Decentralized Damping of Vibrations in 2D Frame Structures Using Controllable Nodes

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ABSTRACT

Extensive research efforts have been recently devoted to semi-active structural control [1,2] with its paradigms of smart self-adaptivity and low consumption of energy, which is used for local adaptation rather than to generate external control forces. Considered application areas include adaptive landing gears, seismic isolation systems, vehicle-track/span systems, power train electro-mechanical systems, damping of flexible space structures, vehicle crashworthiness, arctic engineering, wind turbines, etc.

A part of the research concerns semi-active management of strain energy for damping of structural vibrations. Early works considered truss structures with stiffness-switched bars [3]. They later evolved into either standalone one degree of freedom stiffness-switched dampers and isolators [4] or investigations in triggering modal energy transfer to highly-damped high-order modes, see, e.g., [5,6]. The latter researches seem all to study the fundamental vibration mode of a cantilever beam with two detachable layers and differ mainly in the actuator technologies; the main idea is to employ actuators for a quick release of the vibration-related strain energy.

This research extends the problem to general 2D frames. Controllable truss-frame nodes are incorporated into the structure. Thanks to their controllable ability to transmit moments, they allow for a quick transition between truss and frame modes. We propose a new, decentralized, closed-loop control strategy based on local energy measures. Vibration damping is more effective than in the previously studied control scheme based on a global energy measure, especially for higher vibration modes. Mitigation of vibrations will be presented in representative numerical examples, including a comparison to the global energy–based control strategy. Finally, results of experimental study, conducted on a structure analogous to the one from numerical simulations, will be demonstrated.

REFERENCES


