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CAD MODELS OBTAINING FOR ECO-TECH AND BIOMECHANICS

BRAUN, B[arbu] C[ristian]; REPANOVICI, A[ngela] & IONESCU, M[ircea]

Abstract: *The paper presents the comparison between different methods to scan two types of probes, one of them having application in Eco-technology, and another used for Biomechanics. For both probes, we applied two different scanning methods to obtain the CAD models - the first one is referring to the use of a handy laser scanner and the second one, to a coordinate measuring machine that scans the model surface. Our study on these scanning methods optimization represents a step in the interdisciplinary improvement of the simulation and prototyping of some components in Biomechanics and Technology for a proper and non expansive behavior analysis just in the projecting phase of a finite product.*
Key words: *probe, scanning, surface, CAD*

1. INTRODUCTION

Nowadays two methods for scanning objects with complex geometry were developed: the first with contact and the second without contact for the measuring surfaces, for rapid image obtaining.

The aim of our study was to evaluate both of them in order to obtain a CAD model of an object presenting complex geometry, as we meet currently in different domains applications. Consequently, our research was dedicated to distinguish which of above mentioned scanning method could be a proper solution for two types of proposed research probes.

Due to the fact that nowadays Biomechanics and Eco-technology are both very important domains, we have chosen two representative probes as study objects.

The first object is a wind turbine blade, which obtained model will be used for its behavior analysis (by simulation) in real conditions.

The second object to be studied is a primary model of a human foot (figure 1). Its CAD model will be modeled and analyzed for prototyping some orthesis serving to improve standing and locomotion parameters of handicapped persons.

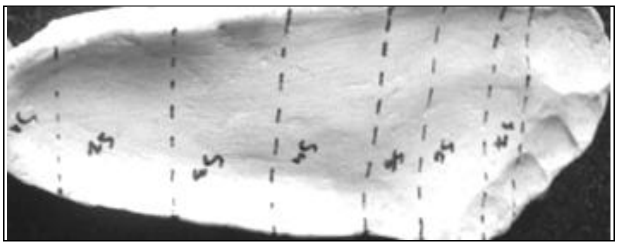

Fig.1. The foot primary model

2. THE USED EQUIPMENT AND METHODS DESCRIPTION

For each object the two scanning methods were used: the first one invoked the use of a coordinate measuring machine, *DEA GLOBAL Performance*, having the contact with the measured surface. The main technical characteristics are presented below:

Measuring range (OX/OY/OZ) [mm]	500/500/500
Measuring accuracy [mm]	0.001
Air consumption (ISO 8778) [l/s]	2.5
Work temperature [°C]	10 ÷ 45

Tab.1. The main characteristics of the used MMC *DEA GLOBAL Performance* [1], [2]

The second method, meaning the non contact surface scanning, a 3D handy scan with laser beam, *EXAScan 30144* (Canada) was used. The main characteristics being are presented in the table below:

Measuring range [mm]	45
Measuring distance [mm]	300
Measurements [measures/s]	25000
Resolution (x, y, z axis) [mm]	0.05

Tab.2. The main characteristics of the used 3D handy scan, *EXAScan 30144* [7]

By the first method, the scanning was made by touching point by point the probe's surface. To perform the model scanning, the *PC-DMIS* software interface of the measuring machine was used. [3]

To obtain a proper CAD model, respecting the scanning accuracy, the wind turbine blade was scanned successively on both lateral surfaces. For each lateral surface, we proceeded to divide its length into 4 equidistant scanning zones, named 0-1; 1-2; 2-3 and 3-4. Due to the irregular geometrical form, in order to ensure a proper scanning, each equidistant zone was divided in distinct mode finite areas for scanning.

For each finite area, we have choose the Patch method, with an increment of 4 mm for x and y axis, in order to ensure a high scanning resolution reporting to the necessary working time [3].

The increment of 4 mm for both X/Y axes was established experimentally: in our research we observed that a lower resolution was not enough to obtain an accurate CAD model. Besides, for a higher resolution, the necessary time for scanning was considerably greater, while the obtained CAD model quality increasement was not very significant. For this reason, a higher scanning resolution was nor justiable [4].

The graphic resulted while scanning for each finite area can be seen in figure 2.

Each scanned equidistant zone was exported as IGES file, in order to be recognized as CAD file, as cloud of points, as it can be seen in figure 3.

In the future, our research will be focused to put together all zones into a single CAD model, representing the blade model. It could be further used for its behavior simulation in different dynamic environments.

