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Sparse Feedback for Estimation in Wireless Structural Control

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ABSTRACT
Feedback structural control is an attractive option for seismic protection by adding a supplemental device that can adapt in real time to introduce damping or alter the stiffness of the structure appropriate for the loading and response of the structure. Typically, a complete set of measurements or states are not available, so the structural system states are estimated for feedback control. With centralized, wired control systems estimation performance and error can be determined and limited with proper assumptions of measurement and modeling error. However, with wireless sensor feedback systems, packet loss can lead to estimator and controller instability. Therefore, the estimator design and measurement feedback must account for packet loss to limit instability in a wireless control system. For wireless sensor networks to be used in large-scale control systems, these challenges with wireless estimation must be understood.

A sparse estimation design approach that weights the constant-gain estimator error covariance as well as measurement sparsity will be investigated on the wireless benchmark problem. The sparse estimation feedback structure highlights the most important measurements for state estimation without requiring a trial and error approach. Additionally, a sparse form allows the control system to operate at a faster sampling rate, which can help overcome packet loss. Finally, an approximation of the bounds on steady- state error covariance under packet loss will be compared with the benchmark simulation results. Ultimately, the closed-loop wireless estimation performance will be compared with a wired centralized system.

KEYWORDS: *Wireless structural control, sparse feedback, Kalman filter*