AUTOMATED MEASUREMENT OF BEVEL GEARS OF THE AIRCRAFT GEARBOX USING GOM

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Abstract

Manufacture of aircraft gearbox elements requires control of gear geometric parameters at different stages of technological process. Acceleration and automation of measurement process can affect the duration of the finished item production.

In case of measurement of gear wheels using modern technologies based on numerical machines, measurement process is based on processing of numerical data obtained by measurement using coordinate measuring machines. The goal of this paper is to present the opportunity to automate the measurement process of bevel gears, using coordinated optical scanner ATOS by GOM, equipped with a turntable.

Using coordinate measuring technique, you can specify a set of methods and procedures for the designation of the complex dimensions of physical objects and transform them into a computer program space of coordinate measuring devices.

The topics included in the article are intended to show the capabilities of the device used to improve the measurement process and shorten its time, and hence, lower its costs. Another thing described in the paper is the impact of measurement performance in automatic mode on the quality of performance - the numerical image of scanned surface, from the standpoint of accuracy and number of collected data points in the shortest time.

The article includes an analysis of conditions related to the measurement works, such as the process of preparing the model and measurement equipment and data processing capacity. The result of the work will be presented methodology for automated scanning measurements of bevel Sears.

Keywords: *gear, aircraft gearbox , coordinate measuring technique*

1. Introduction

Analysis of the accuracy of air items gears at different stages of technological process requires control of geometrical parameters with the use of coordinate measuring methods [1-4].

The development of coordinate measuring technique is closely linked with the development of computer-aided design methods. The measurement process is based on computer processing of measurement data to a discrete form, thus it is possible to determine the dimensions of the measured object in a virtual three-dimensional space. The measurement procedures are based on determining the value of the measured coordinates of points. In the initial phase of development of these basic methods of measuring device was a tactile coordinate measuring machine. At the moment, are booming photonics - using non-contact measurement methods coordinate data processing.

These methods allow you to perform measurements with high accuracy, allow a significant acceleration of the measuring process and the application of automation software and hardware of the measurement process [5-8].

2. Coordinate measuring system GOM

Coordinate measuring system GOM ATOS it’s a optical scanner allows you to perform measurements of the surface of objects with complex shapes including conical gears. Coordinate measuring system GOM ATOS it’s a stereoscopic system based on the two measuring cameras.

Moreover, the system still consists of a projector, a tripod, the control unit and a computer scanner. Schematic of measuring system with rotary table and a view of a measuring station is shown in Fig. 1.

Acceleration measurement process GOM scanner can be obtained using automation hardware and software. Automation hardware is installed, the measured object in the holder with additional axes of rotation. For stationary objects is also possible to install the measuring head on the robot arm. The first level of automation is to use a table with one axis of rotation. This is a solution to significantly accelerate the measurement process, particularly the elements which are axially symmetric gears.

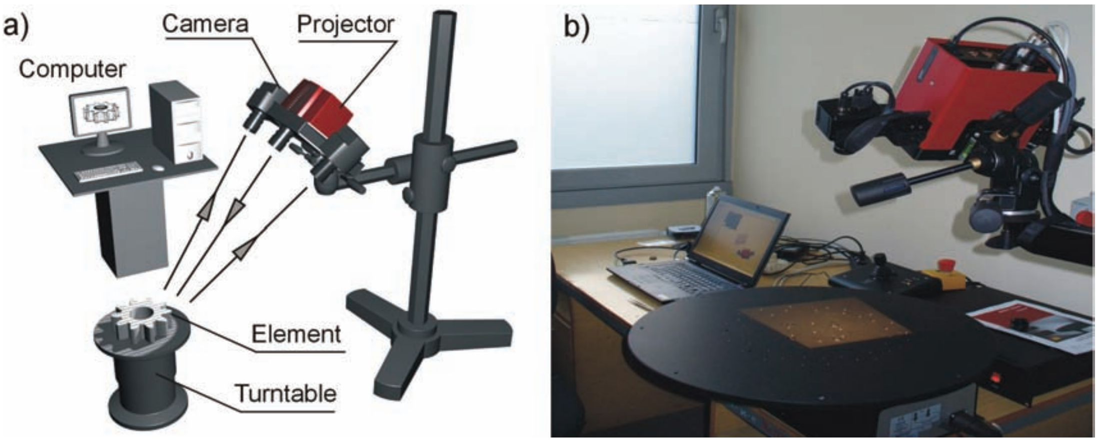

Fig. 1. The measuring system GOM ATOS: a) schema, b) photography

3. Preparation of an object to a measurement

The research is a bevel-gear Gleason type of aircraft gearbox. Preparation of an object to include measuring stick markers and reflective for the imposition of anti-reflective coatings. Markers placed on the test object or its surroundings, eg. scanner turntable serve for a process scanning as an reference points.

