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Influence of Human Factor in the AACMM Performance: a New Evaluation Methodology

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One of the main principles of metrology, when talking about instrument calibration, concern to the idea of reproducing the actual measurement process during calibration (same instrument handling, environment, measurement parameters, etc.) in order to obtain suitable information. In spite of that, this principle is being currently neglected in Articulated Arm Coordinate Measuring Machine (AACMM) evaluation and/or calibration procedures. These procedures are carried out in manufacturer facilities under unknown conditions and measurement parameters instead of "in-situ" procedures with similar measurement parameters. Thereby, reported accuracy has little to do with AACMM common use and, therefore, with its reliability. This work presents a new evaluation methodology for both AACMM and operator performance. To do so, a survey of main measurement parameters (operator, contact force, type of feature) is carried out by mean of contact force sensor on the AACMM probe and geometric gauges. ANOVA have been used for the study of these parameters and its impact on AACMM performance. Additionally, a new evaluation methodology capable of quantifying AACMM, operator and its measuring technique contribution to measurement uncertainty has been developed. It is supported by a feature-base gauge that has been specifically designed for this task.

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NOMENCLATURE

U_{com} = combined uncertainty
u_{stw} = standard weights uncertainty
u_{cre} = creep uncertainty
u_{Eo} = zero uncertainty
u_{res} = resolution uncertainty
u_{hys} = hysteresis uncertainty
u_{rep} = repeatability uncertainty
u_{tem} = temperature uncertainty
u_{exp} = expanded uncertainty
k = coverage factor

1. Introduction

Articulated arm coordinate measuring machine (AACMM) offers a flexible part inspection by making possible fast inspection on production line, assembly site or work stations. The study of AACMMs technology and performance evaluation will broaden their field of action and will guarantee their measurement traceability and reliability.

AACMMs are composed of several segments connected by rotary joints that compose an arm-like structure. An operator handles AACMM movements manually in order to reach each contact point of the part. Such structure is traditionally modelled by the Denavit and Hartenberg (D-H) kinematic model which defines a coordinate system for each joint and the geometric relationship between them. According to each joint relative position, the coordinates of the centre of the tip are calculated. Over time, D-H model and real AACMM geometry lose their relationship, therefore, kinematic model parameters have to be recalculated by calibration. To do so, a well-known gauge is measured. Subsequently, AACMM measurement error is obtained by comparison against reference values of such gauge. Authors use their own criteria to define measurement error and the mathematic method to figure out the new kinematic model parameters. Santolaria et al.[1-4] measured a ball bar and minimize the AACMM error in terms of length between balls and repeatability of ball centres by least square method. Wang et al.[5] propose a method to calibrate AACMMs with a modified D-H