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3D SCANING AND INSPECTION GEOMETRICAL PARAMETERS OF SPROCKET TOOTH PROFILE

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Abstract 3D measurement methods, with a certain accuracy provide a quick response to the measurement request in almost all stages of the machining process. This paper presents an application of 3D scanning (GOM ATOS) to inspection the geometrical parameters of the sprocket tooth profile in the final (post-process machining) inspection. The scanned sprocket was digitized and analyzed from the standpoint of specified tolerances and deviations. A method of analyzing 3D scans was developed in order to define the permissible deviations of the geometric parameters of the sprocket tooth profile. The result of the conducted research is a new method of determining the conformity (quality level) of the product (sprocket) by analyzing the deviation of individual geometric quality parameters (sprocket profile). The deviation analysis method can serve as a basis for the inspection of other sprocket tooth profiles and other similar parts.

Keywords: Laser scaning; product conformity; inspection; deviation; sprocket.

1. INTRODUCTION

3D measuring methods provide a quick response to today's measurement requirements in manufacturing today. In terms of the accuracy of the measurements, they are not like coordinate techniques such as the coordinate measuring machine, however these methods are increasingly being used. The reasons for this are the easy use of 3D scanners and the acquisition of a big data set. On the other hand, the processing of a big data set requires a special effort and a systematic approach adapted to the ultimate needs.

An example of artifact and deviation measurement method is shown in paper [1]. The paper [2] presents the possibility of measuring a semi product for cutting tool and evaluation of the measuring capability of the ATOS GOM optical 3D scanner when measuring the tool diameter. The purpose of the paper [3] is to present the opportunity to automate the measurement process of gears, using coordinated optical scanner ATOS GOM, equipped with a turntable. According to [4] quality control of bevel gears using the ATOS GOM can significantly speed up the scanning process and accuracy of measurements. The paper [5] presents results of the comparative geometrical accuracy tests for different hand-held 3D scanners. The paper [6] deals with the control of the geometry of manufactured tools, because geometry of the cutting tool has a great influence on the machining process, while paper [7,8] deals with aspects affecting accuracy and accuracy of optical 3D digitization. The paper [9] examines the possibilities of using a three-dimensional scanner for workpiece inspection. An exampl application of 3D scanner in large scale housings produced in foundry technology is presented in [10].

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This paper gives one example of a measurement on the ATOS GOM device and gives a complete data processing in the purpose to inspection the geometrical parameters of the sprocket tooth profile in the final (post-process machining) inspection. The result of this paper is a new method of determining the conformity of the product by analyzing the deviation of individual geometric quality parameters -sprocket profile.

2. MATHERIAL AND METHOD

In this paper used real sprocket (Figure 1a) to inspection the geometrical parameters of the sprocket tooth profile (Figure 1c). Sprockets are manufactured and used for power transmission in the automotive industry. By inspecting the sprocket tooth profile, you can directly measure the profile parameters or conformity of the sprocket profile, determined by analyzing the deviation of individual sprocket profile geometrical parameters. The analysis is based on a comparison of the real and 3D CAD geometry (Figure 1b) of the sprocket.

