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Low-force Semi-active Damper Design for Small-scale Wireless Structural Control Experiments

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ABSTRACT

Semi-active actuators show considerable promise for structural control applications due to their inherent stability and the relatively large control forces that they can generate from relatively small input energies. The most recent generation of semi-active dampers includes very promising fluid-based damper technologies that, while limited in control force (relative to tuned- and active-mass dampers), are inexpensive enough to allow for the installation of large networks of such devices into a single structure, thus providing a robust and redundant control solution. Coordinating the efforts of such a network of actuators provides some challenge owing to the cost of installation of shielded signal and actuation cables. Wireless sensor technology can be used to alleviate this challenge, but research is required to demonstrate the effectiveness of wireless sensors in this application, as well as to optimize communication strategies between large numbers of widely spatially-decentralized control devices. This study presents the development and validation of a low-force magnetorheological (MR) damper that can be used for small-scale wireless semi-active control experiments. A fluid-extraction damper that mimics the non-linear stiffness and damping behavior of full-scale MR dampers, but outputs low- magnitude forces with minimal friction, has been developed and validated for this application. Using an array of similar small-scale dampers, wireless control algorithms can be validated experimentally on a MDOF test structure scaled to maintain a 1:1 time scaling factor with full-scale structures, thus allowing proper evaluation of the effects of the computational and communication delays that are inherent in wireless sensor networks.

KEYWORDS: *MR damper, wireless control algorithms, small scale experiments*