Reduction of Thermally Induced TCP Displacement with Structural Strain Measurements

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Abstract

In order to implement an indirect correction of thermally induced displacement errors in machine tools, usually temperatures are measured as supporting variables. With this method, good correction results can be achieved. However, a comprehensive training data set for determining the model coefficients, or very sophisticated physical modelling techniques are necessary. It has been found that simpler model approaches can be used when the deformation field of the machine is directly measured, omitting the need for correlation of temperature with deformation. Once the deformation field is known, the linear relationship between deformation and TCP dislocation can be utilized for the implementation of a geometric-kinematic error model of the machine.

Within this paper a correction concept is presented, which is based on the direct measurement of structural deformation with machine integrated sensors, acting as supporting variable source. The approach has been validated in test benches under laboratory conditions in the past and has now been transferred to a fully operational milling machine. The influence of thermal deformation of the machine's headstock is modelled solely based on design data. The error reduction potential of the model is examined under shop floor conditions, which can reach up to 86 percent. Compared to an experimentally obtained model using temperature measurements, the solution is assessed.

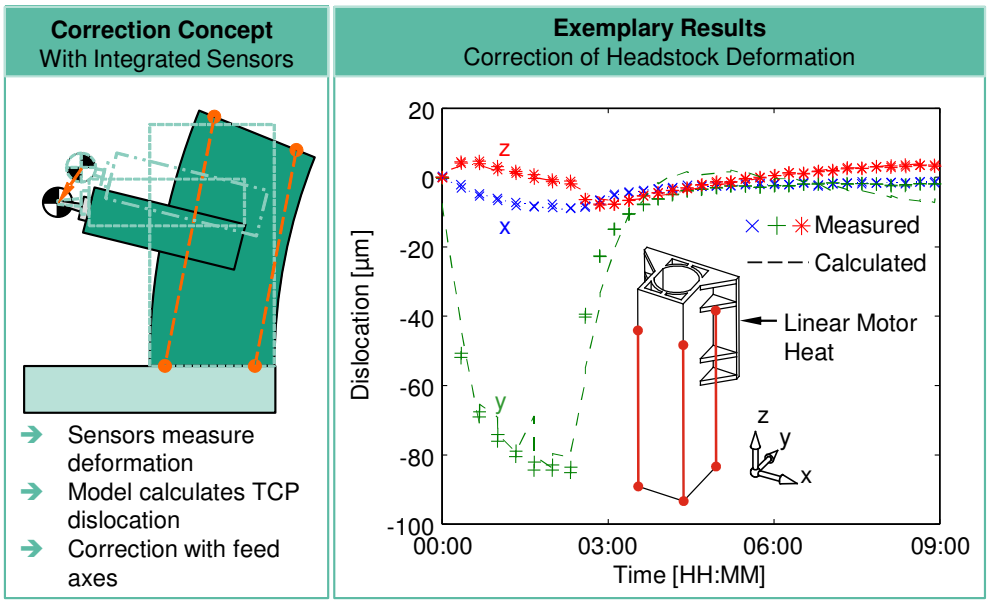

Figure 1: Concept of Correction Utilising Deformation Measurements