

QUALITY CONTROL AND INSPECTION OF BEVEL GEARS OF THE AIRCRAFT GEARBOX UTILIZING THE ATOS 3D SCANNER

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Abstract

Quality control gears of aircraft gearbox has become a key component in today's manufacturing process. Optical 3D scanning, based on the principle of fringe projection, has proven to be both an accurate and cost-effective alternative delivering more dimensional information to aid in quality control and process optimization by creating more meaningful measuring reports.

The ATOS 3D BLUE LIGHT optical scanner has a unique capability of being user-configurable to address various measuring requirements. This is accomplished via the user's ability to change measuring volumes in minutes, in order to increase scan data resolution or increase the measuring field of view. The paper presents the opportunity to automate the measurement process of bevel gears, using coordinated optical scanner ATOS 3D "white light" version and "blue light" version.

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 in both version of ATOS Scanner. 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.

Keywords: *bevel gears, 3D scanning, quality control*

1. Introduction

Analysis of the accuracy of aircraft 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, there 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 [5-7].

2. Coordinate measuring system GOM ATOS II Blue Light

Coordinate measuring system GOM ATOS it's an optical scanner allows you to perform measurements of the surface of objects with complex shapes including conical gears. Coordinate measuring system GOM ATOS II Blue Light 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. 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 II Blue Light

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, e.g. scanner turntable serve for a process scanning as reference points.

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.

3. Preparation of the measuring equipment and measurements

Before the measurements to be made ATOS II system calibration. The calibration is performed using a calibration disc depending on the applicable in the case of field measurement (Fig. 2). 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. 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. 2. Calibrations of GOM ATOS II Blue Light scanner

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. 3). 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 V7.5) allows you to combine scanned images until they receive the entire measuring area. As a result of the measured surface polygonization pinion, millions of points of measurement are described optimized mesh triangles. Measurement data thus obtained were applied to the nominal CAD model pinion (Fig. 4).

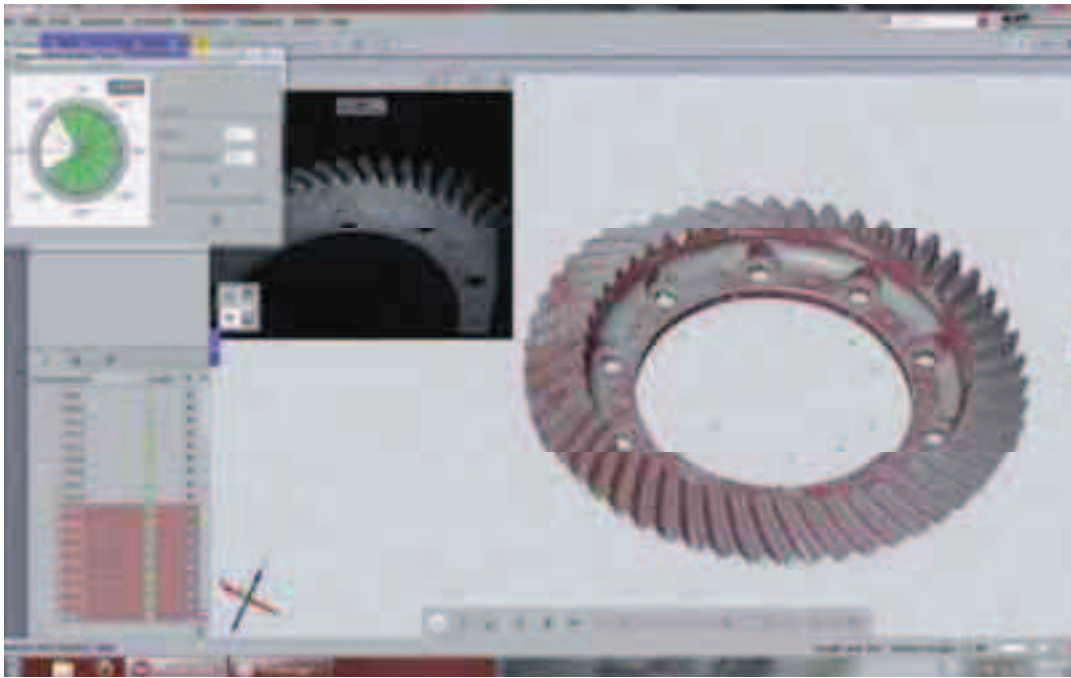


Fig. 3. Measurement pinion using the rotary table – data processing



Fig. 4. Combining nominal model of the 3D-CAD with measure gear

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, the best fit or RPS (Reference Point System).

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 colour 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. 5). 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. 6).

