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ENGINEERING APPLICATION OF REVERSE ENGINEERING TECHNOLOGY

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Abstract: Scanners operating on the optical principle are devices for recording the physical geometry of bodies suitable for non-contact measurement which work in the visible light range. These use the difference in contrasts and the strength of the reflected light for the measurement, by using the classic triangulation principle. This article focuses on reverse engineering technologies and optical scanning process.

Keywords: *digitization, scanning, optical scanner*

1. INTRODUCTION

The two main units of the optical scanner are the projector and the video camera. The projector projects contrast on the object to be examined by projecting a "light-dark" net consisting of increasingly thin bands. The change of border areas of brightness and contrast grid creates comparison data. The difference between the angle of reflection and incidence gives the extent and shape of the object measured at a given point. Averaging principle based on differences creates data, that is, in contrast to 2-dimensional cameras, measurement results without data distortion can be obtained. The surfaces of the object scanned with bright-dark contrast and the reflected light are recorded by one or more colour digital camera. The resolution of the received image, i.e., the digital copy of the object, changes depending on the CCD, i.e., the imaging chip of the digital camera [1], [2].

2. SCANNING PROCEDURE

The Department of Machine Tools of the University of Miskolc has a Breuckmann Smart Scan 3D-HE type three-dimensional optical scanner, with the help of which it can carry out such scanning tasks [3]. A high-resolution scanner alone does not

guarantee that the obtained point cloud accurately shows every detail of the object to be scanned. It happens that due to the particularity of the object, we receive confusing or incomplete information (noise) from the surface of the object. Professional software are needed for the correction of these. To carry out the reparation with software the Geomagic Studio software can be used well. top-quality Smart Scan 3D-HE mobile scanner can provide high-precision 3D coordinates of any object within seconds [4]. The size of the object can vary within wide limits thanks to different sets of lenses, the device also handles shapes with complex geometry excellently. In addition to recording points with a positional accuracy of even less than a hundredth of a millimetre, the system can also recognize and record the colour of the object in the 3D digital file. The scanner works in the range of visible light and collects information about the surface of objects by non-contact sampling. Its main parts are the camera system which consists of two 5 megapixel cameras each, and the central projector which illuminates the objects. Figure 1 shows the image of the illuminated object.

Figure 1. *Illuminated object*

The central projector projects a continuously thickening contrast grid to the surface which consists of vertical ‘dark’ and ‘light’ lines. The distortion of this light grid on the surface of the scanned object provides information about the appearance of the surface. The distorted light grid is photographed by the two cameras, after which the 3D point cloud is created by the software belonging to the device. The cameras have an exchangeable lens system, with the help of which the size of the field of view can be changed. The images taken one after the other are stitched together by software, so we get a complete 3D image of the body to be scanned. The scanning control and data collection software is Optocat. After the scan, a common section of the images in the field of view of the camera system is

displayed on the computer. The images taken one after the other are placed in the software's own global coordinate system, so they have a different orientation than the recordings of the previous scans. The program therefore does not automatically join the images, this task must be performed ‘manually’. Figure 2 shows the consecutive recordings in the unstitched state.

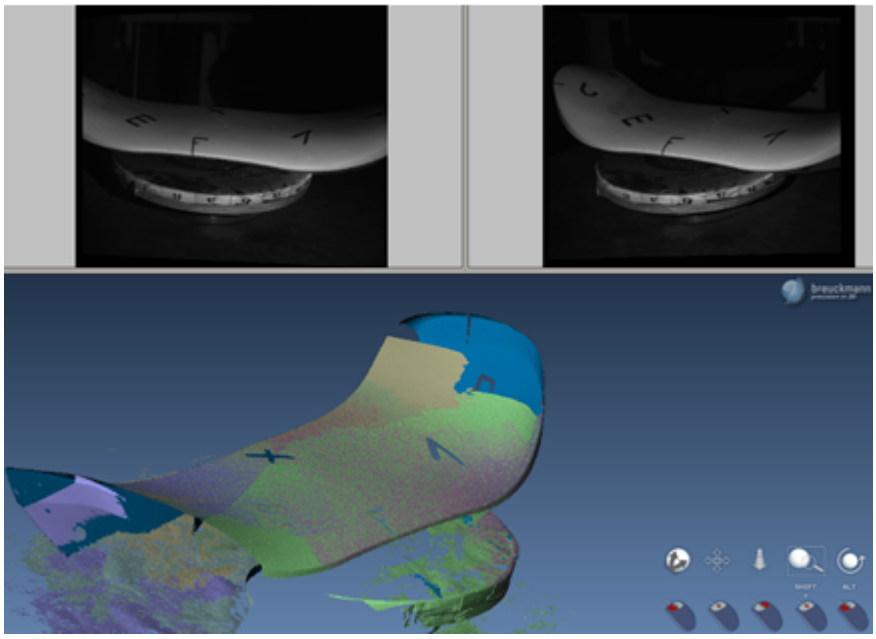

Figure 2. *Scanned objects*

In every case, the more recent pictures must be matched to the previous shots to get the full body model. Stitching is done using markers, as shown in Figure 3.

