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Probabilistic Assessment of Structural Condition Incorporating Uncertainty of Measured Data through Multi-model Identification

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Abstract

This paper proposes a novel procedure of probabilistic assessment of structural condition by incorporating uncertainty of measured data. Multiple FE models are updated through the successive optimizations which use probability distribution functions representing uncertainty of the measured data. In addition, two *machine-learning* algorithms are implemented for probabilistic description and classification of the updated multiple FE models. Principal Component Analysis (PCA) method transforms the updated FE models onto the principal subspace. Accordingly, distribution feature is better represented. Next, Gaussian mixture model is used to identify probabilistic features of the updated FE models. Finally, the probabilistic information about structural condition is obtained by using the updated FE models and the identified probability models. The proposed procedure is demonstrated by applying to assessment of Yeondae Bridge, a 4-span continuous steel-box girder bridge in South Korea. Through the proposed procedure, distribution of rating factors, which represent the probabilistic information about structural condition, is estimated. Especially, clustering-based model selection procedure enables more reliable assessment of structural condition even when higher uncertainty of measured data is associated.

Keywords: Structural assessment; Measurement uncertainty; FE Model updating; Principal component analysis; Gaussian mixture; Load rating.

1 Introduction

The purpose of structural condition assessment is to diagnose its current state, to predict upcoming performance degradation, and ultimately to prevent gradual or sudden failure. Recent advances in structural health monitoring technology enable engineers to collect large amounts of measurement data of behavior of full-scale structures. For example, Seohae Bridge, a cable-stayed bridge with 470m main span located in South Korea, has operated a total of 183 sensors, which include accelerometers, displacement transducers, and strain gauges, to provide valuable long-term information of the bridge since it was opened for traffic in the year 2,000 [1]. However, such measurement data usually exhibit considerable variability due to

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