P6

Experimental Comparison Of Rate-Dependent Hysteresis Models In Characterizing Hysteresis Of Piezoelectric Tube Actuators

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Piezoelectric tube actuators are considered attractive for micro-/nano- positioning and micro manipulating applications [1]. These actuators, however, show rate-dependent hysteresis nonlinearities that increase with the excitation frequency of the applied input. Formulating of a rate-dependent hysteresis model that can account the frequency effect of the applied input is considered essential to expect the response of the actuator at various frequencies as well as to design controllers able to improve the tracking performance of smart actuators [2]. Different methodologies have been proposed in the literature for characterization of dynamic hysteresis nonlinearities of smart materiel-based actuators. One of the the most popular methodologies is to employ a rate-independent hysteresis model (such as the classical Preisach and the classical Prandtl-Ishlinskii) coupled with linear dynamics which is the so-called Hammerstein approximation. Another methodology is to formulate a hysteresis model that can integrate the rate of the applied input in the parameters of the hysteresis model [3].

In this study, a thorough experimental study has been carried out to characterize rate-dependent hysteresis of piezoelectric tube actuator at different excitations of frequency. The experimental measurements were followed by modeling of hysteresis nonlinearities using both the rate-dependent Prandtl-Ishlinskii model and a rate-independent Prandtl-Ishlinskii model coupled with linear dynamics of the piezoelectric tube actuator. The comparison between both the models is presented and discussed along with investigating the output responses at various arbitrary excitations of frequency, which were not considered in parameters identification.

Refrerences

[1] D. Habineza, M. Rakotondrabe, Y. Le Gorrec, Bouc-Wen Modeling and Feedforward Control of Multivariable Hysteresis in Piezoelectric Systems: Application to a 3-DoF Piezotube Scanner, Accepted, To appear in the IEEE Transactions on Control System Technology.
[2] M. Al Janaideh, S. Rakheja, and C-Y. Su, Experimental characterization and modeling of rate-dependent hysteresis of a piezoceramic actuator, Mechatronics, vol. 19, pp. 656–70, 2009.
[3] C. Visone, Journal of Physics: Conference Series vol.138(1), 012028, 2008.