

Unique problems of a structured-light 3D scanner during scanning of various wood species.

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Abstract: The article describes the principles of operation and unique problems that might occur during scanning of samples of various wood species with a structured-light 3D scanner. The article describes (according with literature) where structured-light 3D scanners are classified in the general 3D scanning devices taxonomy. Additionally, the article shows how to solve certain problems that might appear during scanning of certain types of wood species.

Key words: 3D scanner, 3D scanning, structured-light, matting spray,

INTRODUCTION

A 3D scanner is device that measures an existing object in three dimensions, allowing the user to quickly create a 3D model of the scanned item. The variety of 3D scanners available on the market is rapidly growing and different types of 3D scanners have different advantages and disadvantages.

According to Seitz and Curless [2000] and Rychlik [2007] 3D scanners could be divided to two basic groups (according with the method of shape acquisition). The two main groups could then be divided into subgroups etc. One of the most popular types of 3D scanners available on the market is a non-contact, reflective, optical and active device using visible light stripes projected from a digital projector. A non-contact scanner is a device that does not touch the measured object during measuring. A reflective, optical and active scanner uses a light pattern (projected by the device) that is visible on the measured object. A camera measures the object thanks to the distortion of the light pattern on the surface of the object.

A projector from a structured-light 3D scanner projects a pattern on the scanned object. Usually the pattern is a series of white, blue or green stripes with a black background. The width of the stripes changes during scanning allowing the scanner to collect all the data needed to measure the object in a specific position in relation to the scanner. The sensor recognizes the stripes from the pattern and creates a matrix with X, Y, Z coordinates for all the points that the camera can see. The gathered data is called a point cloud. One camera can find points only in a specified closed area called the measurement volume.

Structured-light 3D scanners have limited measurement volumes due to the fact that the projector must be able to project (focused) stripes and the camera must be able to see them. If the stripes are too thin the camera sensor will ignore them, because they are on a surface (of the measured object) that is too close to the projector. If the stripes are too wide the sensor will also ignore them because they are on a surface too far from the projector.

Moreover the environment in which the scanner is working has to be prepared correctly. If the ambient light is too bright the sensor will have problems with distinguishing the edges of the stripes resulting in low quality scans [Rychlik 2007]. A structured-light scanner works best in pitch-black rooms. The environment should be dust free, because any

speck of dust between the scanner and the measured object could result in unwanted noises appearing in the finished scan. The surface of the measured object also has to be prepared to obtain the best (or sometimes any) results [Wylezoł 2006]. A structured-light 3D scanner is unable to scan transparent objects, because of the lack of visibility of the stripes. Black and some very dark colors are impossible to scan because the sensor is unable to differentiate the light stripes from the black background projected on the surface of the object. Reflective surfaces are also impossible to scan, because of the light reflection (similar to a camera flash visible in a mirror) of the projected stripes. To avoid light reflections and to enable the scanning of black and other dark colors, a matting coating (usually white) needs to be applied on some surfaces. To obtain a matte surface anti-glare spray may be used. The spray is filled with fine-grained white matte powder. Although a structured-light 3D scanner (usually) can see different colors, the best results are obtained when the scanned object is pure matte white, which offers the best contrast for the stripes. When a surface is black the camera does not see any stripes which results in an empty space in the scan; resulting in the same effect as when an object is outside of the measurement volume.

MATERIALS AND METHODS

During scanning of various species of wood the following equipment (Fig.1) has been used:

- 1) Smarttech 3D Dual volume scanner with 2 independent measurement volumes, each with a 5 megapixel camera
- 2) HP laptop workstation
- 3) Mesh3D - 3D scanning software.