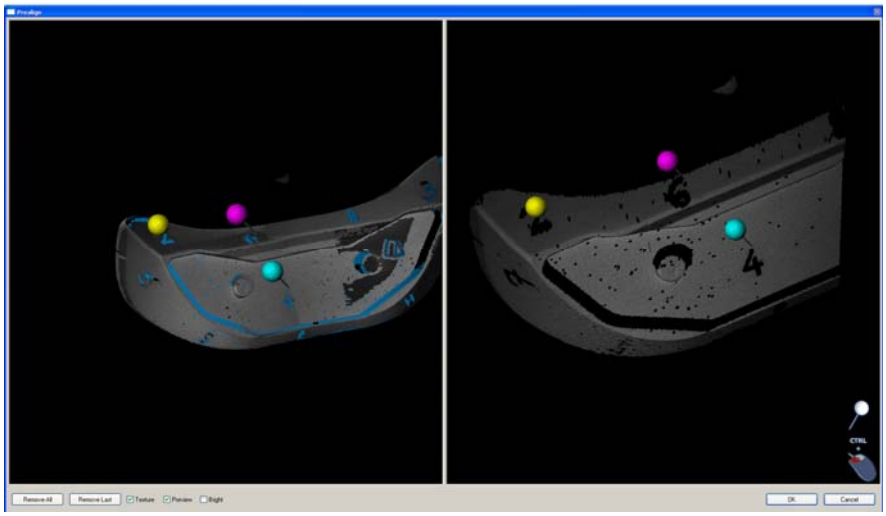

Figure 3. *Connecting 3D objects*

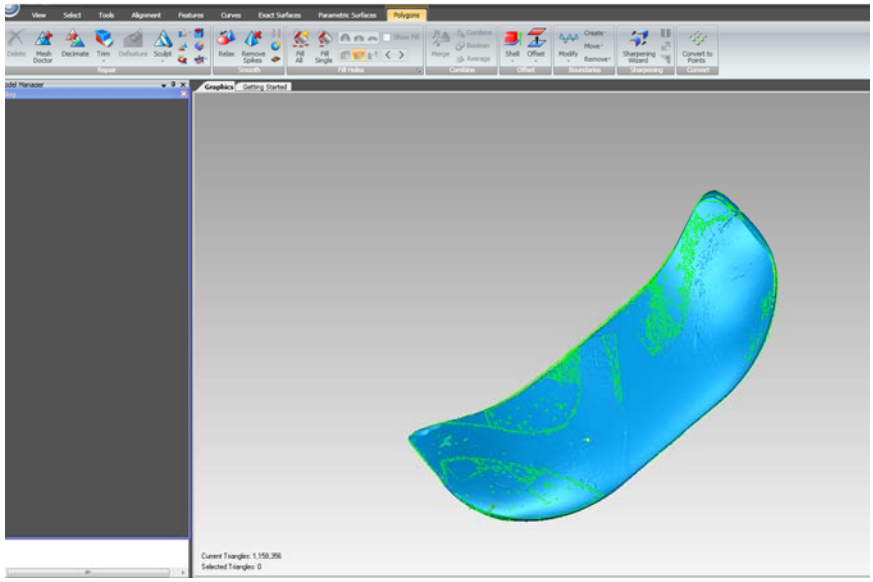

Figure 4. *Correction of model*

The software compares the points in the vicinity of the 'manually' placed markers on the two images (the last scanned part and the previously joined details) and expands the model by assigning the matches to each other. Thus, we get the 3D point cloud corresponding to the entire body. The Geomagic fits surface for the point cloud saved from the Optocat software, in this way the modification and the correction is easier. As it can be seen in Figure 4, with the help of the program, we can remove surface protrusions, unnecessary points, created surface markings and we can eliminate possible continuity gaps.
After this, the corrected model (see Figure 5) saved in a suitable file format can be used for CAD software or RPT technologies.

Figure 5. *Correct model*

3. CONCLUSION

The modern procedure using 3D optical scanning provides an effective tool for size and shape checking, in addition, it can be a good help during finalization of production program and technology objects with complicated surfaces.

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