Fig. 2. Preparation of an object to measure: a) affixing markers, b), c) anti-reflective cover

These uncoded reference points are used to determine the coordinates of the measured wheel well to combine successive measurements. During the measurements, they are automatically identified and numbered sequentially. The volume of reference points depends on the size of the applied measurement field.

4. Preparation of the measuring equipment and measurements

Before the measurements to be made ATOS system calibration. The calibration is performed using a calibration disc depending on the applicable in the case of field measurement (Fig. 3a). Before proceeding to the proper measurement, you need to prepare a measuring system with rotary table.

To this end, reference points were placed on a bench, and then made measurements of their distribution (Fig. 3b). After such a measurement made, file with the measured data points of reference of the table was saved as the master file, and it constituted the basis for the implementation of the relevant measurements.

With this operation eliminates the need to deploy a large number of reference points on the measured circle, which is necessary when measuring in order to obtain the full geometry of the workpiece (Fig. 3c).

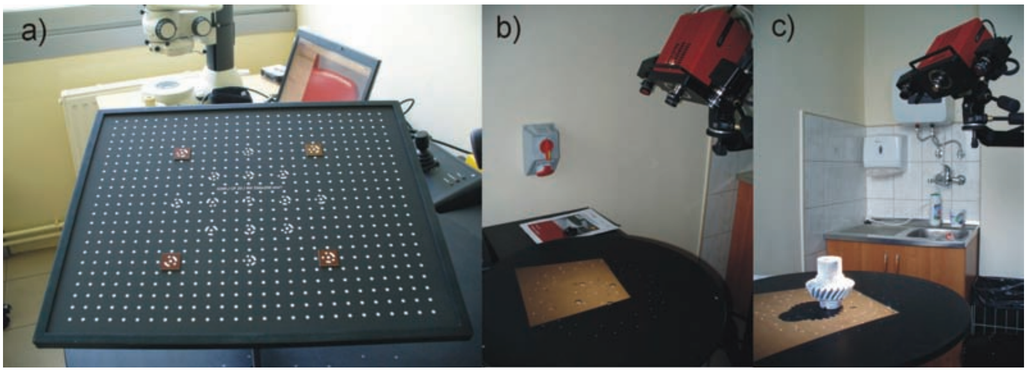

Fig. 3. Measurement with the rotary table: a) calibration, b) turntable calibration, c) measurements of gear

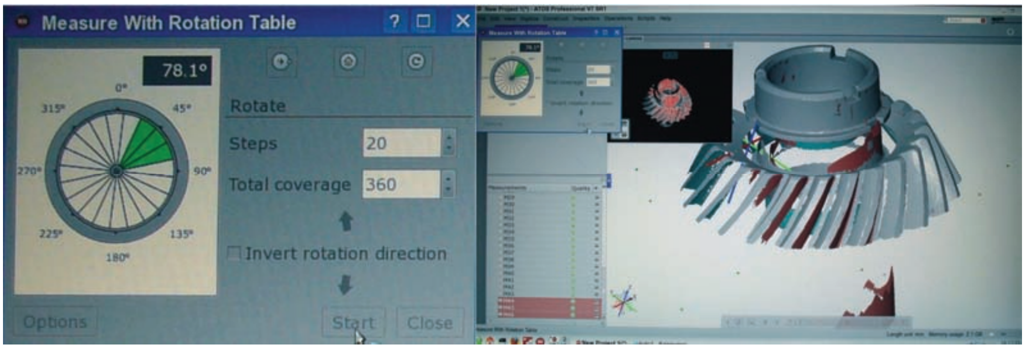

Fig. 4. Measurement pinion using the rotary table – data processing

Rotary table which is fitted to an optical scanner ATOS enables automatic measurement of the pinion, which took place at a given division into stages, rotation of the table (Fig. 4). Number of steps in the table which carries a full rotation is dependent on the complexity of the geometry of the measured element. In the present case (measuring pinion) dependence has been linked to the number of teeth measured wheel and on this basis was determined measuring the number of steps.

When measuring, collecting the measured geometry of circles, took place in an automatic way. After each change the viewing angle of the measuring table, the system automatically enforces the rotation of the table for another angle and surface scan conducted in this position. The measurement process for a given series of measurements was completed after the table is defined by the full rotation angle.

