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ROBUST ADAPTIVE FEEDFORWARD VIBRATION CONTROL FOR FLEXIBLE STRUCTURE

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Abstract. *This paper investigates the feasibility of robust adaptive feedforward control for the vibration suppression of a smart flexible beam. The adaptive least mean square (LMS) feedforward control with sliding mode controller is developed. Finite element model of flexible beam is calculated. The developed adaptive control with sliding mode controller design is numerically verified on a flexible beam model, showing that it has better performance and robustness in vibration suppression with respect to the system parameter variations and external disturbance. Simulation verified the desired performance of the proposed designs and proved that the adaptive feedforward sliding mode control is an effective approach to the vibration reduction problems.*
Keywords: Sliding mode control, Adaptive feedforward control, Vibration suppression

1. **Introduction.** Smart structures with surface-mounted or embedded piezoelectric ceramic patches have received great attention in the vibration control of structures during these years. Vibration control has been a challenging problem for both academic and industrial researchers for many years. Many control theories and techniques have been employed in vibration control problems. Within the last two decades, much attention has been focused on active control of structures to suppress their structural vibrations. Active control methods can be used to damp out undesirable structural vibrations. Adaptive methods are used in active vibration control systems to automatically adjust the response of the controller to compensate for changes in the response of the plant.

Adaptive control can be divided into two categories: adaptive feedback control and adaptive feedforward control. A number of algorithms have been developed for implementations of adaptive vibration controllers. The most common adaptive algorithm is the Least Mean Square (LMS) algorithm. Elliott and Nelson [1,2] presented an algorithm to adapt coefficients of an array of finite impulse response (FIR) filters, whose outputs are linearly coupled to another array of error detection points to minimize mean square error signals. Clark and Saunders [3] summarized LMS algorithm and developed adaptive feedforward control system using filtered-X LMS algorithm. Tao and Kokotovic [4], Ioannou and Sun [5] developed adaptive control methods. Guigou, *et al.* [6] combined an adaptive structure and LMS algorithm to control transmitted vibrations from a machine to a receiving structure. Ma [7] proposed novel adaptive filtering algorithm and hybrid control scheme for vibration control of smart structures with bonded PZT patches.

Sliding mode control is robust control technique which has many attractive features such as good transient, fast response, easy realization, and insensitivity to the variation of plant parameters and external disturbance. The adaptive sliding mode control has the