Evaluation on tracking performance of PID, gain scheduling and classical cascade P/PI controller on XY table ballscrew drive system

ABSTRACT

Today, positioning systems in machine tools aim for high accuracy and robustness characteristics in order to accommodate against various disturbance forces. The objective of this paper is to evaluate the tracking performance of PID, Gain Scheduling and Cascade P/PI controller with the existence of disturbance forces in the form of cutting forces. Cutting force characteristics at different cutting parameters; such as spindle speed rotations is analysed using Fast Fourier Transform. The tracking performance of a classical cascade controller in presence of these cutting forces is compared to the PID controller and gain scheduling PID controller. Robustness of these controllers in compensating different cutting characteristics is compared based on reduction in the amplitudes of cutting force harmonics using Fast Fourier Transform. It is found that the cascade controller performs better than both PID controller and gain scheduling PID controller. The average percentage error reduction between cascade controller and Gain Scheduling controller is about 88% whereas the average percentage error reduction between cascade controller and Gain Scheduling controller is about 84% at spindle speed of 1000 rpm spindle speed rotation. The finalized design of cascade controller could be utilized further for machining application such as milling process. The implementation of cascade P/PI in machine tools applications will increase the quality of the end product and the productivity in industry by saving the machining time. It is suggested that the range of the spindle speed could be made wider to accommodate the needs for high speed machining.

Keyword: Robust control; Tracking performance; Cutting forces; Disturbance compensation