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ROBUST CONTROLLER FOR THE VIBRATION SUPPRESSION OF AN ACTIVE PIEZOELECTRIC BEAM

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Summary: Design and control of smart structures, which can perform optimally despite different environmental influences represents an important research challenge. Very often the optimality performance is influenced by the lack of robustness of mechanical systems due to unmodeled dynamics and external influences. In this paper we tackle the problem of a robust controller design for the vibration suppression of a smart beam with integrated active piezoelectric ceramic material in order to reach the desired robust stability. For this purpose a multi-objective robust control strategy is proposed for vibration suppression of a clamped-free smart beam with piezoelectric actuator and a laser vibrometer sensor in a Linear Matrix Inequality (LMI) framework which is capable of handling weighted exogenous input signals and provides desired pole placement and robust performance at the same time. Modeling of the beam is performed using the finite element approach for modal analysis, assuming the homogeneous material properties of the structure. A reduced order modal system is considered as the nominal model and the remaining modes are left as the multiplicative unstructured uncertainty. A robust controller with a regional pole placement constraint is designed based on the augmented plant composed of the nominal model and its accompanied uncertainty by solving a convex optimization problem. For designed control system the robustness of the uncertain closed-loop model and the effect of performance index weights on the system output are investigated both in simulation and experiment. As critical case, the periodic excitation with the frequency corresponding to the first bending eigenfrequency of the beam is investigated. The implementation of the robust controller results in a considerable suppression of the velocity magnitude measured by the vibrometer at the tip of the beam.