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Software-based compensation of instrument misalignments for X-ray computed tomography dimensional metrology

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Abstract

X-ray computed tomography (CT) is an imaging technique that allows the reconstruction of an imaged part in the form of a three-dimensional attenuation map. The CT data acquisition process consists of acquiring X-ray transmission images from multiple perspectives. Analysis of the reconstructed attenuation map can provide dimensional and material information about the measured part(s). Therefore, CT is recognized as a solution for quality control tasks, for example dimensional inspection of complex objects with intricate inner geometries. CT measurements can suffer from various sources of error in the measurement procedure. One such influence is the geometrical alignment of the CT instrument components. Typical tomographic reconstruction algorithms impose strict requirements on the relative position and orientation of the three main components: X-ray source, rotation axis of the sample stage, and X-ray detector. Any discrepancy in the actual CT geometry from the geometry assumed by the reconstruction algorithm will contribute to errors in measurements performed on the reconstructed data. There is currently no standardized or easily implementable method for users to compensate geometrical misalignments of the CT instrument. In many cases, the procedure of mechanical adjustment of CT instrument is time consuming and impractical. In this paper, we show