Measurement technique analysis of shaped surfaces

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Abstract. The article describes the measurement technology of various complexity surfaces and the reconstruction of the measurement task using CAD software. For example, I present a wave-shaped wheel, a crown gear of spiroid worm gear drive, and a hip joint prosthesis measurement with a coordinate measuring machine. In the case of the prosthesis I have also reconstructed the measurement tasks for further analysis and testing. These results are also presented in the article.

1. Three coordinate measurement

Basic principle of the coordinate measuring technique is simple extremely. The co-ordinate is the physical base a measuring machine (figure 1.) he makes sure, which is at right angles standing with axie of the three (the letter x, the letter y, the letter Z) he is embodying a spatial frame of reference, and hereupon along axies moving possibility they assure a basic system for the measure probe. He means the relating to matters of principle base, that any shape is can be mapped with points, at the same time you the point with time value of the letter x, the letter y and the letter Z with one voice representable in a frame of reference. Measurement has it cultivated it is lying in during the coordinate measuring technique so that we decide upon time values of the letter x, the letter y and the letter Z to different points, then we are figuring the characteristic wished for out with the help of points hereupon. To this on the other hand a perform also need the following conditions is:

- he has to measure taking place moving along up the three a forming a right angle to axie to each other need is in all 3 directions some kind of lenght measured for system,
- the wished for points he has to be able to record, need was a probe system,
- the registered he has to size points up, there is need for computational background.
Main point: the workpiece is scannable with a touching element. For the workpiece as you wish put measured points, and these taking up of his is possible with in a short while large punctuality. Theoretically a co-ordinate measuring machine separately a length measured system 3 conquer it in its seminal, an orthogonal measured axes, what a right-angled co-ordinate system create. In this coordinate system known 3 coordinate of the central point of the measured probe [1].

With this measurement, in principle any workpiece of geometry can be measured and verified. Some practical applications are shown in the following diagrams (figures 2 - 5).
2. Complicated shaped surface – hip joint prosthesis

Hip prosthesis is one of the most complicated prosthetic prostheses, as it must allow provide three-dimensional movement. The hip prosthesis (the implant) is made of either stainless steel or other metal, such as a stem and ball head made of titanium, and a polyethylene "counter". The metal ball head spins in the plastic counterbalance, which is implanted in the hip bone.

2.1. Acetabular measurement

To measure acetabular, as it is a hemispherical body, it was necessary to have a clamping device (figure 6). To make the measurements, I wrote a measuring program using the PC-Dmis software.
Figure 6. Measure of acetabular cup

After the program, we also received the model of the vase wireframe and extracted the coordinate values in the IGES file. I was able to draw the already weighed, defective surface, using this file and a design software.

Figure 7. The measured socket the representation of his picture and a graphic designer

2.2. Reconstruction of the measurement points
The reconstruction of the measurement points carried out with the help of several types of 3D design software, at which I applied the bases of computer geometry and graphics. For instance I used Hermite – interpolation [2] for the composition of the curves.

2.2.1. Hermite – interpolation
Tertiary Hermite – interpolation used not only with interpolated points, but we presuppose the tangent vectors for known one in these [3]. These are sketched with the help of Hermite – arcs visible on the figure below (figure 8).
The surface of the worn cup was reconstructed with the help of the measured coordinate values (figure 9). After it the differences in wear were determined as it can be seen on figure 10.

**3. Determine a coordinate system that is needed for modelling**

As I have already mentioned, the femur head moves in the vault. To create the motion model, it is necessary to determine the coordinate systems that will make the movement of the vagina and the femur head more transparent. This requires the coordinate system of the vase as a standing coordinate system, as the hive is recorded in the pool bone. The femur head can be moved by a coordinate system and a rotating coordinate system. The former is the resting position, the latter when the patient moves. These coordinate systems were taken from the Dudás mathematical model (figure 11).
Figure 11 Coordinate systems

These coordinate systems were used in the simulation.

3.1. Simulation of the deviations
A FEM simulation was performed in order to get information about the deviation of wear values. The ANSYS finite element software [4] has been used for the investigation. Construction of the 3D model of the socket and ball was necessary to the investigation. It was designed with the software Pro Engineer.
The analysis was done in static state.
Simulation of dynamic for reaching dynamic state simulation, input parameters were set up as changing in time.

3.2. Steps of the analysis
3D models of the acetabular cup and the ball was designed as two parts. Before simulation they have to be assembled (figure 12).

The test was made in two different ways:
First we put the sphere head and the socket in each other and some force was applied towards the centre (figure 13). After the test we analysed the findings separately for the sphere head and the socket (figures 14 and 15).
In the second stage we applied the torque to the system and we examined tension and values of deformation (figures 16).

Figure 13 The analysis of tenseness and deformation, in a complex state

Figure 14 The analysis of tenseness and deformation on the head

Figure 15 The analysis of tenseness and deformation on the socket
Figure 16 The analysis of tenseness and deformation on the socket

4. Summary
3D Measurement Techniques, as we have seen, can be measured with a very wide variety of complex shapes and complexes. Depending on the purpose of using high-precision gauges, we can use it to audit production processes or to identify defects in the quantities, both in volume and graphically. Using the coordinate values defined by the coordinate measuring machine, we can create 3D models which can be further analyzed, simulated, and examined for its function and the effect of influencing factors.

By modelling or simulating, we can change geometric and other parameters even in the design phase.

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