Iterative learning control for thermal error compensation of 5-axis machine tools

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Background
Productive precision manufacturing requires deep understanding of geometry, kinematics and dynamics of machine tools, especially for complex 5-axis machining. Furthermore, an essential challenge of such machine tools is the thermal behavior and the resulting deviations of the tool center point (TCP). Up to 75% of the overall geometrical errors of machined workpieces can be induced by the effects of temperatures. To compensate these errors, a phenomenological model was developed at IWF, where the most dominant thermal deviations of the rotary axes can be reduced significantly. The results show that the compensation accuracy decreases over time and the long-term stability cannot be guaranteed due to changing boundary conditions (e.g. environmental temperature, cutting fluid temperature, etc.). To adopt to changing boundary conditions, the model parameters need to be updated iteratively. This is done by an on-machine measurement system, what enables updating the model parameters during machining.

Task
1. Design of a measurement setup for simultaneous use of a touch probe and R-Test
2. Validation of the developed measurement setup
3. Implementation of an iterative learning control for a phenomenological thermal model
4. Building a simulation to estimate the long-term model uncertainties
5. Optimization of optimum measurement and model update intervals
6. Long-term validation measurements on machine tool
7. Evaluation of spontaneously changing boundary conditions

Software
The use of MATLAB and LabVIEW is essential for this thesis, the skill to use a CAD/CAM system can be beneficial.

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