Active Vibration Mitigation of High Modal Density of BLUM with Piezoelectric Patches

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Abstract

In this study, active vibration control of bladed drum (BLUM), which has a high modal density, with piezoelectric patches utilizing decentralized controller evaluated experimentally. BLUM has 76 protruding blades, which create 76 modes in a short interval of frequency named as high modal density. High number of modes in a very short frequency range makes mitigating them quite challenging. In this article, 76 collocated pairs of piezoelectric patches are used to damp the vibration of these modes. These modes relate to the displacement of the blades. Therefore, piezoelectric patches are used as sensor to measure the displacement of each blade. Then the collocated actuator piezoelectric patch applies a force in a reverse direction to reduce displacement of the blade, actively. In order to avoid to cause any disturbance for air flow around the blades, the piezoelectric patches are glued in the bottom groove of BLUM where there is no air flow. The blades of BLUM are inclined and in order to increase the performance of the system, the piezoelectric patches are produced in a trapezoidal shape which will increase the control authority of system. 76 Open loops are extracted and an IFF controller is designed to implement in a decentralized manner. 76 pairs of piezoelectric patches are glued on the structure and connected to the connector board. Also, a circuit is designed and produced based on the controller's transfer function to apply on the setup in a decentralized way. The 76 controller boards are connected to the connector board to control the structure's vibration. The structure is excited by the acoustic speakers in the frequency band which the first family mode exists. The structure displacement is measured by a laser vibrometer. The performance index of system shows that in the controlled condition all of 76 modes in the first family mode are damped remarkably.

Keywords: BLUM, Active Vibration Control, Decentralized Controller, Piezoelectric sensor/actuators, Family Mode, High Modal Density.