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Inspection of Geometrical Integrity of Work Piece and Measurement of Tool Wear by the Use of Photo Digitizing Method

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Abstract**—**Considering complexity of products, new geometrical design and investment tolerances that are necessary, measuring and dimensional controlling involve modern and more precise methods. Photo digitizing method using two cameras to record pictures and utilization of conventional method named “cloud points” and data analysis by the use of ATOUS software, is known as modern and efficient in mentioned context. In this paper, benefits of photo digitizing method in evaluating sampling of machining processes have been put forward. For example, assessment of geometrical integrity surface in 5-axis milling process and measurement of carbide tool wear in turning process, can be can be brought forward. Advantages of this method comparing to conventional methods have been expressed.

Keywords**—**photo digitizing, tool wear, geometrical integrity, cloud points

I. INTRODUCTION

SOME of influenced phenomena in machining processes include: roughness, surface torsion, geometrical integrity of surface, residual stresses, machining forces, temperature resulted from machining process, metallographic changes, hardness of subsurface, tool wear and tool life. To measure these phenomena, measuring tools such as profile meter, strain gage, dynamo meter, thermometer, SEM, ultrasonic method, interferometer are applied. These methods bear some limitations including shortage of measurement amplitude, impressibility of environment temperature. Lack of portability of equipments and impossibility of using them to measure freeform and sculpture work pieces[1, 2, 3, 4]. It should be said that in many of these methods, 3D measuring is not possible and consecutive 2D sampling is performed. Besides, efficacy of conventional methods is confined to measurement theme. Now by the aid of photo digitizing method, operator can conquer listed problems. On the other hand special ability will emerge. This important ability is benefit of this method in developing CAD data from sample to apply them in maintenance, reconfiguration and creation of change. Modeling and supplying computer data from prior products that you don’t have access to pervious plan or file, are known as applications of these methods as well.

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II. EQUPMENTS

Equipments that are necessary for this method include a light source for radiating on work pieces, two cameras for recording pictures resulted from light reflection that are able to change lens and focus on picture, granite desktop and fixtures for work pieces, Linux software by the aid of ATOUS software can proper a final and perfect picture of model surface. ATOUS software is able to correspond, received image from both cameras. Equipments needed for this method are produced only by few companies in the world. In this paper utilized equipments have been made by GOM Company in Germany. Figure 1 shows cameras, granite desktop and fixture of work piece.

Fig. 1 Equipment of photo digitizing system

III. METHOD OF TEST

Primarily, surface of models are covered with a dimmer powder in order that they can be totally dimmed. It is due lack of intense light reflection reflected on surface to scan model. In order to correspond images from two cameras and delete common recorded parts from each camera, labels named referenced points are applied. These labels are inserted either on pieces or around the pieces. The method is considering a number for each of these points after setting up. After recording pictures, firstly points are corresponded according to numbers and then over lapped parts are deleted and final image will be gained. In figure 2 you can see referenced of an insert. Time of scanning position of each camera and cloud pointes resulted from scanning a model has been shown in figure 3, 4 and 5.

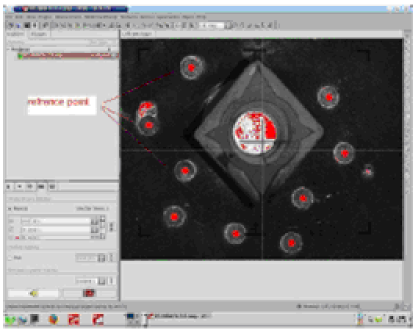

Fig. 2 An example of reference points

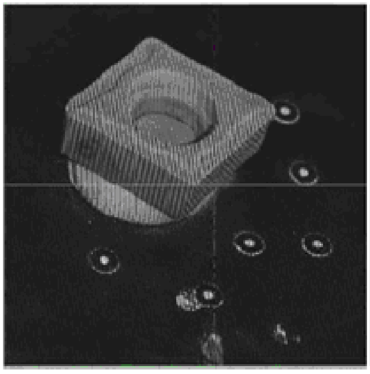

Fig. 3 Scanning an inserts

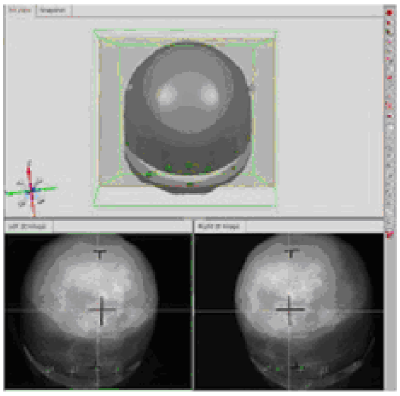

Fig. 4 Situation of two cameras view

IV. Case Study

A. Inspection of geometrical integrity of work piece in 5-Axis milling process

Orientation middle tool and work piece constitute level of tendency of tool axis to normal axis of surfaces of work piece. Regarding cinematic type of 5-axis milling machine, this motion is exerted either by work piece or tool [5]. Tendency of tool is determined by two tilt angle and lead angle [1]. It is clear that in 5-axis milling machining with variant tilt angles and lead angles, numerous points of spherical surface of tool come to contact with work pieces and because of difference in cutting speed of this point a different geometrical integrity on surface of work piece will develop [2].

