Active and Semi-active Vibration Control for Driver's Seat System in Automobile

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ABSTRACT

This thesis describes an active vibration control (AVC) technique and semi-active vibration control (SAVC) technique for reducing vibration in automobile driver's seat. The primary part describes an application of active controller for reducing vehicle seat small amplitude vertical vibration. Three different control structures are applied and compared in the experimental works. Apart from adaptive control and robust control, a hybrid control algorithm which is a combination of the adaptive controller with filtered-x least mean squares (FXLMS) algorithm and feedback structure with robust synthesis theory for obtaining the fast convergence and robust performance is proposed. A frequency domain technique is used for achieving the objective of system identification and controller design. All of the proposed AVC controllers are implemented in digital signal processor (DSP) platform, using finite impulse response (FIR) filter for real time control. The characteristic analysis and experimental comparison of three control algorithms for reducing the small amplitude vertical vibration of vehicle seat are also presented in this thesis. Furthermore, electrorheological (ER) fluids is one of the most favorite actuator materials used in smart materials and structures due to its fast, reversible, controllable and continuous change of rheological properties. An optimal electric field control and on/off control for ER fluids in squeeze mode with differential vibration source is presented. The proposed optimal controller is equivalent approaches based on the 2-norm (H2) principle for minimizing broadband vibration spectrum energy. On the side, the on/off controller is designed based on frequency counting technique for vibration attenuation performance in various frequencies. Both of the theoretical derivation and experimental investigation are conducted in present research work. In the theoretical derivation, the control strategies of fundamental ER squeeze mode and numerical simulation from model are presented. In the experimental work, the optimal controller is designed with an optimal damping coefficient and the on/off controller is implemented on a single-chip microprocessor. The results of experiment indicated that the proposed technique is effective in vibration control of squeeze mode ER fluids system.

Keywords : active vibration control, semi-active vibration control, automobile driver's seat, digital signal processor, electrorheological fluids.

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