November 2012, ANSHM held its 4th annual workshop in Adelaide, Australia, hosted and supported by the University of Adelaide. On the basis of the high-quality presentations at the forum, the speakers were invited to submit enhanced and extended versions of their presentations for publication in a special issue of The International Journal of SHM. After a rigorous pre-screening by the executive committee of the journal, peer review and revision process, 10 papers were accepted for inclusion in the special issue.

Civil structures are usually large and contain many structural components. Most of these structures are unique, and hence, there is no single technique that can fulfil all essential requirements for SHM of these structures. This makes the development of SHM for civil structures particularly challenging. This special issue addresses a wealth of topics relevant to the SHM, covering both local and global approaches. A structural failure at a local safety-critical section could lead to catastrophic failure of structures. Mustapha et al. presented the use of guided ultrasonic waves generated by piezoelectric ceramics transducers to detect corrosion at rebar of reinforced concrete beams. Ng proposed a Bayesian approach to quantitatively identify damages in beam-like structures using guided ultrasonic waves. Instead of only pinpointing the multivariate damage characteristics, the uncertainty associated with the damage identification results was also quantified. Dackermann et al. demonstrated a supervised machine learning approach to detect damages in timber utility poles using damage feature extracted from guided ultrasonic waves. An autoregressive method was used to extract damage features in the study. In addition, Li and Hao proposed a damage identification method of a substructure using a wavelet domain response reconstruction technique. Different to the aforementioned damage detection approaches, this method detects damages on a substructure rather than targeting a single structural element.

The global approach is another attractive method for monitoring civil structures. K. Nguyen et al. presented a study of SHM for Sydney Harbour Bridge. A random project algorithm was used for dimensionality reduction on the measured vibration data and then a machine learning approach was used for damage detection. Bandara et al. proposed a damage detection method using frequency response functions (FRFs). The method employed the principal component analysis to reduce the dimension of the vibration data and an artificial neural network was then used for damage detection. Dackermann et al. proposed to use cepstrum-based operational modal analysis to determine FRFs from measured vibration data. Principal component analysis was applied to reduce the data size of the FRFs and then an artificial neural network was used to detect damages in structures. Ali and Ying presented an experimental study using an auto-regressive moving average with exogenous input (ARMAX) model to quantify the measured vibration data. An iterative self-fitting algorithm was proposed to construct and fit the ARMAX model for damage detection. T. Nguyen et al. presented a statistical damage identification method using the Mahalanobis squared distance. A controlled data generation scheme was proposed, which is based upon the Monte Carlo simulation method combined with several controlling and evaluation tools, to compensate for data shortages and improve computational stability, and hence, the reliability of damage identification using Mahalanobis squared distance. The proposed method was also fully validated using the field measured vibration data.

As the guest editors of this special issue, we would like to thank the authors who willingly submitted their high quality work to realize this special issue and all the anonymous reviewers who provide detailed and constructive review comments to the manuscripts submitted to this special issue. Finally, we would like to express our sincere gratitude to the Managing Editor and Editor for Special Issues, Douglas A. Adams and Victor Giurgiutiu. We also would like to thanks Monaz Gandevia, Mervyn S. George and Pooja Khatri from SAGE Publications for assisting the publication process. Finally, we would like to thank Associate Editor Xiaoming Wang for initiating the publications of this special issue.