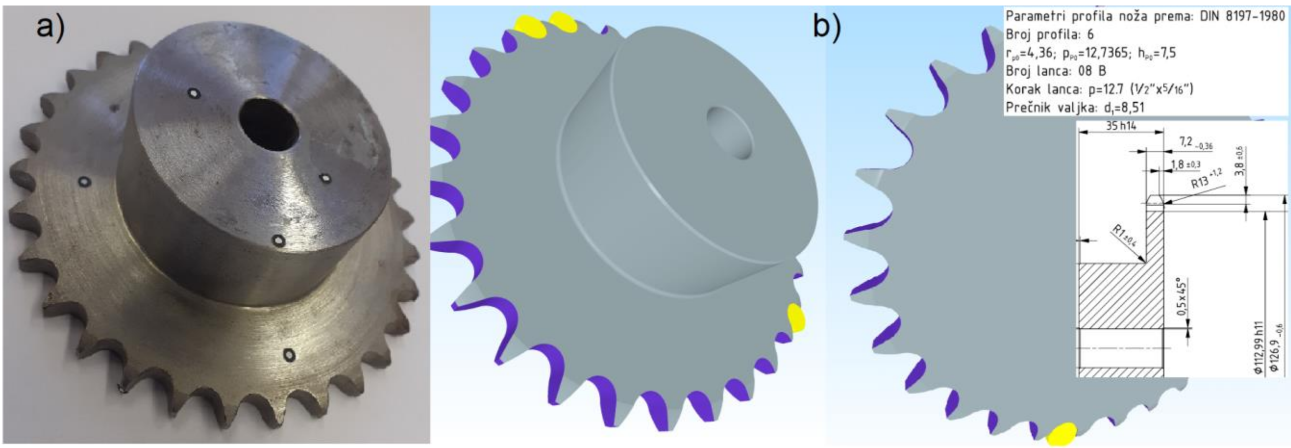

Figure 1. Workpieces: a) real sprocket; b) 3D CAD model of sprocket, and part of the parameters of the sprocket tooth profile.

GOM ATOS it's a optical scanner allows you to perform inspection the geometrical parameters of the sprocket tooth profile. Coordinate measuring system GOM ATOS it's a stereoscopic system based on the two measuring cameras, projector, a tripod, the control unit and a computer scanner [3]. Schematic of measuring system is shown in Fig. 2a, while real system is shown on Figure 2b. In addition to the mentioned hardware components, software is also used for acquisition and display of measurement results. To measure rotating parts or parts with repeating elements, such as a sprocket, it is necessary to have one rotating axis that enables the rotation of the measuring part. The measurement process is additionally automated by the possibility of placing the scanner on a stand with several (min. 3) degrees of freedom, and a robotic arm can also be used. When using the stand, manipulation is intermittent and manual. As mentioned, the principle of operation of the device ATOS GOM is triangulation of light.

Data analysis was carried out in MatLab software based on the algorithm presented in [1]. The verification was done by comparing the nominal and measured (statistical) geometry. The deviation results are shown in a spectrum of colors from green to red in next chapter.

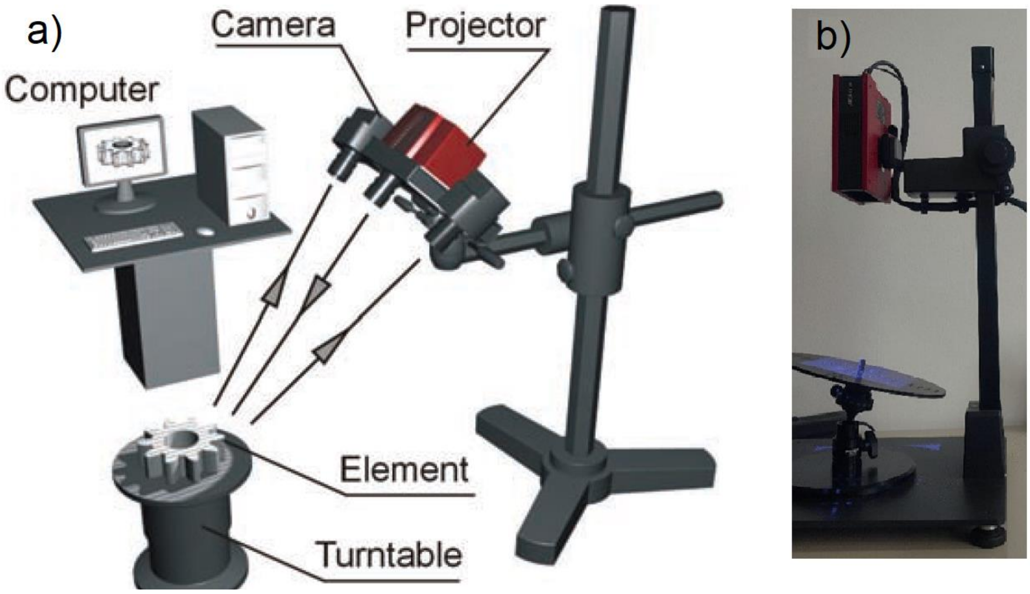

Figure 2. The measuring system ATOS GOM: a) schema according [3]; b) real system.

