Synopsis

Thesis Title : VIBRATION CONTROL OF STRUCTURES WITH MR DAMPERS USING BIO-INSPIRED CONTROL ALGORITHM

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The concept of structural control is gaining momentum in the recent past to dissipate energy from the earthquakes and reduce structural vibrations. Among the various control devices, semi-active control devices are proved to be more energy efficient than active devices and more effective in reducing seismic structural vibrations than passive devices. Semi-active devices are advantageous because they offer the adaptability of active control devices without requiring the associated large power sources, thus allowing for the possibility of effective response reduction during a wide-array of dynamic loading conditions. All these advantages leads to the structural vibration control using semi-active control as the prime research interest of the present work.

A semi-active control device is one that does not increase the mechanical energy in the controlled system (i.e., including both the structure and the device), but has properties that can be dynamically varied. Several such semi-active devices have been proposed for civil engineering applications. One such device magneto rheological (MR) dampers which use MR fluids to provide controllable damping forces, are gaining popularity over several other semi-active control devices for civil engineering applications. These devices have many attractive features such as low power requirements. Reliability, and are inexpensive to manufacture.

However, MR dampers are highly nonlinear devices whose dynamics are characterized by a hysteretic force-velocity response. Hence modelling of them becomes inevitable. The current work forces on using the MR Dampers in reducing the dynamic response of the structure during seismic loading. To better implement this, the characteristics study and modelling of MR dampers using modified Bouc-Wen model is carried out in this study. The model is developed using MATLAB / SIMULINK and simulation studies are carried out. The obtained results are compared with experimental results available in the literature for validation of the model.

Additionally, the systems where the MR Dampers are installed, are characterized by parametric uncertainties, limited measurement availability and unknown disturbances. The presence of all of these factors makes mandatory the use of complex control techniques in order to get a reliable performance of the control system. In this thesis, a new bio-inspired control algorithm, Brain Emotional Learning Based Intelligent Controller (BELBIC) which is based on the neurologically inspired computational model of limbic system of human brain is studied. The mathematical modelling of the algorithm is done using MATLAB / SIMULINK and performance studies are carried out.

The performance of BELBIC algorithm is investigated with the help of numerical simulations using MATLAB / SIMULINK for a SDOF and a MDOF system equipped with a

MR damper reported in the literature. The structures are subjected to a board spectrum of earthquake time histories like El-Centro, Northridge, Kobe and Spectrum compatible time history. The numerical results obtained for SDOF structure are compared with the fuzzy controlled structure and it is found that the BELBIC algorithm outscores the fuzzy controller. The results of MDOF structure using BELBIC controller are found to be superior then other traditional control algorithms such as Clipped optimal, Passive-off and Lyapnov algorithm. Hence it is found that the proposed BELBIC algorithm outperforms most other control strategies in vibration control of seismically excited building structure.