Special Issue on Innovations in Structural Identification and Condition Assessment

Preface

Recently, structural identification of physical parameters of a structure has been highlighted due to its wide application in the field of structural health monitoring (SHM), including bridge rating, damage location identification and finite element model updating. Since physical parameters of a structure can be estimated directly through identification procedures, the estimated parameters are typically compared to design parameters of the structure to assess its damage severity, or utilized as inputs of special condition assessment methods. To inform readers cutting-edge technologies on structural identification and its application to the condition assessment of social infrastructures, the special issue on Innovations in Structural Identification and Condition Assessment was organized, and 13 papers were carefully selected for the special issue. These papers are the extension of papers presented at the mini symposium entitled 'Advances in Structural Identification and Condition Assessment' at the 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-6), 9-11 December 2013, Hong Kong, China. The special issue covers the following topics.

Structural identification algorithms: New algorithms for the identification of physical parameters of a structure are introduced. Xu and He identify physical parameters of substructures and external excitations with the limited number of response measurement, combining weighted adaptive iteration algorithm (WAI) and extended Kalman filter with weighted global iteration (EKF-WGI). Nagarajaiah and Yang extend their work on time-frequency independent component analysis for output-only modal identification of nonproportionally damped structures by separating a measured structural response into multiple modes. Zhang *et al*. utilize multiple-reference impact test data to identify structural flexibility of a structure, which shows the possibility that the identified result can be used in the prediction of structural deflections under any static loading test.

Damage detection: One of the prominent application areas of structural identification is damage detection. In this special issue, a number of damage detection techniques are introduced. Liu *et al*. propose a new structural time-varying damage detection method by adopting invertible synchrosqueezing wavelet transform to extract the instantaneous frequencies of damaged structure, and defining a new damage index based on the extracted information. Yang *et al*. develop an impedance measurement system which performs excitation and sensing a MFC based on wireless data transmission, and utilize the system to detect pipe corrosion and bolt-loosening under temperature variation. They verify the performance of the proposed technique through lab-scale tests using carbon steel elbow pipes. Wang *et al*. propose a damage detection technique based on the nonlinearity of a structure. To assess the nonlinearity, analytical mode decomposition (AMD) and Hilbert transformation are utilized, and a structural response is decomposed into intrinsic mode functions (IMF), from which rapidly-varying instantaneous frequencies are eliminated by integration with respect of time. Li *et al*. apply power spectral density transmissibility into structural damage identification by deriving a formulation which shows a relation between two auto-spectral density functions of output responses. Using acceleration response measurements in the damaged state, the damage identification is conducted by a dynamic response sensitivity-based model updating method. Zhu *et al*. combines genetic

algorithm (GA) and artificial neural networks (ANNs) to develop a two stage structural damage identification procedure. After establishing modal strain energy index (MSEI), the method extracts the flexural stiffness that as damage severity. Lei *et al*. develop a two-stage and two-step algorithm for the identification of structural damage and external excitation using extended Kalman filter. The two-stage approach enables to reduce the number of unknown variables in each step and in each stage identification and reduce computational burden.

Social infrastructure maintenance: The condition assessment system for social infrastructures is another spotlighted topic in SHM society. Teng *et al*. introduce the purpose and the detailed configurations of structural health monitoring systems installed at two real world structures – Shenzhen Vanke Center and Shenzhen Bay Stadium in China. Also, a new algorithm based on fuzzy pattern recognition and Dempster-Shafer evindence theory is proposed for stress identification using the limited number of strain gauges. Li *et al*. introduce a multi-scale finite element modeling method for static and dynamic analysis of a bridge and load resistance evaluation, which is used in the structural health rating system applied to Stonecutters Bridge, Hong Kong. Ji *et al*. develop a time reversal based pulse position modulation (TR-PPM) communication for the structural health monitoring of large concrete structure. In the proposed method, a piezoelectric aggregate pair transmits and receives single channel stress wave information within the concrete structure to resolve multipath channel dispersion.

Sensor placement: Yi *et al*. present a sensor placement optimization method based on the distributed monkey algorithm (DMA), and verify the effectiveness of the method through a numerical case study of a high-rise building. By adopting dual-structure coding and harmony search algorithm (HSA), the method find an optimal solution of sensor placement with a fast convergence.

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