3. EXPERIMENT AND DATA ANALISIS

The first step in evaluating the accuracy of the machined part using a 3D scanner is to define a new coordinate system of the point cloud obtained by scanning, which should correspond to the coordinate system of the CAD model (Figure 3). After that, according to the algorithm defined in the paper [1], the nearest triangle of the representative CAD model from the selected scanned point is determined, as well as their mutual distance. Depending on the distance from the CAD model, a color contrast is added to each point that corresponds to its deviation from the nominal model. As a result, a colored model composed of a cloud of points is obtained with a display of the value of the deviation from the nominal model over a color tone (Figure 4). This method can not only be used to check the complete geometry of manufactured parts in real time, but it can also be used to evaluate the processing accuracy of individual geometric entities as shown in Figure 5. By comparing the obtained values with technical documentation or a predefined database, a possible is a simple real-time inspection.

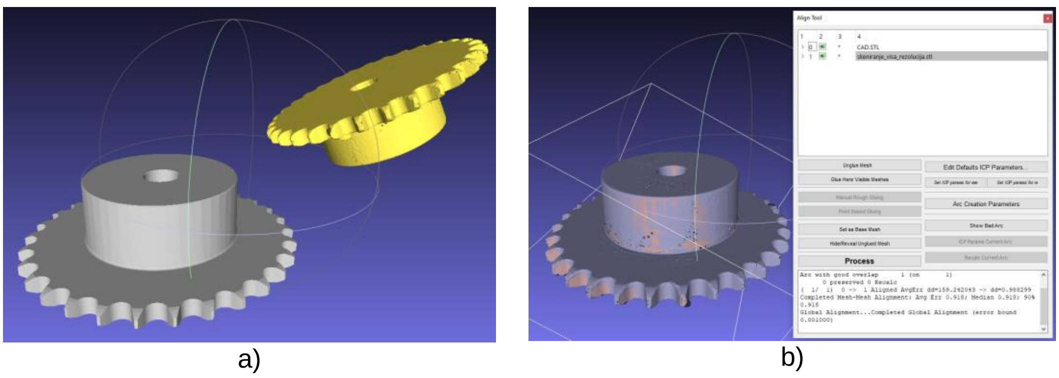

Figure 3. New coordinate systems: a) CAD model and point cloud with its coordinate systems, b) CAD model and point cloud with matched coordinate systems.

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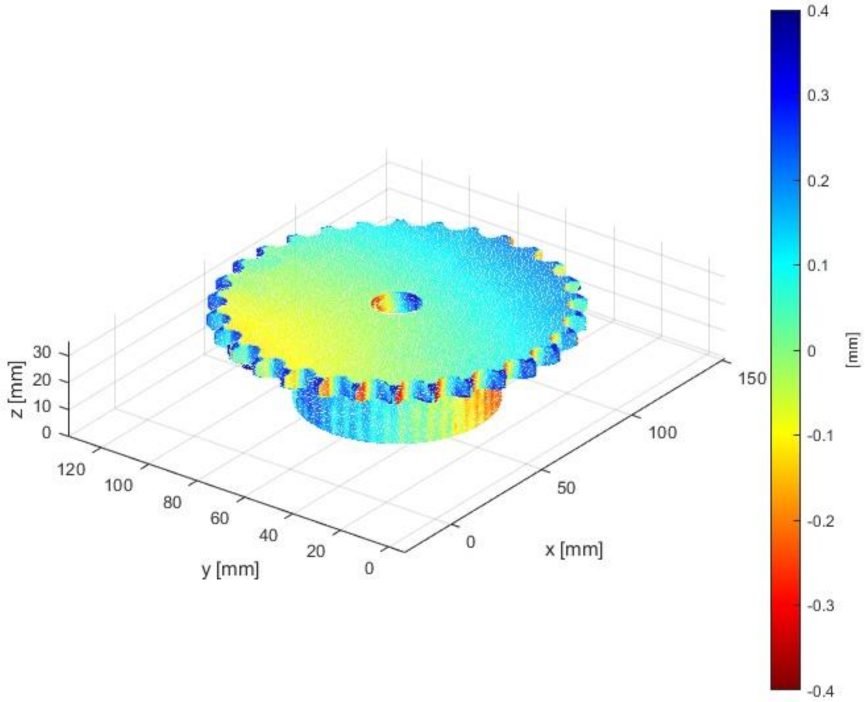

