DESIGN AND IMPLEMENTATION OF A SLIDING MODE CONTROLLER FOR A SEISMIC SHAKE TABLE

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Abstract

Shake tablesare effective tools for simulating dynamic behavior of structures exposed to seismic loads. The main core of a shake table is its control system. The aim of the controllerin a shake table is to track the displacement, velocity, and acceleration profiles of a realor scaled version of a predefined earthquake. On the other hand, shake table control problem faces uncertainties arose from unknown model parameters and unmolded dynamics. Furthermore, the shake table is designed to test various test structures with different inertias. Therefore, the moving mass of the table is an uncertain parameter which should be concerned in the controller design in order to attain optimal control performance. In this paper, a supervisoryrobust sliding mode controlleris proposed for controlling motions of a laboratory-scale seismic shake table. For this purpose, a model is developed for the shake table and is validated against experimental data. Furthermore, the controller is implemented in the shake table and its performance is evaluatedvia test data. The shake table test results prove effectiveness of the proposed controller at tracking seismic profiles in the presence of the uncertainties. At the same time, the chattering frequency is confined to an applicable range.

Introduction

Earthquake is a natural hazardwhich can lead to a disaster if the structures are not fortified enough to withstand it. In order examine dynamic behavior of structures when subjected to seismic loads, simulation or shake table test may be employed. Although simulation is a fast and inexpensive approach for analyzing dynamic behavior of structures, it may not make real sense in the designer. However, shake table provides the capability of testing a full-scale or reduced model of a real structure in order to measure performance of the structure in confrontation with a real earthquake. In recent years, shake tables have been employed widely to analyze and control various(Kim et al., 2006, Baratta et al., 2012, Wu and Samali, 2002, Lu and Jiang, 2011).

Shake table is a system which simulates seismic disturbances via emulating earthquake motions in laboratory scale. Shake tables, depending on their pay load, may utilize hydraulic or electric driving system. The hydraulic shake tables can generate huge loads and therefore they are suitable for test of heavy structures. On the contrary, the electric shake table which benefits from an electric motor, as the driver, is suitable for test of light structures.Since 1890, when Millen and Emory built the first shake table, seismic