For the foot model, the procedure was similar, but in this case the probe's dimensions allowed performing a single scanning operation. As a result a CAD model was obtained, as shown in figure 4.

On the non contact scanning, the first needed operation is calibration of scanner, in order to ensure the scanning accuracy and to establish properly the sensor's measuring range. Further, we proceeded to scan the model's entire surface, respecting the necessary measuring distance, correlated continuously with the sample profile, via associated software [5], [6]. After scanning, a filtering operation was necessary and performs as to eliminate the parasites areas (figure 5, a).

In our research we applied followed two ways to calibrate the scanner: the first one invoked the calibrating manually, by establishing the proper scanning distance to the object's surface. It was manually established the corresponding distance to the highest scanning resolution. For the second calibration way, we choosed the option *Auto Adjust*, the proper distance being made automatically by software.

For the foot primary model it was observed that for regular surfaces the *Auto Adjust* calibration option ensured an accurate scanning in s short time. For complex surfaces (like fingers area), it has been proved that the manual scanner calibration is a better solution on accuracy. The CAD model obtaining was made by using both scanner calibration methods, so that the total necessary time for scanning was about 6 min.

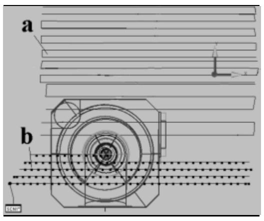

Fig.2. The graphic results while scanning: a) - after scanning; b) - during scanning

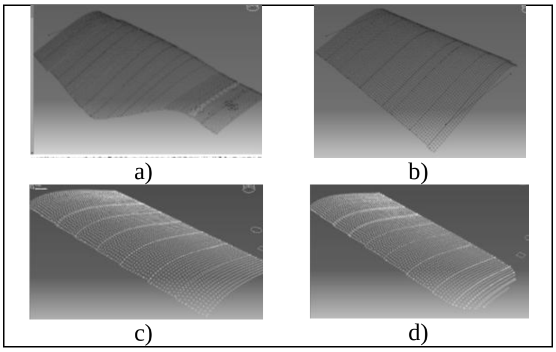

Fig. 3. The CAD models for each equidistant scanned zone portioned from the blade's 1st lateral surface: a) zone 0-1; b) 1-2; c) 2-3; d) 3-4

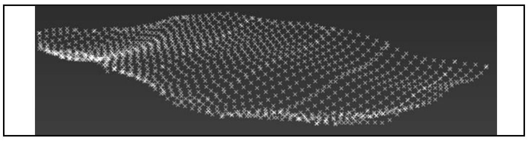

Fig. 4. The foot CAD model obtained after scanning, using the coordinate measuring machine.

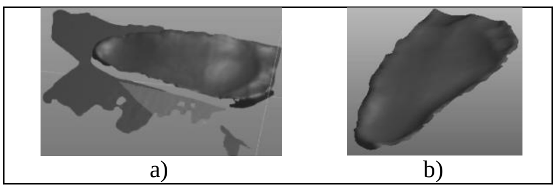

Fig.5. The procedure of obtaining the foot CAD model by scanning, using the laser beam 3D handy scanner: a) the filtering of model's intermediate image; b) final model

3. CONCLUSIONS

The second method, meaning the laser beam 3D handy scanner using could be successfully applied only for the foot model. Because of the wind turbine blade great dimensions, it was possible to scan only the two ends of the blade. For the surface area that it could be scanned, the *Auto Adjust* calibrationg method was used, due to the blade's regular surface.

Both researched objects through the present study took into account, first of all, to obtain a CAD model via scanning methods resulted in some further research directions. The first one invokes a research team from Transylvania University from Brasov who makes some studies on the simulation of the blade's behavior in different dynamic conditions, in order to optimize its design just in primaries projecting phases, without additional costs.

The second research direction on the Biomechanics application is joined to a post doctoral theme on the prototyping of some orthopedic elements designated to correct the stability and locomotion parameters of some persons with disabilities

Obtaining the CAD models, by different scanning methods, represents just the first step of both researches, the aim of this study being to establish which scanning method could be the proper solution. As we could see from our scanning results analyze, a rapid scanning using the non contact method seems to be a good solution if an immediately CAD model obtaining and modelling is required. The solution could be successfully applied for different object without radiant surfaces, with application in any domain. But, if different accurate geometric parameters must be also known, the method based on the use of coordinate measuring machines is the correct solution. Besides, our researches demonstrated that this method is more proper and efficient for high dimension objects like, for example, the wind turbine blade.

4. ACKNOWLEDGEMENTS

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