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DECENTRALIZED OVERLAPPING CONTROL FOR CIVIL STRUCTURES

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Summary: The paper presents a decentralized overlapping active control design of decentralized overlapped LQG controllers for the earthquake-excited 20-story building structure of the second generation benchmark models proposed within the structural control community to design and compare control schemes.

Generally, decentralized control schemes offer numerous advantages when considering large-scale complex systems. When applying these schemes for controlling civil engineering structures these benefits may be summarized as follows: reduction of transmission costs within the feedback loop; increase of reliability of the control operation in case of sensor/actuator/controller failures; reduction of overall computational effort and the ability of parallel implementation in real time.

The height of the building suggests the overlapping decomposition of a finite element overall dynamic 2D model into two basic overlapped subsystems, each covering 12 stories. The stories between the 8th and 12th floors as well as their inter-story elements serve as the overlapping part in both proposed subsystems of the overall building structure. A new extension of the metodology originally proposed for a cable-stayed bridge includes the solution of more realistic problems for high fidelity 2D models of buildings. The novelty concerns: a) Decomposition-based placement of actuators; b) Analysis of incompletely failed local controllers; c) Evaluation of the overall closed-loop system performance for both the pre-earthquake model and the post-eqrthquake model.

First, the control design problem for is formulated in this paper. Then, the decentralized solution methodology based is proposed including the corresponding algorithms and simulations.

The idea of decentralization of control has been numerically tested in a MATLAB/SIMULINK simulation framework and compared to the benchmark sample centralized LQG control design. The robust performance of the decentralized overlapping control design has been assessed by means of given benchmark evaluation criteria, eigenvalue analysis and time responses.

The paper contributes with a new decentralized overlapping control design procedure resulting in the dynamics of the closed-loop benchmark model with the local controllers which exhibits an acceptable behavior though slightly worse than in the centralized case, however including the above benefits of the decentralized design of decentralized controllers.