

## Particle Swarm Optimization Based Vibration Suppression of a Piezoelectric Actuator Using Adaptive Fuzzy Sliding Mode Controller

**Authors :** Jin-Siang Shaw, Patricia Moya Caceres, Sheng-Xiang Xu

**Abstract :** This paper aims to integrate the particle swarm optimization (PSO) method with the adaptive fuzzy sliding mode controller (AFSMC) to achieve vibration attenuation in a piezoelectric actuator subject to base excitation. The piezoelectric actuator is a complicated system made of ferroelectric materials and its performance can be affected by nonlinear hysteresis loop and unknown system parameters and external disturbances. In this study, an adaptive fuzzy sliding mode controller is proposed for the vibration control of the system, because the fuzzy sliding mode controller is designed to tackle the unknown parameters and external disturbance of the system, and the adaptive algorithm is aimed for fine-tuning this controller for error converging purpose. Particle swarm optimization method is used in order to find the optimal controller parameters for the piezoelectric actuator. PSO starts with a population of random possible solutions, called particles. The particles move through the search space with dynamically adjusted speed and direction that change according to their historical behavior, allowing the values of the particles to quickly converge towards the best solutions for the proposed problem. In this paper, an initial set of controller parameters is applied to the piezoelectric actuator which is subject to resonant base excitation with large amplitude vibration. The resulting vibration suppression is about 50%. Then PSO is applied to search for an optimal controller in the neighborhood of this initial controller. The performance of the optimal fuzzy sliding mode controller found by PSO indeed improves up to 97.8% vibration attenuation. Finally, adaptive version of fuzzy sliding mode controller is adopted for further improving vibration suppression. Simulation result verifies the performance of the adaptive controller with 99.98% vibration reduction. Namely the vibration of the piezoelectric actuator subject to resonant base excitation can be completely annihilated using this PSO based adaptive fuzzy sliding mode controller.

**Keywords :** adaptive fuzzy sliding mode controller, particle swarm optimization, piezoelectric actuator, vibration suppression

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