Modelling and control of a nonlinear magnetostrictive actuator system

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ABSTRACT

This paper explores the implementation of a feedforward control method to a nonlinear control system, in particular, Magnetostrictive Actuators (MA) that has excellent properties of energy conversion between the mechanical and magnetic form through magnetostriction effects which could be used in actuating and sensing application. MA is known to exhibit hysteresis behaviour and it is rate dependent (the level of hysteresis depends closely on the rate of input excitation frequency). This is, nonetheless, an undesirable behaviour and has to be eliminated in realising high precision application. The MA is modelled by a phenomenological modelling approach via Prandtl-Ishlinskii (P-I) operator to characterise the hysteresis nonlinearities. A feedforward control strategy is designed and implemented to linearize and eliminate the hysteresis by model inversion. The results show that the P-I operator has the capability to model the hysteretic nonlinearity of MA with an acceptable accuracy. Furthermore, the proposed control scheme has demonstrated to be effective in providing superior trajectory tracking.

KEYWORDS:

Energy conversion; Hysteresis; Magnetic actuators; Magnetostrictive devices; Mechanical actuators