FAST RESPONSE CONTROL FOR MACHINE TOOL FEED DRIVES

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ABSTRACT

The presence of uncertainties in a plant's parameters, disturbances acting on a system and output limitations are important obstacles to achieving high performance in an industrial controller. The optimization of such controllers for fast response is a problem of special interest in machine tool feed drives as motion errors can result in dimensional deviations on final parts. Different controllers have been introduced in the past to overcome these problems. The objective of this paper is to present a novel control algorithm to address these problems. The algorithm employs a switching technique that selects the control output from three standard controllers.

Simulation results from a rotary DC motor model and experimental results using a linear motor test bed are presented to demonstrate the effectiveness of the algorithm. The approach was found to give better response for second order systems with uncertain and bounded parameters operating in the presence of disturbances while including output limitations. A 5 mm move with a 25% error in the system's mass was applied to the linear motor test bed using both the new algorithm and a PID controller. The move was completed 5 ms faster with the new algorithm.

INTRODUCTION

The study of different techniques to control an uncertain second order system with bounded parameters and control limits have been an area of ongoing interest in the last few years due to its industrial importance. The implementation of various control schemes to provide reasonable robustness and invariance has been extensively studied in the literature.

High speed machining is one of the challenging applications that requires fast response along with high accuracy, robustness and invariance. System invariance is a major challenge in any controller. One of the main reasons for this system parameter variation is the mass change associated with the workpiece and the load fluctuation during cutting. This requires a controller with less sensitivity to mass and load disturbances. VanBrussel and Braembussche stressed these points in their work (1998). Alter and Tsao demonstrated in their work that conventional PID controllers can achieve reasonable performance for turning operations, but they also stated that other controllers can achieve better performance with higher speed and disturbance rejection (1994). Numerous researchers in the last few years investigated the effect of parameter variations on the controller structure and its behavior. Examples of such