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指数型变幅杆螺旋驱动直线压电作动器

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Spiral-driving linear piezoelectric actuator based on exponential amplitude transformer

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摘要 为实现微小型机电系统中驱动单元的小型化,设计了一种采用指数型变幅杆放大定子振幅的螺杆式直线压电作动器。分析了作动器运行机理,设计了作动器定子基体内螺纹副和变幅杆。然后,利用有限元软件仿真分析了定子基体的振动模态。最后,确定了作动器尺寸并加工出样机;搭建实验平台,对作动器样机的机械性能进行了测试。测试结果显示,在电压有效值为300 V,激励频率为15.6 kHz,两相激励电压之间的相位差为$\pi/2$时,作动器输出直线速度最大值达到3.392 mm/s,最大输出力达到15.02 N。得到的结果表明:作动器具有良好的输出性能,具备了作为微小型机电系统直接驱动单元的能力,可满足微小型设备微量进给的要求。

关键词 : 直线压电作动器, 指数型变幅杆, 螺旋驱动, 弯曲振动

Abstract : To miniaturize the driving unit in a micro-electro-mechanical system, a spiral-driving linear piezoelectric actuator based on an exponential amplitude transformer was designed. the operation mechanism of the actuator was analyzed, and the screw pairs of stator and the exponential amplitude transformer were designed. Then, the stator vibration modes were analyzed by finite element software in simulation. At last, the dimension of actuator was determined, the prototype was made, an experimental platform was established and the actuator output performance was tested. Under the conditions of an effective voltage of 300 V, resonant frequency of 15.6 kHz, the phase difference between two driving voltages of $\pi/2$, the actuator reaches a maximum linear velocity of 3.392 mm/s, and the output force of 15.02 N. The test results indicate that the actuator has a good output performance, and it can be employed in MEMS driving unit to meet the demands of subminiature equipment for the micro feed.

Key words : linear piezoelectric actuator exponential amplitude transformer spiral-driving bending vibration

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