Editorial

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1 Introduction

With the increasing age of civil infrastructures combined with the application of new technologies and materials, there is a need to derive knowledge about the actual condition of a structure, aiming not just at knowing that its performance may have deteriorated, but rather to be able to pinpoint the degradation location and more importantly to assess remaining performance levels and life. This has led to the development of the field of SHM and system identification (Carden and Fanning, 2004; Das et al., 2016). Due to inherent randomness, probabilistic methods must be applied, while considering all aspects of uncertainties arising from external loading, structural properties, etc. for better description and assessment of structural behaviour and health status during the service period.

2 Contributions

This special issue collected five outstanding papers covering various aspects of system identification and health monitoring of civil structures. A key focus of the present special issue is to highlight the contribution of probabilistic approaches in the relevant research field to better interpret the true behaviour and health status of structures during the service period via a variety of applications. In the following, the main scope and contributions of each individual paper included in this special issue are briefly summarised for the interested reader.

The first paper by Hu, Lam and Chung, 'Operational modal analysis and Bayesian model updating of a standing seam metal roofing system' investigates the issues of modal and model parameter identification with respect to a laboratory model of steel frame supported standing seam metal roofing. This study demonstrates the feasibility of quantifying the clip stiffness of this kind of structural model by utilising the Markov chain Monte Carlo (MCMC)-based Bayesian model updating method with the measured modal parameters extracted from the ambient vibration testing. The present research work is vital for the further development of a SHM system with dynamic measurement for metal roofing structural system under operational condition.

The second paper by Yang, 'An efficient method for Bayesian system identification based on Markov chain Monte Carlo simulation' develops an efficient MCMC-based Bayesian system identification approach by using time-domain data. System dynamic response is derived based on the modal superposition approach, and a multi-level sampling method based on the idea of simulated annealing is also developed to sample from the posterior probability density function (PDF) of the uncertain parameters, ensuring the efficiency of exploring the high-dimensional parameter space. The obtained results show the capability of the proposed method to handle globally identifiable as well as unidentifiable problems.

The third paper by Zheng, Zong, Liu, Niu, Zhou and Zhong, 'Multi-scale finite element model validation method of cable-stayed bridge based on the support vector regression' investigates the structural model updating problem of a large-scale bridge based on the developed two-phase multi-scale FE model updating approach. Also, the quantification and transmission of the uncertainty arisen from the model updating process is analysed by employing the support vector regression method. A validated multi-scale FE model is obtained by applying the method in a cable-stayed bridge with the long-term monitoring data acquired through the embedded SHM system, and can be further employed for the purpose of structural damage prognosis and safety prognosis.

The fourth paper by Huang, Shao and Yan, 'Fractal signal processing method of acoustic emission monitoring for seismic damage of concrete columns' studies the localisation and assessment of seismic damage of concrete columns by using a newly developed fractal theory-based acoustic emission (AE) signal processing approach. They found that both the curve lengths and fractal dimensions of AE signal were related with damage evolution, based on which a series of AE tests of pseudo-static experiment of three different concrete columns were conducted for validation. The results show that the damage can be localised approximately by assessing the diversity of damage assessing index values from distributed piezoelectric ceramic transducers.

The fifth paper by Mu, Guo, Zhang and Su, 'A parametric study of bridge load effect under stochastic vehicular load' focuses on the investigation of how the bridge load effect is affected by the stochastic vehicular load. By choosing two key parameters for characterising the properties of stochastic vehicular load, namely the probability of the existence of vehicle and the probability of random slowing down, the statistical relationship behind the these two parameters is clearly revealed by the Gaussian process regression approach, which is crucial for the reliability and life-cycle assessment of bridge structures in service period.

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