Robust Active Control for Structural Systems with Structured Uncertainties

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Abstract: Although control theory has been widely applied to constrain motion response of tall, slender structures and long bridges undergoing large forces from natural hazards such as earthquakes and strong wind, numerous uncertainties in these structures such as model errors, stress calculations, material properties, and load environments need to be included in design of the control algorithm. This paper develops a robust active control approach to treat structured uncertainties in the system, control input, and especially, disturbance input matrices that have not been treated previously. Special SVD decomposition is applied to all forms of the structured uncertainties. Robust active control provides multi-objectives, including robust α-degree relative stability, robust H_∞ disturbance attenuation and robust H_2 optimality. The H_∞ norm of the transfer function from the external disturbance forces (e.g., earthquake, wind, and etc.) to the observed system states is restricted by a prescribed attenuation index δ. Settling time of the controlled structural system is robustly less than $4/\alpha$. Preservation of robust H_2 optimality of uncertain structural systems is also discussed. Numerical simulations of a four-story building under robust control are carried out for motion induced by the 1940 El Centro earthquake. Evaluation of controller performance is measured by application of six indices, including a comparison with an LQR controller. Results of the proposed approach may be applied to robust control design of structural systems.

Keywords: *Robust active control; structural systems; structured uncertainties; multi-objective;* H_∞/H_2 *optimality.*

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