

## **Vibration Data Synthesis By Using Finite Element Analysis And Artificial Neural Network**

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The research on vibration-based structural damage detection methods via supervised learning methods has achieved remarkable results in recent years. However, those methods have an obvious limitation, that the acceleration data collected from the target structure in its damaged states are indispensable for training machine learning models. Actually, it is very difficult, or even impossible, to acquire sufficient data from the damaged structure in many cases. This is also the reason why most of the publications only demonstrated the effectiveness of the vibration-based damage detection methods on numerical simulation datasets or real structures with simulated damage. Meanwhile, the vibration data generated by using finite element (FE) analysis are not suitable to be directly used as training data, because these data are unrealistic compared to the measurement data. To address this problem, we proposed a method to synthesize realistic vibration data. The method requests both the vibration data collected from the real structure and the simulated vibration data generated by FE analysis. Then an artificial neural network is trained to project the vibration data from the space of FE analysis to the space of real structure through supervised learning. To validate the proposed method, experiments were conducted on an I-shaped steel beam. The quality of synthesized vibration data by the proposed method is analyzed. The merits and the limitations of the proposed method are also discussed.