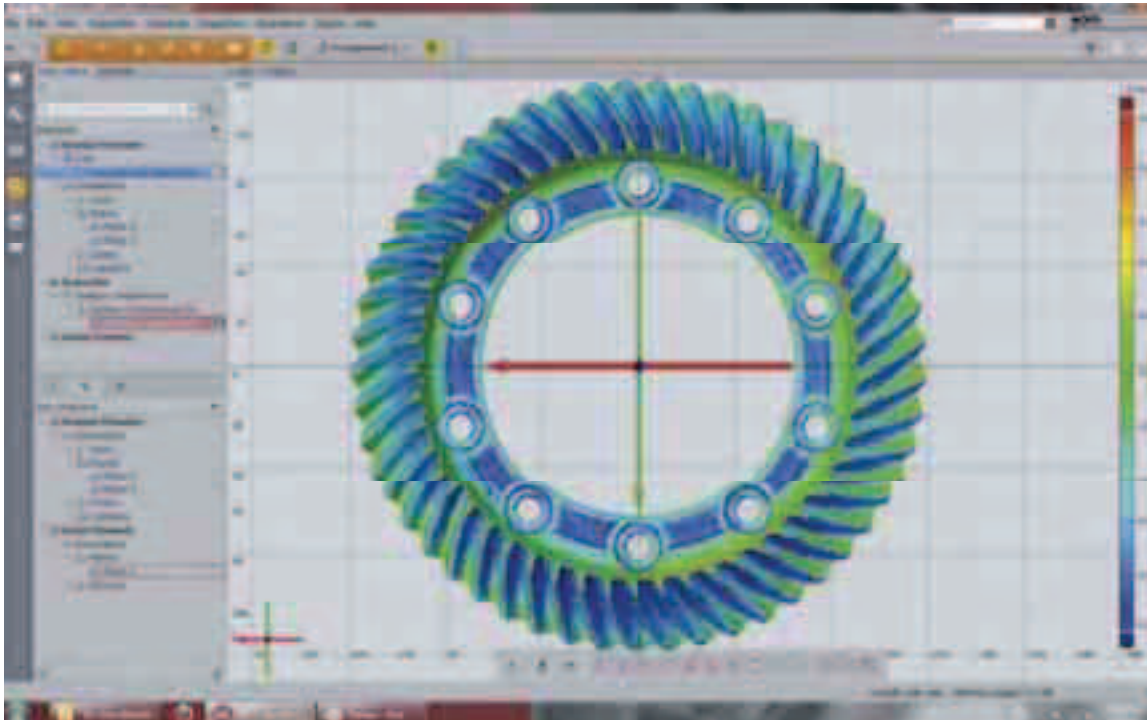


Fig. 5. Analysis of the pinion surface displacement with respect to the CAD model

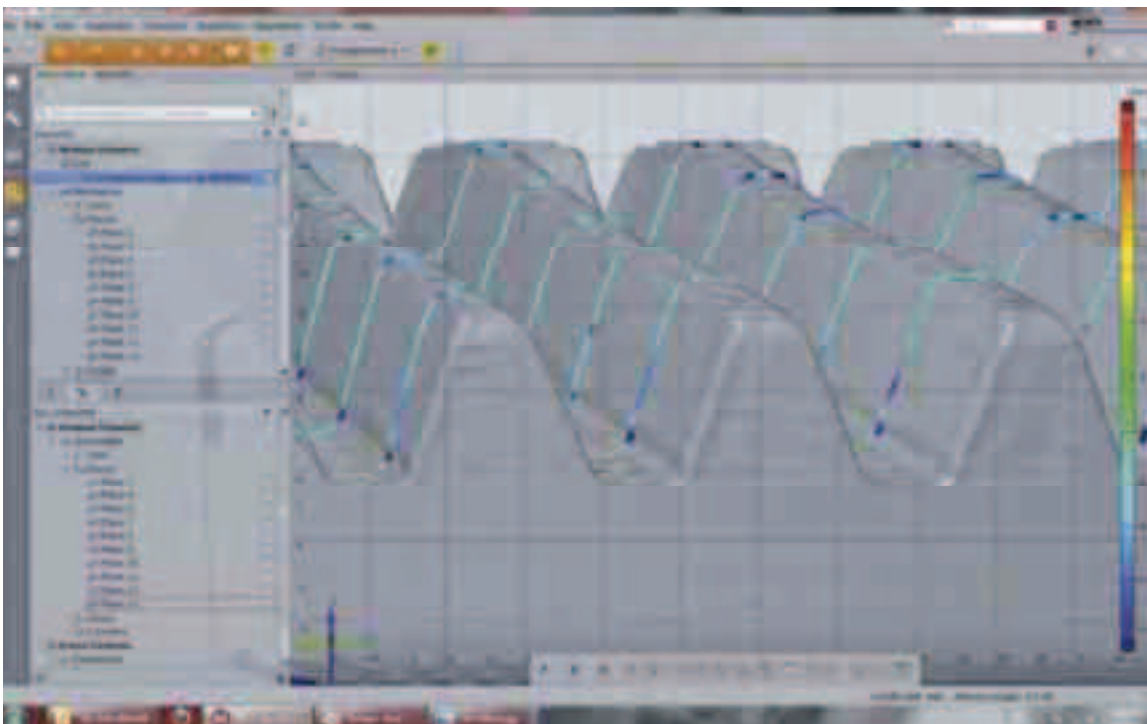


Fig. 6. Detailed analysis of the deviations of the selected values of the teeth measured wheel

Conclusions

Measurement of bevel gears using the GOM ATOS II Blue Light can significantly speed up the scanning process and accuracy of measurements. Process of automation does not eliminate the need for proper preparation of the model to measurements in Blue Light technology. 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 (e.g. wheel of gear), 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 II Blue Light 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. Outdoor lighting has little influence on accuracy of scanning process with ATOS II Blue Light system.

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