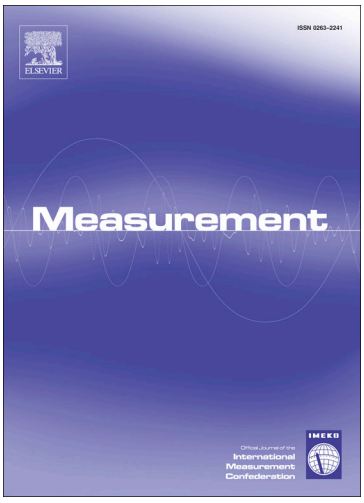

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Developing Skin Model in Coordinate Metrology Using a Finite Element Method

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Abstract

Coordinate metrology processes typically include measurement of a limited number of discrete 3D points from the measured surface to estimation the geometric deviation zone of the entire surface from an ideal geometry. Three main computational tasks required in coordinate metrology of manufactured surfaces include Point Measurement Planning (PMP), Substitute Geometry Estimation (SGE), and Deviation Zone Evaluation (DZE). The issue of uncertainties in the results of any of these three tasks potentially jeopardizes the accuracy of the entire inspection process. It is also shown recently that interactive closed-loops between DZE and PMP, or SGE will increase the efficiency, and reduce the sources of uncertainties in the computational processes. This paper presents a methodology to complete a comprehensive DZE for the entire measured surface using the geometric deviations of the limited number of measured discrete sample points. The result of a detailed DZE is a skin model of the measured workpiece, representing the geometric deviation at any point on the measured surface from the ideal geometry. The developed skin model is definitely needed when the inspection results are used for all possible downstream processes, planning for precise finishing operations, manufacturing error compensation, closed-loop of manufacturing and inspection, dynamic process control, or accurate verification of design tolerance. The developed methodology in this paper uses a finite element approach to solve the differential equation for detailed DZE of the entire surface estimating the geometric deviations for any location that is not measured on the surface. The methodology is fully implemented, and employed in various case studies on several industrial parts. The resulting skin models are examined and successful results are achieved. The developed methodology can be easily adopted by commonly used coordinate metrology computational software tools.

Keywords: Skin model, Deviation Zone Estimation, Coordinate Metrology, Finite Element Method, Poisson Equation.

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