Online Compensation of Thermal Errors in Machine Tools using Temperature Field Observer

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Abstract

Thermal loads in machine tools caused by drives, process heat, fluids and the environment lead to deformation of the machine structure and thus to deviations at the TCP. Therefore, it is necessary to compensate thermal errors to ensure the process reliability and the product quality. Nowadays, more and more model-based methods of thermal error compensation, which calculate temperature fields and the resulting offset of the TCP, are implemented into the machine control system. Unfortunately, computing time is rising significantly with increasing datail of the machine model. On-line compensation becomes difficult.

This paper presents a method to compensate thermally induced errors in machine tools in real-time using a temperature field observer. For this purpose, the native CAD geometry of the machine tool is simplified and modelled by means of FEM. Afterwards, the order of the model is reduced to achieve adequate computing times. Power losses of drives as well as heat sinks are the inputs of the model. On-line simulated temperatures will be compared to sensor data from specific measurement points. An observer adapts the simulation of the whole machine tool structure according to this comparison (see fig. 1). Hence, the quality of error compensation is significantly increased. The selection of appropriate temperature measurement points is supported by thermomechanical simulations and experimental validation. First realization steps are represented by modelling a multi-spindle turning machine.

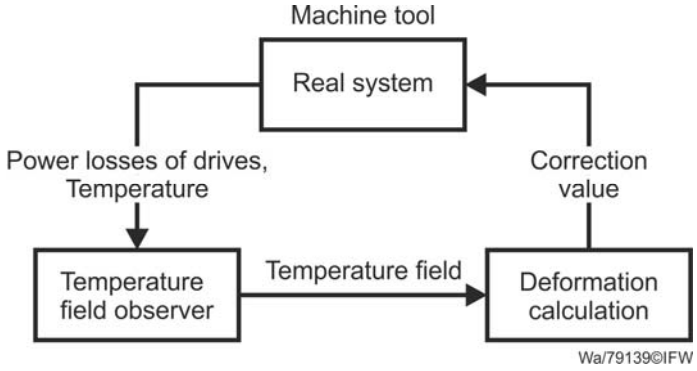

Figure 1: Illustration of the method of compensation