ABSTRACT

Song, Wei. Ph.D., Purdue University, August 2011. Dynamic Model Updating with Applications in Structural and Damping Systems: from Linear to Nonlinear, from Off-line to Real-time. Major Professor: Shirley Dyke.

Dynamic model updating is a technique to investigate the status of a structure by using dynamic information identified from structure vibrational data. By satisfying certain criteria, the dynamic properties of a mathematical model can be updated to match those from the measurements of a physical specimen. Based on the purposes of model updating, the updating criteria, the complexity of the structural models to be updated, and the types of dynamic information sought, model updating methods can be categorized into the following: i) linear finite element (FE) model updating using modal information, ii) nonlinear FE model updating using modal information based on a linearized model under certain operation conditions, and iii) nonlinear hysteretic model using time series data for real-time updating.

The focus of this dissertation is to develop the above three different updating methods and demonstrate their effectiveness in corresponding updating applications. Both linear and nonlinear hysteretic models are considered in the study. Numerical simulations are carried out for all the three model updating techniques to demonstrate the performance and efficacy of the updating techniques developed. Two sets of experiments are conducted in the lab, one set contains the real-time updating tests on magnetorheological (MR) dampers and another set contains the quasistatic cyclic test and real-time updating test using shake table on a steel shear building. The real-time feature is achieved by the latest high performance host-target environment enabled by xPC Target™, a product from MATHWORKS®. In addition to the development of the model updating techniques,

a power supply unit model and a nonlinear hysteresis model modified from Bouc-Wen model are proposed and successfully applied in the experimental study. The study conducted herein demonstrates that the model updating techniques developed can be effectively applied to various updating scenarios. The developed nonlinear hysteretic model updating technique is able to achieve hard real-time functionality, which can provide the most up-to-date assessment of the structure status. This technique also requires minimal data-buffer, and has potential to have a significant impact on nonlinear structural control applications.