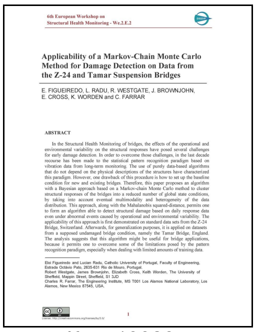

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Applicability of a Markov-Chain Monte Carlo Method for Damage Detection on Data from the Z-24 and Tamar Suspension Bridges

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ABSTRACT

In the Structural Health Monitoring of bridges, the effects of the operational and environmental variability on the structural responses have posed several challenges for early damage detection. In order to overcome those challenges, in the last decade recourse has been made to the statistical pattern recognition paradigm based on vibration data from long-term monitoring. The use of purely data-based algorithms that do not depend on the physical descriptions of the structures have characterized this paradigm. However, one drawback of this procedure is how to set up the baseline condition for new and existing bridges. Therefore, this paper proposes an algorithm with a Bayesian approach based on a Markov-chain Monte Carlo method to cluster structural responses of the bridges into a reduced number of global state conditions, by taking into account eventual multimodality and heterogeneity of the data distribution. This approach, along with the Mahalanobis squared-distance, permits one to form an algorithm able to detect structural damage based on daily response data even under abnormal events caused by operational and environmental variability. The applicability of this approach is first demonstrated on standard data sets from the Z-24 Bridge, Switzerland. Afterwards, for generalization purposes, it is applied on datasets from a supposed undamaged bridge condition, namely the Tamar Bridge, England. The analysis suggests that this algorithm might be useful for bridge applications, because it permits one to overcome some of the limitations posed by the pattern recognition paradigm, especially when dealing with limited amounts of training data.

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