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

Mehdi SOLEYMANI
Assistant Professor, Arak University, Arak, Iran
m-soleymani@araku.ac.ir

Bahador GHANBARI SINI
Graduate Student, Arak University, Arak, Iran
ghanbaribahador@gmail.com

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Shake tables are employed to simulate seismic excitations in laboratory scale. However, the pay load of a shake table is altering constantly during its operation life, as various structures with different mass and moment of inertia are placed and tested on it. These uncertainties may degrade proper tracking performance of the shake table. Therefore, in order to have an acceptable tracking, the shake table controller must tolerate parametric uncertainties imposed on the model due to load variations. Sliding mode control is one of the efficient approached employed for control of shake table in the presence of uncertainties. Astranv and Terza proposed a sliding mode controller for an electro hydraulic shaking table (Strano and Terzo, 2013). In this paper, in order to control the motion of an electric shake table in the presence of load variations, a new robust sliding mode controller is designed and implemented. The aim of this controller is reducing displacement, velocity, and acceleration tracking errors while the system is experiencing some degrees of uncertainties. Specifications of the shake table (Larza) are shown in Table 1. Figure 1 also depicts the shake table and the control system.

Table 1. Specifications of LARZA shake table

Specification	Value
Motor Type	AC permanent magnet synchronous motor
Motor Power	1 Kilowatt
Table Dimensions (B × L)	750 × 550 mm
Displacement (mm)	±90
Maximum Velocity (mm/s)	1000
Maximum Acceleration (g)	2
Maximum Payload (kg)	35
Ball-screw Lead (mm)	20
Acceleration Sensor	dual-axis MEMS accelerometer with a measurement range of ±1.7g
Displacement Sensor Resolution (μm)	5

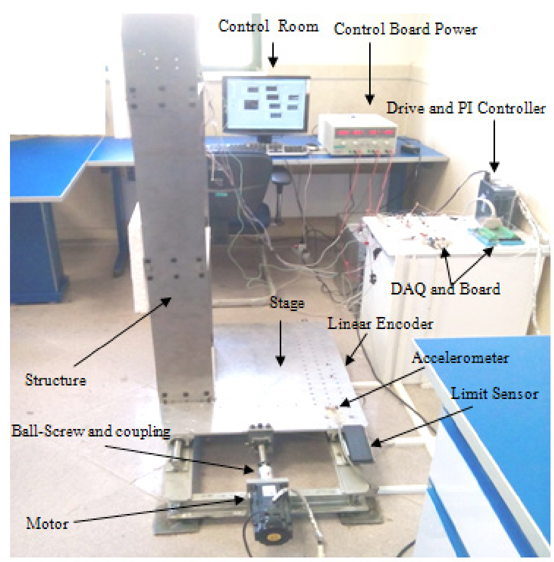

Figure 1. Main parts of shake table

The control scheme comprises two loops i.e. a PI central loop and a sliding controller as the supervisor. Figure 2 compares the performance of the proposed control approach with PI control method. As it is seen in this figure, application of the supervisory sliding control caused a considerable improvement in the tracking performance.

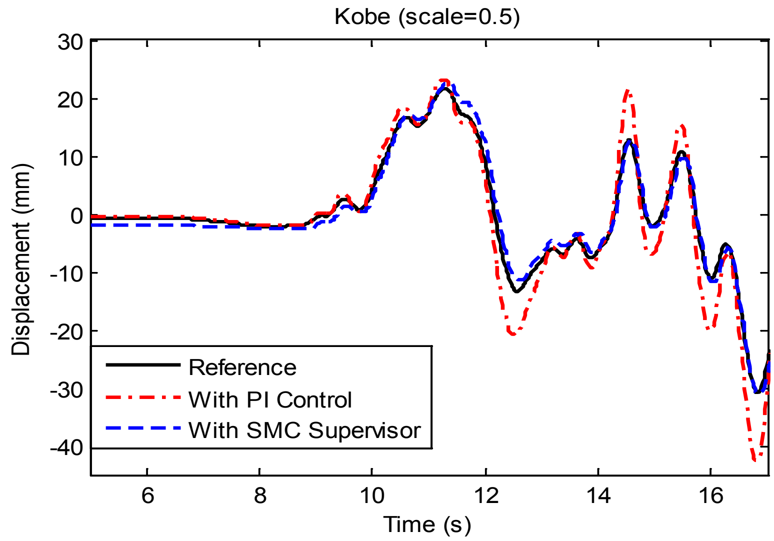

Figure 2. Displacement histogram of Kobe earthquake without uncertainties

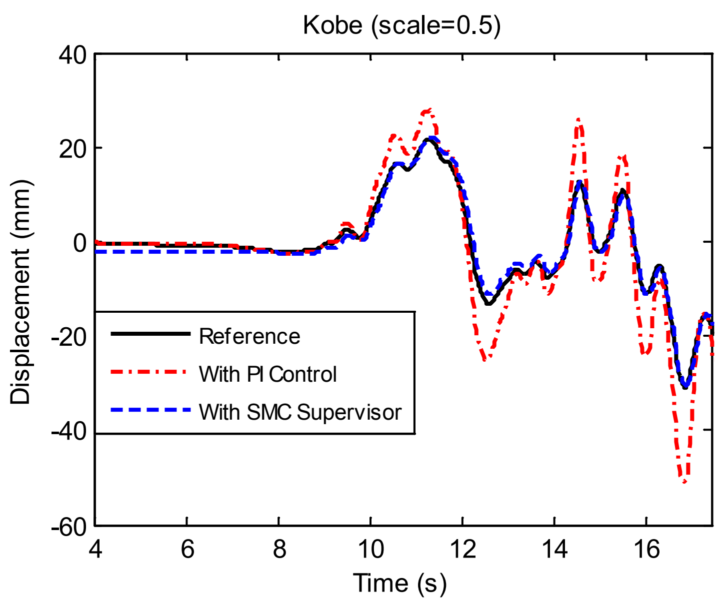

Figure 3. Displacement histogram of Kobe earthquake with uncertainties

Figure 3 on the other hand, depicts performance of the supervisory controller in the presence of mass uncertainty. As it is seen in this figure, the conventional PI controller cannot cope with uncertainty, as its tracking performance has been degraded when model is contaminated with uncertainty. However, the sliding controller can successfully tackle the uncertainty imposed on the model.

REFERENCES

Strano S and Terzo M (2013) A non-linear robust control of a multi-purpose earthquake simulator, *Proceedings of the World Congress on Engineering*, Vol. 3