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Servo control strategy for uni-axial shake tables using Long Short-Term Memory networks

*Pei-Ching Chen[1)] and Kui-Xing Lai [2)]

[1), 2)] Department of Civil and Construction Engineering, National Taiwan University of Science and Technology, No.43, Keelung Rd., Sec.4, Da'an Dist., Taipei City 106335, Taiwan
[1)] peichingchen@mail.ntust.edu.tw

ABSTRACT

Servo-motor driven uniaxial shake tables have been widely used for education and research purposes in earthquake engineering. These shake tables are mostly displacement-controlled by a digital proportional-integral-derivative (PID) controller; however, accurate reproduction of acceleration time histories is not guaranteed. In this study, a control strategy is proposed and verified for uniaxial shake tables driven by a servo-motor. This strategy incorporates a deep-learning algorithm named Long Short-Term Memory (LSTM) network into a displacement PID feedback controller. The LSTM controller is trained by using a large number of experimental data of a self-made servo-motor driven uniaxial shake table. After the training is completed, the LSTM controller is implemented for directly generating the command voltage for the servo motor to drive the shake table. Meanwhile, a displacement PID controller is tuned and implemented close to the LSTM controller to prevent the shake table from permanent drift. The control strategy is named the LSTM-PID control scheme. Experimental results demonstrate that the proposed LSTM-PID improves the acceleration tracking performance of the uniaxial shake table for both bare condition and loaded condition with a slender specimen.

[1)] Professor
[2)] Graduate Student