Fuzzy-neural control for a magnetorheological elastomer vibration control system with sinusoidal excitations

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ABSTRACT

Recently, magnetorheological elastomer (MRE) vibration control method, with the advantages of low power consumption, good stability and adjusting parameters under the applied magnetic fields, has attracted more and more attention in engineering fields [1-4], such as civil structures, precision manufacturing and vehicle suspension. Control strategies play an important role in MRE vibration control system with fixed system structure [2-5]. There are ON-OFF control, a clipped-optimal control, Lyapunov-based control, sub-optimal H_∞ control and fuzzy control. Due to the independence of system model and strong robust, fuzzy control has been paid more concern. Howerver, fuzzy controller desinged in MRE vibration control system usually estimated the relationship of the feedback signals and controlled force, and was not describe the nonlinear function of controlled force and coil current accurately in real time control system, which made the limited vibration attenuation. Therefore, this paper presents the design method of a fuzzy-neural controller (FNC) for a MRE vibration control system with sinusoidal excitations to improve the vibration attenuation. A semi-active FC is designed to obtain the conrolled force based on the feedback signals of the relative displacement and absolute displacement of the isolation structure, then the BP neural network with good learning capability is employed to emulate the dynamic behaviours of output force of fuzzy controller, excitation displacement, velocity and controlled current applied to the coil in MRE isolator. The acceleration responses of the system with FNC are evaluated by physical experiments, the results indicate that the FNC could maintain satisfying control effect in the presence sinusoidal excitations and is also more optimal than conventional fuzzy controller (FC), the reason is that the neural network controller can approximate the nonlinear function relationship among the controlled force, excitation displacement, velocity and controlled current, but the function relationship is only considered as the linear function in conventional FC.

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