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Robust Loop Shaping Control for a Nano-Positioning Stage

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Abstract

This paper proposes robust loop-shaping techniques for a two-axis nano-positioning piezoelectric stage. Piezoelectric transducers are usually used to drive precision mechanisms because of their favorable properties, such as high resolution, high accuracy, and large driving force. However, the nonlinear characteristics of piezoelectric materials can degrade system performance. Therefore, we model a piezoelectric stage as a linear system, and regard its nonlinear factors as system uncertainties. Because robust control can guarantee stability and performance for systems with uncertainties and disturbances, we apply loop-shaping techniques and design standard robust controllers for the stage. In addition, we consider fixed-order robust control for the system in that controllers with lower orders are preferred for hardware implementation. Lastly, the designed controllers are implemented for experimental verification. The results demonstrate the effectiveness of these robust controllers in tracking reference signals and suppressing high-frequency vibrations