Influence of Roughness on Conoscopic Holography Digitizing of DIN 34CrMo4 Surfaces

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ABSTRACT

Conoscopic Holography is a non-contact digitizing technique used in inspection and reverse engineering tasks. A laser beam is projected onto a surface, and its reflection generates a holographic pattern inside the sensor. This pattern is later analysed and the distance between sensor and surface is calculated. Like other optical techniques, conoscopic holography shall be affected by surface properties and ambient conditions. This works deals with the influence of surface roughness and manufacturing process on the quality of digitizing. 34CrMo4 steel test specimens have been manufactured to obtain four different *Ra* levels. Two different manufacturing process, electrical discharge machining (EDM) and ball-end milling (BEM) have been also considered. Quality of the digitized point clouds under different sensor configurations has been analysed, in order to provide a recommendation for optimal capture conditions.

Keywords: Conoscopic holography; surface digitizing

1. Introduction

Conoscopic Holography (CH) is a non-contact digitizing technique. When the reflection of a laser projected onto a surface passes through a conoscope, an interference pattern is generated and registered in a CCD. The computational analysis of this image provides a value for the distance between the sensor and the surface. Sirat et al. [1] reported the advantages of CH when compared with other non-contact techniques, like laser triangulation. According to their work, CH shows better accuracy and repeatability up to 10 times for a given depth of field. CH has also shown better behaviour for a wide variety of materials and has been proved capable for measuring points upon 85° sloped surfaces. Due to their collinear design, CH sensors can incorporate mirrors for laser light redirection to digitize hard-to-access geometries such as holes or narrow cavities. CH is being used in different industrial fields, including quality assessment, reverse engineering or in-process inspection. In these applications, accuracy assessment becomes a key factor (Álvarez et al [2]).

Nevertheless, like other optical techniques, CH digitizing quality may be affected by surface optical properties. Lathrop et al. [3] have applied CH technology for surface digitizing of biological tissues. In this work, sensor main configuration parameters, power (*P*) and frequency (*F*), were adjusted to provide good quality measurements. Additionally, the Signal-to-Noise Ratio (SNR) parameter, which is automatically provided by the sensor itself for every single measurement, has been used as a quality criterion. Therefore, following recommendations of the manufacturer, a minimum 50% SNR is demanded for high quality measurements. These authors have also considered repeatability as a performance indicator. They have found that the nature of surface material (colour, texture) has an influence on the digitizing quality. Consequently a specific adjustment of tuning parameters must take into account surface characteristics.

The use of SNR as a quality indicator is well established in different works [4-6]. However, this a signal quality indicator, and it is not clear is the best SNR value (the maximum one) for a particular digitizing test provides the best results according to geometrical or dimensional criterions.

Integration of a CH sensor on a CMM and the later calibration procedure have been discussed in previous works [7] as part of a study for a better understanding of the CH technology and capabilities. Additional works (actually under review) have focused on quality differences when digitizing a wide variety of materials, including metals, plastics and reflectance standards.