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Study of Detailed Deviation Zone Considering Coordinate Metrology Uncertainty

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Abstract— The detailed Deviation Zone Evaluation (DZE) based on the measurement of the discrete points is a crucial task in coordinate metrology. The knowledge of detailed deviation zone is necessary for any form of intelligent dynamic sampling approach in coordinate metrology or for any downstream manufacturing process. Developing the desired knowledge of the deviation zone using only a finite set of the data points always needs an efficient interpolation and extrapolation techniques that are selected based on the nature of the perusing pattern of the geometric deviation. The objective of this work is to study the efficiency of a DZE approach for the various combinations of the manufacturing errors and coordinate metrology accuracies. The first employed DZE method is governed by a Laplace Equation to estimate the geometric deviations and a Finite Difference scheme is used to iteratively solve the problem. The other DZE method utilizes a metaheuristic approach based on Genetic Programming. Several cases of surfaces manufactured by various levels of fabrication errors and also different types of metrology systems are studied and the convergence of the employed methodologies are analysed. It is shown how efficient the DZE solutions are to reduce the uncertainty of the resulting deviation zone based on the number of points acquired during the measurement process. The DZE solutions are successful to minimize the number of the required inspected points which directly reduces the cost and the time of inspection. The results show a great improvement in reliability of deviation zone evaluation process.

Keywords: *Deviation Zone Evaluation, Coordinate metrology, Finite Difference Method, Genetic Programming, Manufacturing Accuracy, Measurement Uncertainty*

1. INTRODUCTION

Development of computational algorithms to improve efficiency and reliability of coordinate metrology process has been a challenging research task during the last three decades. Concurrent to rapid technological changes of the Coordinate Measurement Machines (CMMs), the demand for more advanced computational algorithms to plan,