Modeling and control of a piezoelectric actuated precision tip-tilt mechanism

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Abstract

Fast positioning system is required in optical systems for diverse applications, such as optical engineering, inter-satellite laser communication, semiconductor industry, biotechnology, and nanotechnology, etc. Tip-tilt mechanism is the critical installation in the fast positioning system, which is a kind of actuators driven by piezoelectric stacks, voice coils or other driving devices. This paper presents a novel piezoelectric (PZT) actuated precision tip-tilt mechanism system, including a control module, driving module, a fine positioning mechanism, which can control the mechanism move quickly and precisely. The strain gauge sensor integrated in the mechanism measures the angle output of the mechanism. The driving, mechanism and measure integrative model of the system has been built. The increasing type digital proportional-integral-differential (PID) feedback control is studied. The simulation in the MATLAB/SIMULINK has been conducted to verify the control method and the performance of the system is test. Finally, the control method is verified on a self-developed Field-Programmable Gate Array(FPGA) and power booster amplifier PB58 based control and driving board. The experimental results confirm the validity of the design and the theoretical analysis of the tip-tilt mechanism system.

Keywords: Fast positioning system; Tip-tilt mechanism; Piezoelectric actuator; Proportional-integral-differential, Field-Programmable Gate Array