Structural Health Monitoring Using Two Stage Algorithm Combines Non Model-Based and Model-Based Techniques

Mostafa Kamel Metwally Zidan ,M. AMIN;Mohamed Aboelseoud

Abstract

The aging of civil infrastructure and aerospace structures has led to an increased need to monitor the overall structural health. If growing damage not identified on time, it may has serious consequences, both safety related and economic. However, the complexity of large structures and the difficulty in accessing them makes the use of commonly existing conventional Non Destructive Evaluation (NDE) methods such as visual inspection and instrumental evaluation methods, impractical. An effective alternative in Structural Health Monitoring (SHM) is the use of methods that depend on Vibration-Based Damage Identification (VBDI) techniques. These methods use limited instrumentation to detect the changes in the measured modal characteristics of the structure, that is, its frequencies and mode shapes. These characteristics change with the physical properties of the structure (stiffness, mass and damping matrices) and can be used to help find the location and extent of damage. Optimal matrix update method is one of the VBDI algorithms that depends on finite element modelling (FEM) of the structure and is therefore referred to as model-based damage identification algorithm. The FRF differences method is also one of the VBDI techniques that depends on the directly measured frequency response functions data and is therefore referred to as non model-based or modal-based damage identification algorithm. However, VBDI algorithms still faces a number of challenges that have not been fully resolved. Some of these challenges are highlighted through modal tests designed to provide estimates of damage in a 3D eight-bay free-free frame. Details of tests on a healthy structure as well as on a structure in which predetermined damage has been introduced are presented. A proposed algorithm combining the aforementioned model-based and non-model based methods is introduced to improve the reliability of damage detection. The algorithm is first tested through numerical simulation to predicting damage on the basis of modal test data and the predictions are compared with the known damage.

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