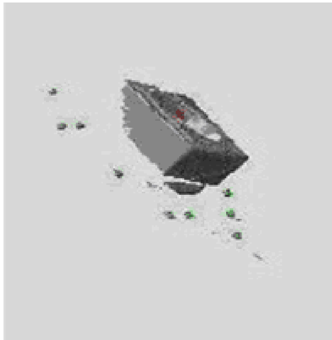

Fig. 5 An example of cloud points made by scan of insert

Figure 6 shows images concerning variation of different orientation of tools toward work piece. In this case study at first universal profile meter was used to measure geometrical integrity of work piece. That failed to respond to problem because of 2D diagrams, lack of correspondence of prior CAD data and also unavailability of to all regions studied at the same time.

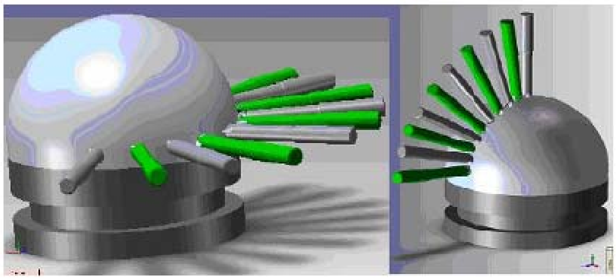

Fig. 6 Variation of different orientation of tools toward work piece

Figure 7 shows an example of form diagram regarding geometrical position of spherical work piece. Therefore it is obvious that you need photo digitizer scanner. The method of use of photo digitizing for studying geometrical integrity of surface is as follows: first of all, the made CAD data in CAD software are transmitted to CAM software and work piece is machined according to CAM data. Then by the use of photo digitizing, the produced work piece is evaluated and data recorded by cameras are transmitted to ATOUS Software. Finally recorded data resulted from photo digitizer and prior CAD data are corresponded in order to compare and assess final geometrical integrity.

In fact probable deformations of machined surface are compared to CAD data (in the form of either p ledge or notch). Level of these deformations is determined by colorful spectrum, since each color represents for positive or negative deviation toward CAD data. In order to facilitate the recognition of intervals among corresponded data, an indicator that shows applied color is benefited.

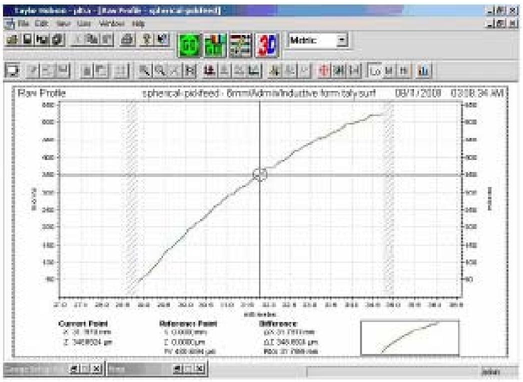

Fig. 7 of form diagram regarding geometrical position of spherical work piece

Figure 8 and 9 demonstrate two colorful spectra in conjunction with two different orientations of two. In these figures the highest level of difference in positive situation (the highest level of ledge) is shown with red color and the highest level of difference in negative situation is presented with blue color (the highest level of dip). Green color has been applied as natural situation. In other words if green color is observed in any region, it can be said that total correspondence has been occurred.

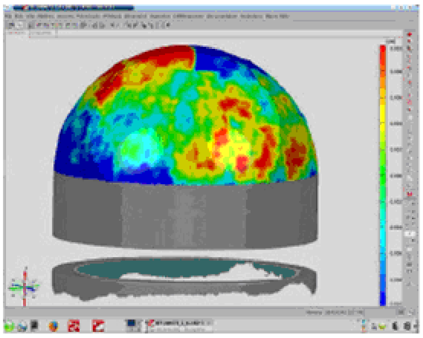

Fig. 8 Colorful spectrum for lead angle 0 and tilt angle 0

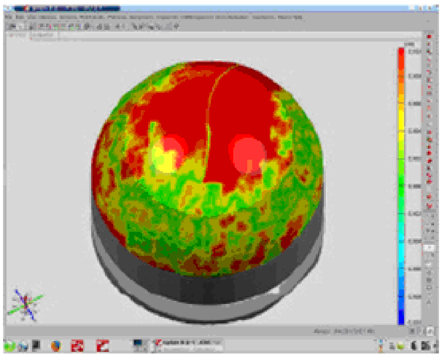

Fig. 9 Colorful spectrum for lead angle 20 and tilt angle 22

By the aid of software, conformity tolerance of two surfaces for colorful spectrum can be altered. In this case the used tolerance was 0.02mm. It has been gained by try and error. Indeed on the effect of choosing closer tolerance for corresponding, the whole surface of spherical model is shown with one color. In contrast by choosing larger tolerance, it is impossible to distinguish color. Consequently it was impractical to denote various regions of model surface.

