DECENTRALIZED SEMI-ACTIVE SEISMIC CONTROL USING FUZZY CONTROLLER

Amin KAVEI DEYLAMI
M.Sc. Student, School of Civil Engineering, University of Tehran, Tehran, Iran
amin_kavee@ut.ac.ir

Amir K. GHORBANI-TANHA
Assistant Professor, School of Civil Engineering, University of Tehran, Tehran, Iran
ghtanha@ut.ac.ir

Keywords: Decentralized Control, Semi-Active Control, Fuzzy Control, Tall Buildings, Seismic Control

There are many different methods to find required control forces or damping values to decrease structural responses due to seismic excitations by a one centralized controller. In tall buildings there are some additional problems like time delay and controller unreliability, because of the higher number of sensors, actuators or dampers. In this paper, a decentralized semi-active control algorithm is proposed. In decentralized control, the structural system is decomposed into several substructures. Different controllers are available each one dealing with one substructure to obtain control properties using a certain that may be different to other subsystems Control forces or natural characteristics modifications are applied just to the respective substructure. In present study, based on local substructure information, fuzzy controller calculates damping values for its subsystem. Each controller receives displacement and acceleration values of its floor as feedbacks and controls them. Controlling these values automatically results in decreasing of story drift and other useful values. The effectiveness of decentralized semi-active control algorithms is demonstrated through numerical examples. A model of building subjected to seismic excitations is developed and the dynamic responses are obtained in both uncontrolled and controlled cases by employing proposed decentralized control method. Moreover, the results for controlled case are compared to those obtained by using available decentralized methods to show the efficacy of the proposed algorithm.

In past researches decentralized control has been used in two main approaches. In First approach, unknown interconnection forces between adjacent subsystems are treated as a bounded disturbances with Gaussian nature, then by using a recursive estimator like Kalman filter, control forces or damping values and system states will be calculated based on optimal control theory. This approach is called Linear Quadratic Gaussian (LQG) (Loh and Chang, 2008; Lei et al., 2012). In second one, by designing a robust nonlinear controller like sliding mode control, system states like story's velocity and displacement will be determined with robustness to unknown subsystem interconnection forces values variation. It means variation of unknown system parameter has no effect in goodness of system responses (Rofooei and Monajemi-nazhad, 2006).

In this study, fuzzy controllers calculate the damping ratios based on information come from local substructure sensors without need to estimate states like first recent mentioned approach or any nonlinear control algorithms. We use if-then rules come from common available rules that being used for semi-active MR dampers, including mostly triangle and trapezoidal shaped if-then rules.

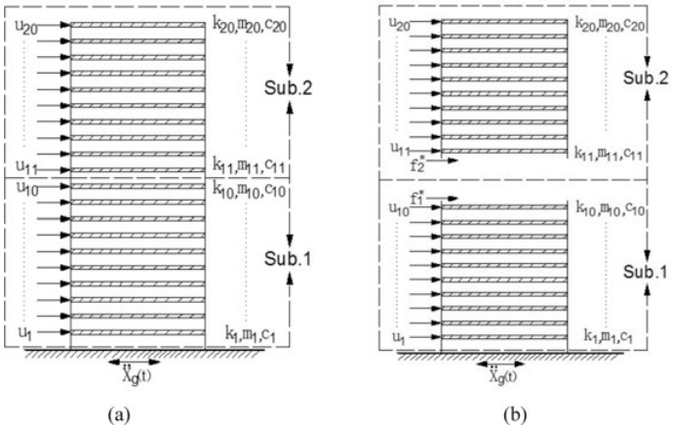

Figure 1. A sample decomposition of a structure to two substructures for decentralized LQG control (Lei et al., 2012)

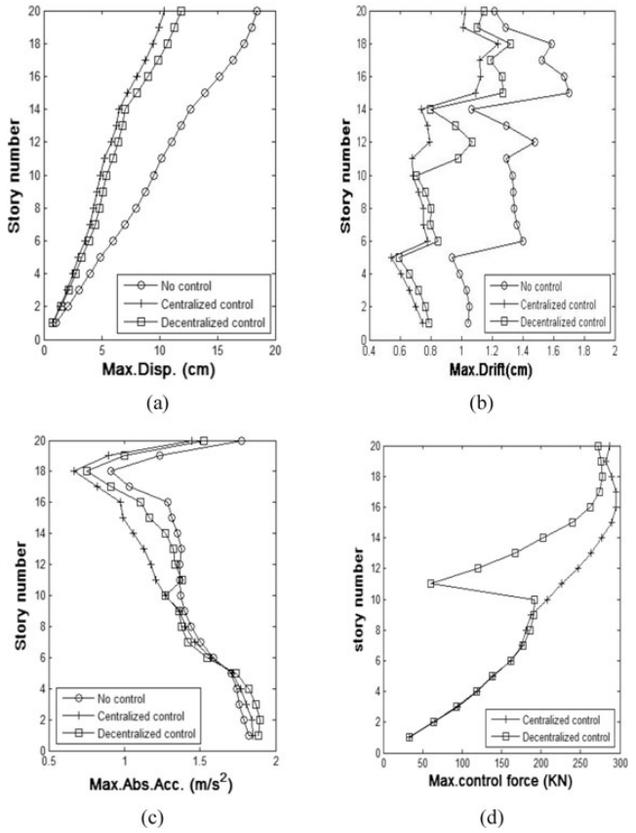

Figure 2. A Comparison of the decentralized and centralized controls (Lei et al., 2012)

REFERENCES

Lei Y, Wu DT, Jafari MK and Lin Y (2012) A Decentralized Control Algorithm for Large-Scale Building Structures, *Computer-Aided Civil and Infrastructure Engineering*, 27(1): 2-13

Loh CH and Chang CH (2008) Application of Centralized and Decentralized Control to Building Structure: Analytical Study, *Journal of Engineering Mechanics*, 134(11): 970-982

Rofooei FR and Monajemi-nazhad S (2006) Decentralized Control of Tall Buildings, *The Structural Design of Tall and Special Buildings,* 15(1): 153-170