Transient and position dependent compensation of thermal errors in machine tools

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Abstract

High precision milling machines can benefit from real time compensation of thermal errors to improve their accuracy, but there are a number of challenges that need to be addressed and overcome in order to achieve a robust solution: e.g. the choice of optimal temperature probe locations, the experimental characterization of the most relevant thermal effects, or the identification of a model that can extrapolate robustly to general machine working conditions. The thermal state of the machine is typically transient due to intermittent operation, measurement cycles, etc., and the positioning error will change with the position in the workspace, increasing the complexity with respect to other applications.

A general discussion of all these effects will be presented, with main focus on identification of optimal temperature probe locations and on the model structure for capturing transient and position dependent machine behaviour. Simplified models will be used to illustrate the concepts and methods, which will be applied to real machine tool data. Discussion will include Singular Value Decomposition, thermal modal analysis for optimal probe location and static vs dynamic thermoelastic models will be compared when used for thermal error compensation of transient and position dependent errors.