More ever, it is possible to prepare cut plan in several angles, both vertical and horizontal. The layer between two surfaces can be viewed as different colors. Figure 10 demonstrate a cut plan of correspondence of scanned surface and CAD data concerning spherical model.

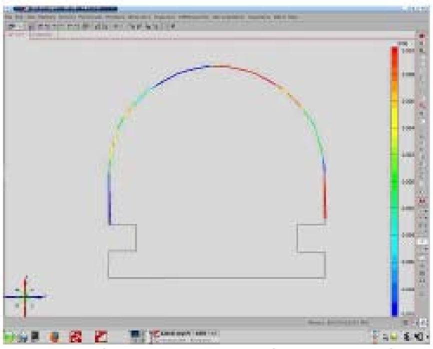

Fig. 10 A cut plan of correspondence of scanned surface and CAD data concerning spherical model

B. Measurement of carbide tool wear, in mild steel turning

Tool wear is regarded as main parameter of exhausting of tool life. As a result of assessment of level of wearing has become vital action. Taking various parameters of machining in to account, wear has been studied in different circumstances [4, 6].

In this case study two kinds of measuring tools were used to measure the accurate rate of tool wear. The first tool is SEM. Its pictures have been shown in figure 11. However it failed to solve the problem as there was no indicator for measuring. SEM is not able to determine the precise location of the highest level of wear, too.

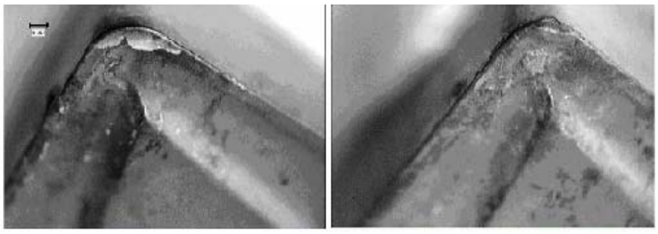

Fig. 11 A tool flank wear picture, product by SEM

To gain better advantages, photo digitizing method was used. To reach this goal, at first studied inserts were scanned before starting machining process and relevant data was saved in a file. At the next step, after examinations and machining process the worn tools are scanned again, using photo digitization method and new data was saved. Finally in order to major wear rate of each model, data concerning before and after machining this model was corresponded in ATOUS software. In this research to benefit from colorful spectrum, 0.11mm tolerance was used. This method is used to gain maximum wear by aid of an order named “maximum point”. The highest rate of wear and its location was closely characterized. Further more in the location of maximum wear was sliced and two positions were evaluated in cut plan. It was preformed in two situations: before and after machining process. Figure 12 demonstrates a plan of colorful spectrum and maximum point. Figure 13 presents cut plan at two points. These points include maximum wear point and favorite point with colorful spectrum and figure 14 shows interval between maximum wear point and tool tip.

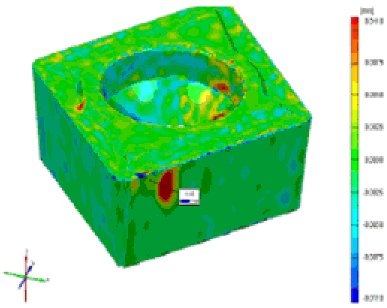

Fig. 12 Colorful spectrum with maximum point

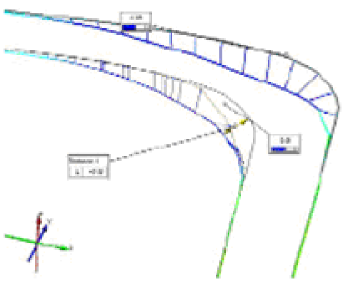

Fig. 13 Cut plan of maximum point

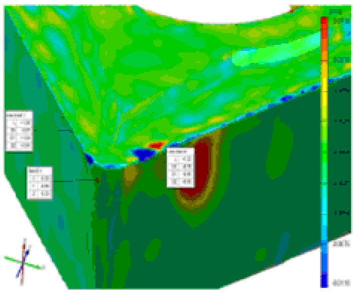

Fig. 14 Distance between flank wear location and tool tip

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