Figure 4. Measurement results using a 3D scanner and a developed algorithm [1].

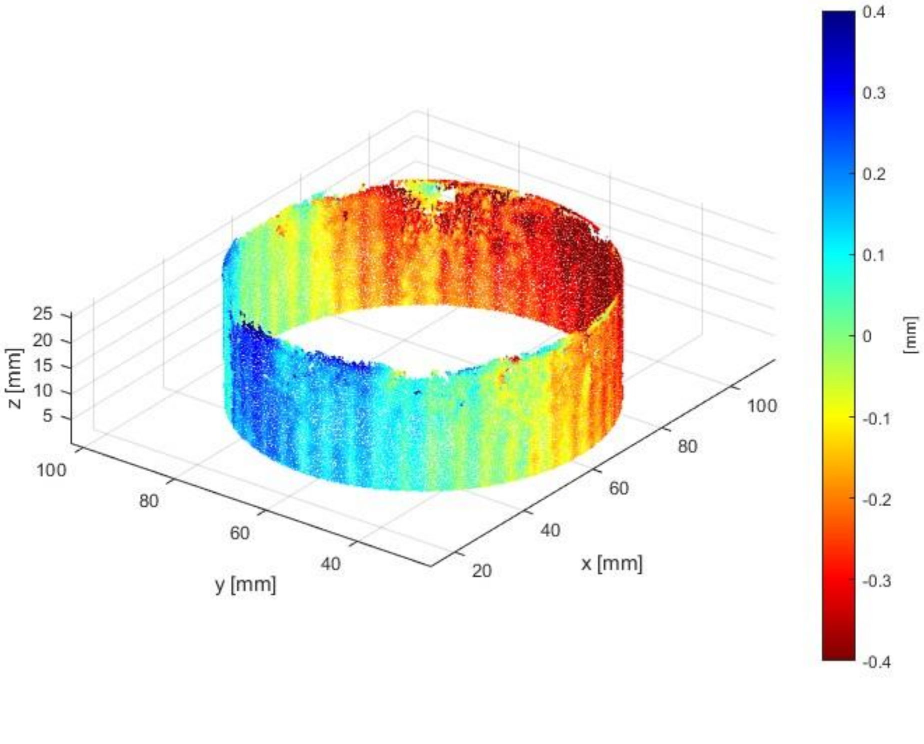

Figure 5. Measurement results of one entity (cylinder).

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4. CONCLUSION

3D measurement methods are in the expansion of application, especially in the final control of products. The easy use of the device and the quick acquisition of a big data set enable these methods to be used for measuring various forms (geometry) of machine parts. This paper presents an application of 3D scanning to inspection the geometrical parameters of the sprocket tooth profile in the final (post-process machining) inspection. A method of analyzing 3D scans was developed in order to define the permissible deviations of the geometric parameters of the sprocket tooth profile. The result of this paper is a new method of determining the conformity of the product by analyzing the deviation of individual geometric quality parameters -sprocket profile.

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