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Design and Analysis of a Piezoelectric Linear Motor Based on Rigid Clamping

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Abstract : Piezoelectric linear motors have the characteristics of great electromagnetic compatibility, high positioning accuracy, compact structure and no deceleration mechanism, which make it promising to applicate in micro-miniature precision drive systems. However, most piezoelectric motors are employed by flexible clamping, which has insufficient rigidity and is difficult to use in rapid positioning. Another problem is that this clamping method seriously affects the vibration efficiency of the vibrating unit. In order to solve these problems, this paper proposes a piezoelectric stack linear motor based on double-end rigid clamping. First, a piezoelectric linear motor with a length of only 35.5 mm is designed. This motor is mainly composed of a motor stator, a driving foot, a ceramic friction strip, a linear guide, a pre-tightening mechanism and a base. This structure is much simpler and smaller than most similar motors, and it is easy to assemble as well as to realize precise control. In addition, the properties of piezoelectric stack are reviewed and in order to obtain the elliptic motion trajectory of the driving head, a driving scheme of the longitudinal-shear composite stack is innovatively proposed. Finally, impedance analysis and speed performance testing were performed on the piezoelectric linear motor prototype. The motor can measure speed up to 25.5 mm/s under the excitation of signal voltage of 120 V and frequency of 390 Hz. The result shows that the proposed piezoelectric stacked linear motor obtains great performance. It can run smoothly in a large speed range, which is suitable for various precision control in medical images, aerospace, precision machinery and many other fields.

Keywords : piezoelectric stack, linear motor, rigid clamping, elliptical trajectory
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