Modeling of piezoelectric-driven stick-slip actuator

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Abstract

Piezoelectric-Driven Stick-Slip (PDSS) actuator featured with a long range and a high resolution is a promising device in many micro positioning and manipulation applications. Many factors such as the mass of the piezoelectric actuator (PEA), the mass of the stage and the friction force between the systems can significantly contribute to the end effecter displacement of a PDSS actuator. Specific quantitative relationship between those factors and the displacement dynamics of PDSS actuator are still remained to be addressed. The aim of this research is to develop a model to represent the displacement of the end effecter of the PDSS actuator, in which presliding friction and the PEA dynamics are considered.

In the research model, LuGre model was chosen to describe the presliding friction, and a linear second order dynamic system model was employed to represent the combination of a PEA and its driven mechanism. This model was developed to present the end effecter displacement of the PDSS actuator. Experiments were conducted based on a prototyped actuator to identify the parameters involved in the model. Then the identified parameters were employed in the developed PDSS model to simulate the displacement and results were compared with experimental results. The comparison suggests that the model developed in this study is promising for the end effecter displacement of the PDSS actuator. This model can be of guidance for optimizing parameters in designing new PDSS actuators.

Keywords: Piezoelectric; Stick-Slip; End effecter; Presliding friction; Dynamic