Equivalent geometric errors of rotary axes and novel algorithm for geometric errors compensation in a nonorthogonal five-axis machine tool

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ABSTRACT

The indirect identification of the geometric errors (GEs) in the rotary axis of a machine tool yields six equivalent GEs (EGEs) that are position-dependent; through an analytical proof, this study demonstrates that these errors also represent four position-independent GEs of the axis. Moreover, a novel algorithm using ball bar measurements to calculate the EGEs of a nutating rotary *B*-axis and a rotary *C*-axis is presented herein. This paper also presents a new analytical solution for the actual inverse kinematics of a nonorthogonal five-axis machine tool; this solution is used for GE compensation. The presented algorithms are implemented in a self-developed software that alters the nominal numerical control code in order to eliminate GEs. The compensation accuracy and efficiency are tested using a simulation system. The results demonstrate that the proposed compensation algorithm eliminates all identified GEs. Lastly, a cutting test executed on a machine confirms that the proposed algorithms considerably improve machining accuracy.

Keywords: Equivalent geometric errors; Geometric error compensation; Geometric error identification; Nonorthogonal five-axis machine tool; Kinematic model

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