Validation Methods for 3D Digitizing Precision Concerning Jet Engine BLISKs

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ABSTRACT

The demand for higher efficiency of jet engines requires new technologies within the design and manufacturing processes. Since those methods influence the structural and aerodynamic behavior of the engine, several effects need to be considered. These effects can be estimated using different simulation techniques considering real geometry data. This can be accomplished either within a reverse engineering process, using the real digitized surface, or within a probabilistic simulation. The second method is taking a certain amount of measured parts (e.g. BLISKs or airfoils), gaining typical geometry parameters and evaluating their distributions. By using these distributions it is possible to build up digital three-dimensional models, representing the manufacturing or wear based geometry scatter. These models allow the user to evaluate not only a deterministic response of the numerical simulation, but a whole response value distribution within a probabilistic evaluation. This way it will be possible to robusten the intentional design towards the manufacturing or wear variability. For both methods it is an essential task to capture the parts geometry with high accuracy.

There are several techniques and purposes of capturing a part's geometry. This paper will concentrate on digitizing a high pressure BLISK of a jet engine by using tactile coordinate measurement machines (CMM) and optical structured blue light projection systems. With this focus it is essential to determine the purpose and the fields of application of both digitizing systems as well as their advantages and disadvantages. While the tactile CMM are commonly used by the BLISK manufacturer for tolerance checks, these methods seem not to be sufficient anymore concerning reverse engineering applications. Optical methods are able to digitize complete three-dimensional surfaces with a quality sufficient to describe all features of interest of a BLISK. Because of the different digitizing approaches of tactile and optical systems, it seems hard to deliver a quantified comparison with valid conclusions. This paper tries to give a first quantification of different error values as well as their statistical probability of occurrence.

The aim of the presented paper is to improve the understanding and estimation of the precision of structured light projection systems used within BLISK digitizing. This includes statements about the precision as well as the accuracy. The results will give a quantified statement about precision of the projects measurement setup as well as a quantified comparison between typical airfoil parameters of tactile and optical measuring systems. The work contributes towards a better acceptance of the optical measuring systems within the manufacturing tolerance checks, the parts integrity estimation during maintenance and for all kinds of reverse engineering processes.

KEYWORDS

Jet Engine, BLISK, Compressor, Uncertainty Quantification, Optical and Tactile Measurement, Accuracy and Precision