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微纳技术与精密机械

基于双曲函数的Preisach类迟滞非线性建模与逆控制

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摘要： 为了补偿压电双晶片驱动器的迟滞非线性，提出了基于双曲函数的Preisach类迟滞非线性建模方法，并用该模型设计了压电双晶片驱动器的逆控制器。首先，用两个双曲函数分别拟合迟滞主环的上升段与下降段，利用坐标变换描述依附于主环的一阶曲线；然后，根据Preisach模型理论的记忆擦除性与次环一致性，基于一阶上升与下降曲线分别描述了次环的上升段与下降段。由于这种建模方法所需的参数远小于Preisach等经典迟滞模型，非常适用于压电驱动器等智能材料系统。实验结果显示，基于这种迟滞非线性模型设计的逆控制器，控制后的最大误差比控制前减小了44.26%，有效地提高了压电双晶片驱动器的定位控制精度。

关键词： Preisach模型 压电驱动器 迟滞非线性 精密定位

Modeling and inverse control of Preisach type hysteresis nonlinearity using hyperbola functions

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Abstract: To compensate the hysteresis nonlinearity of a piezoelectric biomorph actuator, a new model with hyperbola functions was proposed to describe the Preisach type hysteresis nonlinearity, and an inverse controller was designed with the proposed model. Two hyperbola functions were used to fit the curves of hysteresis major loop and then the first order ascending and descending branches were described by the coordinate conversion. Based on the wiping out and congruency property of Preisach model, the minor loops were modeled by the corresponding first order curves. As the parameters of the proposed model are much less than those of classic hysteresis models, such as Preisach model, the proposed model is suitable for the smart material systems including piezoelectric actuators. Experimental results show that the inverse controller designed with the proposed model can compensate the hysteresis of piezoelectric biomorph actuator, and the maximum control error with inverse controller has reduced by 44.26%.

Keywords: Preisach model piezoelectric actuator Hysteresis nonlinearity Precision positioning

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