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LOCALIZATION AND QUANTIFICATION OF LOCAL DAMAGE USING FREQUENCY CHANGES

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Abstract

Numerous vibration-based structural damage detection methods have been developed over the past decades. These methods are grounded on the fact that structural damage may cause changes in vibration characteristics. However, most previous model updating techniques adopt the Tikhonov regularization (or l_2 regularization) approach, which causes the damage detection solution distributed to many structural elements. However, this result does not match the practical situation in which damage usually occurs only at several locations.

This study utilizes the sparsity condition of structural damage and develops a new damage detection method based on the latest sparse recovery or sparse reconstruction theory. A novel l_1 regularized model updating method will be developed to identify sparse damage with the use of the first several natural frequencies. This process enables the structure of interest to be modeled with a relatively large number of elements, such that the local damage is directly represented by the stiffness reduction in the corresponding element. Thus, the damage index to be identified can be regarded as a sparse vector with several non-zero items at the damaged locations but with many zeros at others. One laboratory structure is employed to verify the proposed method. Such parameters as the number of damaged elements, severity of damage, number of frequencies, and uncertainty in measurements will be studied.

Keywords

Damage detection; frequency changes; sparse recovery; model updating; regularization.