After such measurements should be made of the mutual submission of all the scan results. The software used in scanning systems GOM (ATOS Professional V7.SR1) allows you to combine scanned images until they receive the entire measuring area. As a result of the measured surface polygonyzation pinion, millions of points of measurement are described optimized mesh triangles. Measurement data thus obtained were applied to the nominal CAD model pinion (Fig. 5).

Application program GOM Inspection Module allows the subsequent analysis of the accuracy of the measured performance of the element with respect to the nominal model. The possibility of analyzing the whole item - described thousands or even millions of points - it gives a complete picture of the accuracy of its execution.

In addition, optical measurement coordinate system gives the possibility to use different systems of measurement to match the CAD model: the geometric elements, best-fit or RPS (Reference Point System).

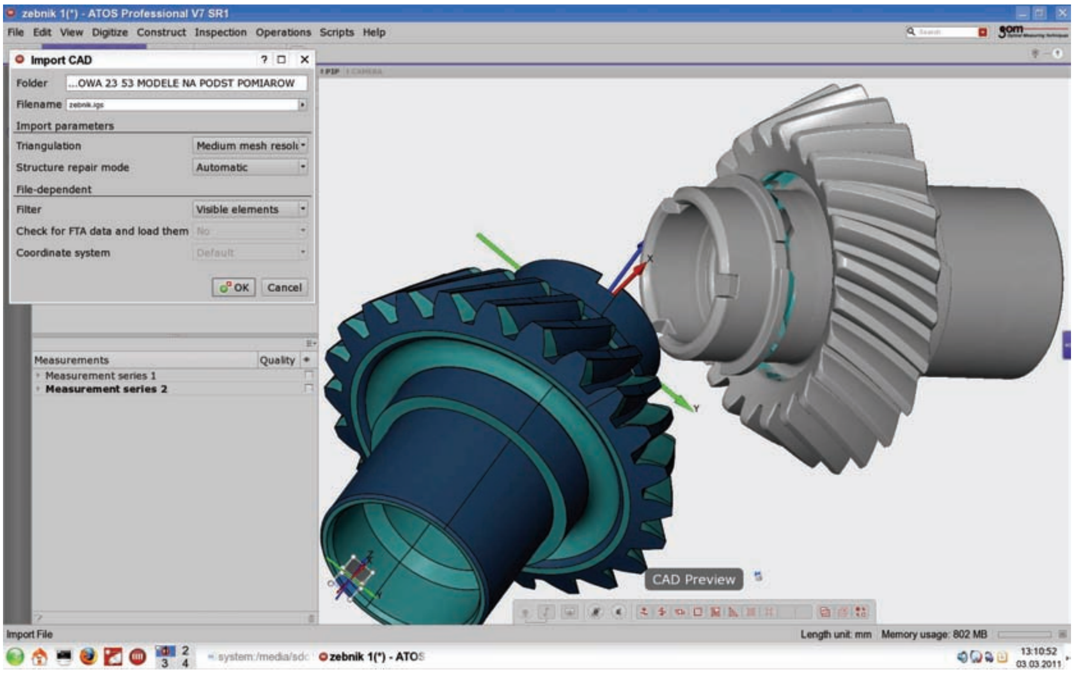

Fig. 5. Combining nominal model of the 3D-CAD with measure gear

In relation to the outline of the nominal deviations are calculated for all single points. Since the density of collected points is a big deviations are visualized as a color map. Analysis of the measured wheel is made completely in accordance with the coordinate system of reliance on the actual axis of rotation of pinion (Fig. 6). After such an analysis can be carried out to define the points of inspection and dimensions, which are included in the plan of measuring. Critical points can be clarified and documented for further analysis (Fig. 7).

