EXPERIMENTAL AND THEORETICAL VALIDATION METHOD FOR ESTIMATION OF STRAIGHTNESS DEVIATION AND ASSOCIATED UNCERTAINTY IN CNC-CMM MEASUREMENT

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Abstract- Geometrical deviation in intelligent metrology system is an important factor in precision engineering. Estimating the deviation and associated uncertainty in straightness feature remains a necessary requirement to ensure highly accurate metrology method especially in CNC-CMM measurement. Optimization in straightness measurement using soft algorithm techniques is a widely encountered solution in coordinate metrology. In this work, straightness deviation has been measured precisely in 2D and in 3D using slab surface by CNC-CMM at the Egyptian national metrology institute (NIS). The work has been investigated experimentally and theoretically analyzed. The straightness deviation and its uncertainty results from 2D measurement have been estimated experimentally. The straightness deviation result of the 3D discrete points measurements have been analyzed theoretically using the standard Particle Swarm Optimization (PSO) algorithm. The probability density distribution of the measured straightness was calculated using a Sequential Monte Carlo (SMC) technique. A

probability density histogram is obtained with an expanded measurement uncertainty based on coverage factor k equals 2 providing confidence level 95%. The computational results of straightness deviation and expanded uncertainty have been also estimated for 3D discrete point measurements. Comparison with relevant report showed agreement with our result since we used a computationally efficient modified SMC technique and PSO algorithm. The results of the straightness deviations and associated expanded uncertainties for both 2D and 3D measurements have been discussed and compared. They were found to be suitable for the proposed validation method. This work confirms that the developed strategic alternative methodology can be achieved successfully. Systematic acquisition of CNC-CMM data is another contributing factor for improving the required accuracy in measurement. Moreover, the confidence in the proposed hybrid validation method for estimating the straightness deviation with associated uncertainty has been achieved.

Index terms*: CNC-CMM, straightness, uncertainty estimation and validation method.*