

Damage Diagnosis of Bending Structures Using Support Vector Machine

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To reduce maintenance costs or extend the life of structures, a concept of Structural Health Monitoring (SHM) is attractive. Many methods for the structural health monitoring have been proposed for the purpose of maintenance cost reduction or performance guarantee of civil and building structures.

For the purpose of realizing practical SHM systems, many advanced sensors and system identification tools have been proposed. Therefore, it is not difficult to obtain the detailed health information of a structure if sufficiently many sensors are installed and good identification tools are available. However, it is not practical to assume experts are always available to explain the measured data. The budget available for a structural health monitoring system is usually very limited. If we assume an occasion of applying the system to a tall building, it would be unrealistic to say it is economically feasible to deploy several acceleration sensors to each floor for the monitoring purpose. Thus, automatic systems and innovative diagnosis mechanisms are necessary for SHM. In line with this scenario, the purpose of this research is to propose a system that can obtain the detailed damage information by installing the minimum number of sensors. The system is optimized to minimize the possibility of incorrect judgments.

Modal frequencies of a structure are used for pattern recognition in the proposed method. A natural frequency change associated with a certain mode does not provide the spatial information of structural damage. However, multiple natural frequency changes can provide the spatial information on the location of damaged stories. Typically only two vibration sensors on the roof and the ground detecting a single input and a single output for a structural system are needed to determine modal frequencies. Out of many pattern recognition tools, we propose to use Support Vector Machine (SVM). The SVM was recently proposed as a new technique for pattern recognition and is effectively utilized in the system to achieve this purpose. Based on the modal frequency changes, the damage location and its severity are defined by the SVM.

In our previous studies, it was shown that our proposed method worked very well for structures modeled by shear frames. However, this modeling is only appropriate for low-rise building structures and is not appropriate for tall buildings. Therefore, it is our purpose here to extend the method to bending frames that are appropriate models for tall buildings. In the analytical evaluation, we constructed the finite element models to represent bending structures. Then, we conducted a series of experiments for verification. We could show that the damage detection method using SVM was also effective for bending structures.



Figure 1: Experimental equipment

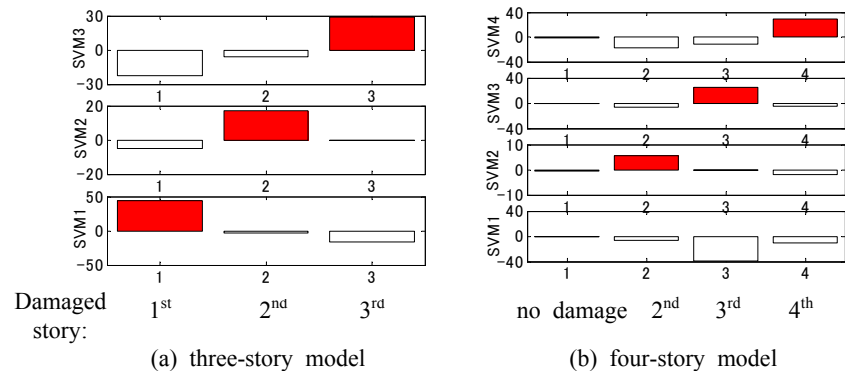


Figure 2: Outputs of updated SVM