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Indentification of machine errors in a small volume by 3D ball probing measurement

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ABSTRACT

Some machine tool error sources require significant axis motion to develop while others may change significantly even in a small motion envelop such as those related to hysteresis effects. In this work, it is proposed to use a simple setup consisting of a precision sphere, as artefact, and the machine tool's own touch trigger as instrument to gather data that combine the errors of both the machine and the probe, the sphere is assumed of negligible form error. A multi-step reversal procedure, and associated identification model is applied that should, in principle, allow the separation of the pre-travel of the probe and the machine errors. An identification matrix is proposed for the separation of the different sources of errors. There are 24 target points per circle, similar to parallels on a globe, and for the whole sphere, 9 such circles are measured, at latitude increments of 10°. In order to distinguish the different error sources through an error separation technique, the spindle is rotated by 15° and the process is repeated. In total, there are 24 different spindle indexations. The approach considers the machine volumetric errors, including backlash, and the probe errors. To validate the separated machine errors from the measurement of probe, a set of three orthogonal capacitive proximity sensors as a cluster is mounted at the tool side to measure the machine volumetric errors directly using the same target sphere as a reference. The movement of the sensors' cluster is similar to that used for the probe but without any spindle indexation. Results show that probe errors are sensitive to the length of the stylus: for longer stylus, the probe errors are larger. As expected, the machine errors do not rotate with the rotation of the spindle and some backlash is observed.