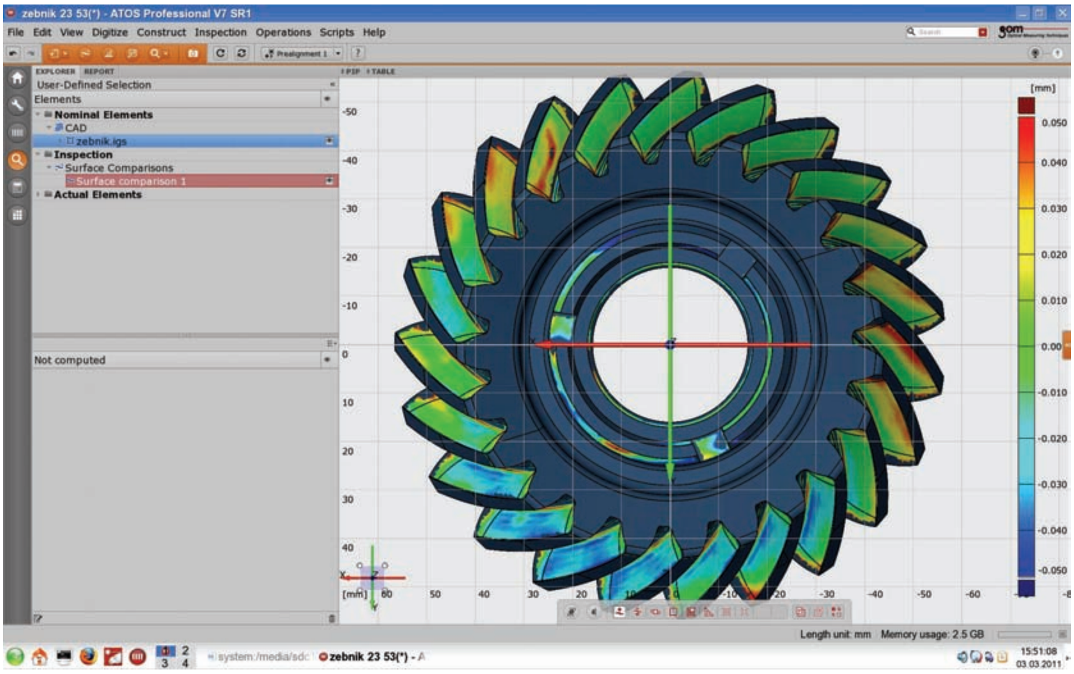

Fig. 6. Analysis of the pinion surface displacement with respect to the CAD model

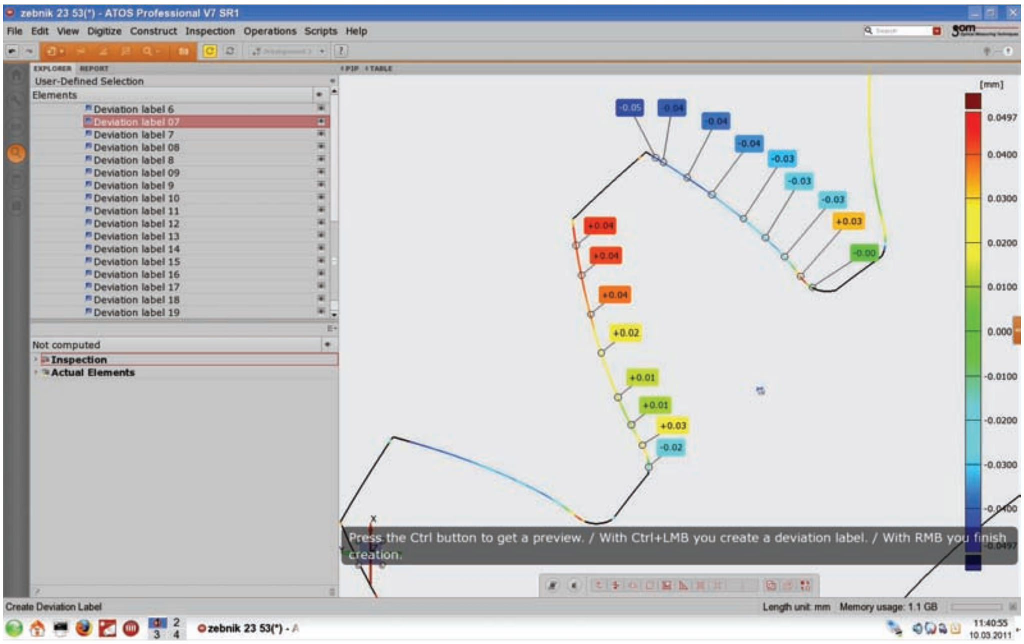

Fig. 7. Detailed analysis of the deviations from the outline of the selected values of the teeth measured wheel

5. Conclusions

Automated measurement of bevel gears using the gear air GOM can significantly speed up the scanning process. Process of automation does not eliminate the need for proper preparation of the model to measurements. However, gives the possibility of reducing the number of points on an object stuck through the use of the base element which is the surface of rotary table.

When measuring objects with a regular - axially symmetric structure, there may be errors, adverse events based on the results of a limited number of reference points. The correct setting of light intensity and adequate to cover the surface of the reflective model ensures correct identification of an appropriate system of numerous markers.

The accuracy of optical methods of measurement and depends on the ATOS system: camera resolution, stability, number and rate of recovery of images, the visibility of markers on the surface of the object being scanned, the calibration procedure and software used.

Acknowledgement

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