Adaptive Control System for the CNC Controller

Subject: Mechatronic
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Since years, the development of wear resistant abrasives and powerful machinery has led to a considerably increase of the grinding-process efficiency. However, this manufacturing process is still complex, difficult, and expensive to adjust and the machining yield must be improved. An adaptive controller is necessary to enable the maximization of machining throughput despite the variation of machining conditions.

Motivation

Grinding of cutting tools is the target operation for our application of the adaptive controller. The controller will allow to automatically control the load on the spindle during machining. Currently, human operators manually determine the situation in which the limit load is likely to be exceeded, and the advance speed is proportionally. The adaptive controller allows machining at the maximum capacity of the machine and to achieve optimum productivity.

Project scope

The subject, adaptive control for the CNC control, has been proposed as part of Mechatronic Specialization. The controller will be implemented, tested, and verified on a testbed that is setup for this work in the laboratories of the University of Applied Sciences Bern (BFH), and will finally be added to the solution NUMroto, which is the reference software for cutting and sharpening tools of the company NUM.

Regulation

The objective is to regulate the grinding power for maximum performance. The machining force and the feed rate must be adjusted by an adaptive controller. The evaluation of the current state-of-the art allowed me to choose the model of the grinding process and the type of adaptive controller useful for my work. The model is used in the construction of the Model Reference Adaptiv Controller (MRAC) controller built and simulated in Matlab and Simulink.

The Figure 1 shows the behavior of the MRAC, its good matching to the position profiles, and its capability to reduce the feed speed when a disturbance occurs.

Test

A testbed (Figure 2) has been designed, built, and controlled with the dSPACE facilities. The tuning of the controller is made for tests simulating machining creep-feed grind like cutting tools.

Discussion

Tests continue to prove the effectiveness and benefits of the developed controller on real machines. The tuning can further be detailed and refined. Finally, the integration into the NUMroto control software for the machine tools is future application of the Adaptive Control System for the CNC Controller.

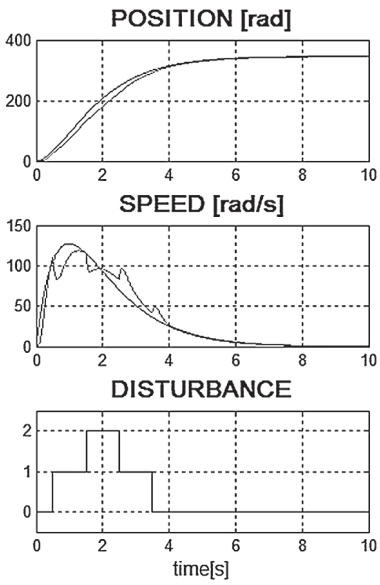

Figure 1

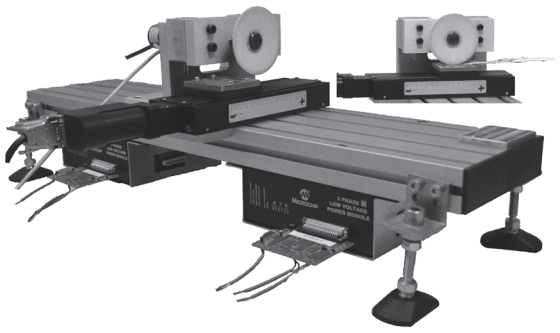

Figure 2

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