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Ultraprecision control performance of high power ultrasonic linear motor

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Recently, high power ultrasonic linear motor with high accuracy has been widely adopted in the semiconductor and measurement field because the ultrasonic linear motor has several advantages such as high power, simple mechanism, fast response and low electromagnetic noise level. To obtain the high power and nanometer level accuracy, we selected the hybrid bolt clamped Langevin-type ultrasonic linear motor. The hybrid-bolt clamped Langevin-type ultrasonic linear motor is vibrated at its different modes of resonance frequencies in both the sixth lateral mode and third longitudinal mode directions. The driving frequencies of the two vibration modes must be same to obtain the high power and ultraprecision control performance. However, the performance of hybrid bolt clamped Langevin-type ultrasonic linear motor is limited due to its discordance of resonance frequency between longitudinal and bending mode. This discordance can be occurred due to the contact mechanism at the driving point and the manufacturing error, in addition to environmental factors. To overcome discordance of resonance frequency, we propose a frequency matching method based on the impedance adjustment such as preload variation and external inductance. In addition we employ the dead-zone compensation at the nonlinear region caused by friction and the nominal characteristic trajectory following (NCTF) controllers which only needs a simple experiment because it is difficult to model hybrid-bolt clamped Langevin-type ultrasonic linear motor due to the nonlinear factors. Finally, the developed ultrasonic linear motor system with two axis successfully produced good performance in terms of driving power, positioning accuracy, and contour accuracy.

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