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Application of a Model-Free Artificial Neural Networks Approach for Structural Health Monitoring of the Old Lidingö Bridge

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Abstract : Systematic monitoring and inspection are needed to assess the present state of a structure and predict its future condition. If an irregularity is noticed, repair actions may take place and the adequate intervention will most probably reduce the future costs with maintenance, minimize downtime and increase safety by avoiding the failure of the structure as a whole or of one of its structural parts. For this to be possible decisions must be made at the right time, which implies using systems that can detect abnormalities in their early stage. In this sense, Structural Health Monitoring (SHM) is seen as an effective tool for improving the safety and reliability of infrastructures. This paper explores the decision-making problem in SHM regarding the maintenance of civil engineering structures. The aim is to assess the present condition of a bridge based exclusively on measurements using the suggested method in this paper, such that action is taken coherently with the information made available by the monitoring system. Artificial Neural Networks are trained and their ability to predict structural behavior is evaluated in the light of a case study where acceleration measurements are acquired from a bridge located in Stockholm, Sweden. This relatively old bridge is presently still in operation despite experiencing obvious problems already reported in previous inspections. The prediction errors provide a measure of the accuracy of the algorithm and are subjected to further investigation, which comprises concepts like clustering analysis and statistical hypothesis testing. These enable to interpret the obtained prediction errors, draw conclusions about the state of the structure and thus support decision making regarding its maintenance.

Keywords : artificial neural networks, clustering analysis, model-free damage detection, statistical hypothesis testing, structural health monitoring
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