Cutting-Tool Wear Characterization by means of Conoscopic Holography

P. Zapico[(1)], D. Blanco, C. Cuervo, G. Valiño, J.C. Rico

[(1)] IPFResearch Group, University of Oviedo, Gijón, 33203, Spain, zapicopablo@uniovi.es

ABSTRACT

The ability of conoscopic holography (CH) to provide accurate digitizing of tool wear is analysed in this work. Firstly, test have been conducted to check out the performance of the sensor when digitizing inserts without chip breaker geometry, which have been artificially worn using electro-discharge machining (EDM). A methodology for determining the number of digitizing orientations has been also developed, in order to achieve best results in surface reconstruction. Secondly, digitizing tests have been carried upon inserts with chip breaker geometry and different grades of wear. These inserts have been used in the machining of sintered metal parts. Results show that CH is a suitable technique for tool wear characterization.

Keywords: Conoscopic holography, Tool Wear, Digitizing

1. Introduction

Tool wear is among the key aspects that influence the quality of machined parts in many ways: it conditions the relative positioning between tool and part, which affects dimensional accuracy; it modifies chip flow over the rake surface of the tool; it also conditions the structural integrity of the tool. Therefore, characterization of cutting tool wear turns out to be an important issue, which is the reason why it has been the subject of numerous studies over the past decades.

On-line characterization of tool wear seems to be the best option from an operational point of view, since real time monitoring of tool condition results in a greater control over the process. Nevertheless, the techniques that are commonly used for on-line monitoring (like forces, vibrations or acoustic emission) are greatly affected by the particularities of each application. Moreover, they cannot really provide a direct control of tool wear magnitude, since they are all indirect methods. In fact, cutting conditions, tool geometry or even signal processing methods severely affect in-cycle techniques capacity to characterize the wear. At this moment, there is no reliable and universal approach to the problem of on-line monitoring of tool wear [1].

On the other hand, although in-cycle characterization techniques have certain advantages, they force the interruption of machining operation in order to allow direct observation of tool surfaces. Nevertheless, they can provide a more reliable and universal wear characterization, frequently through the calculation of the classic wear parameters (flank wear width or VB and depth of the crater or KT). This capacity has motivated the work of an important number of researchers, who employ very different techniques to characterize the wear. These techniques can be classified into two categories depending on the use of bi-dimensional or three-dimensional approach.

Most in-cycle tool wear monitoring applications have addressed the inherent difficulties of discrimination between both the worn out area and the intact one. The integration of artificial vision equipment, either in the machine itself or in attached installations, does not present a special difficulty. However, good lighting of the tool is often pointed out as a key issue for subsequent image processing [2]. Hence, Zhang [3] incorporates an additional source of LED lighting to improve the quality and sharpness of digital tool images. There are also other factors that complicate the task of delineating the precisely worn zone. As a consequence, there are several examples of different methods used to determine a boundary between the worn and the intact area, like the evaluation of grey level difference [3] or statistical descriptors [4]. Nevertheless, it seems clear that these techniques suffer when transforming two-dimensional information into a geometric boundary, and they also present problems for the correct interpretation of anomalies as the built-up edge.

3D reconstruction techniques of cutting tool geometry could be a more robust option, since they use to be less dependent on ambient lighting and they permit simultaneous digitizing of different tool surfaces