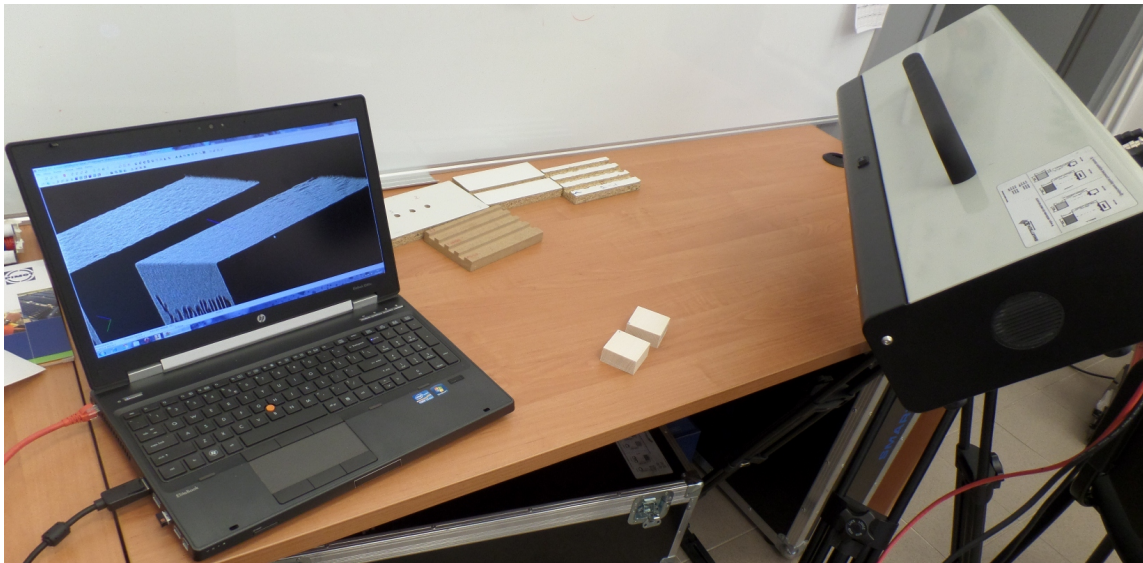


Fig.1. Layout of equipment used for scanning

For test scanning the following wood species have been selected: Beech, Merbau, Oak, Obeche, Poplar, Spruce, Tatajuba, Wenge. All the samples had similar dimensions. They were approximately 50mm wide, 50mm deep and 25mm high.

RESULTS AND DISCUSSION

After placing the scanned object in the measurement volume the scan was executed and in a couple of seconds a point cloud is visible on the computer screen (Fig. 2)

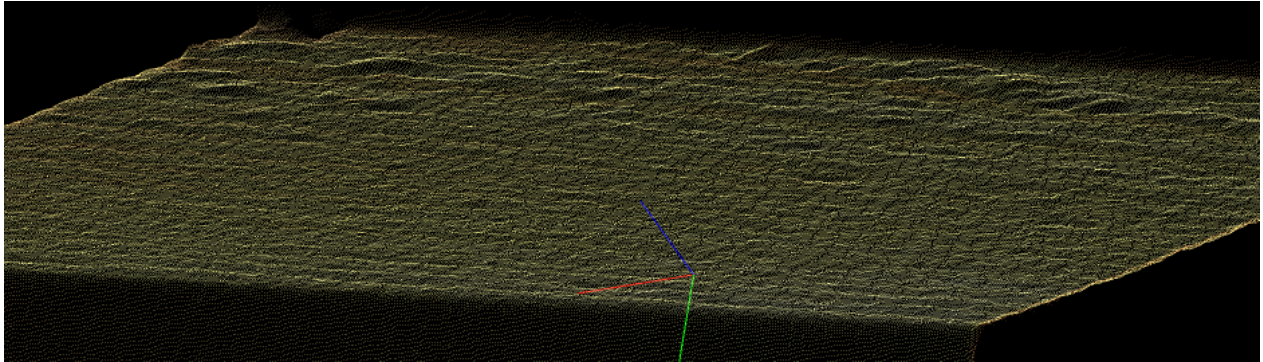


Fig. 2. 3D scan point cloud

The samples were scanned several times in different light conditions, with different scanner settings, with and without a white matting coating. Some of the species like spruce and poplar were easy to scan and some like wenge and merbau were more difficult. All the samples (after matting) could be successfully scanned. A series of collective scans show how the samples look before matting, after light matting and after normal matting. The most important characteristics for the scanned species have been summarized below:

- 1) Wenge - Impossible to scan without a white matting coating
- 2) Merbau - Impossible to scan without a white matting coating in the presence of ambient light
- 3) Tatajuba - Possible to scan without a white matting and in the presence of ambient light but the results are poor
- 4) Oak - Possible to scan without a white matting and in the presence of ambient light but results are poor. If the scanner is set at a specific angle to the oak sample the light from the projected stripes might be reflected from the glossy surfaces of ray flecks causing the "flash effect" if the sample is not covered with a matting coating
- 5) Beech - Possible to scan without a white matting and in the presence of ambient light with good results
- 6) Obeche - Possible to scan without a white matting and in the presence of ambient light with good results
- 7) Spruce - Very good scan results can be achieved without white matting
- 8) Poplar - Very good scan results can be achieved without white matting

A detailed comparison of the scanned results is shown in table 1.

Table 1. Comparison of the scanned results

Species	Without matting coating		With matting coating	
	Ambient light	Without ambient light	Ambient light	Without ambient light
Wenge	N.P.	N.P.	N.R.	R.
Merbau	N.P.	N.R.	P.	R.
Tatajuba	N.R.	P.	R.	R.
Oak	N.R.	P.	R.	R.
Beech	P.	P.	R.	R.
Obeche	P.	P.	R.	R.
Spruce	P.	R.	R.	R.
Poplar	P.	R.	R.	R.

CONCLUSION

The presented in the article results of experimental 3D scanning show that different types of wood species involved different problems that might appear during scanning. Fortunately the same date shows how to solve certain of these problems.

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Streszczenie: *Specyficzne problemy skanowania próbek drewnianych skanerem 3D światła strukturalnego.* Artykuł opisuje zasadę działania oraz charakterystyczne problemy mogące się pojawić podczas skanowania próbek drewna różnych gatunków skanerem 3D światła strukturalnego. W artykule pokazane jest gdzie znajdują się skanery 3D światła strukturalnego w ogólnej systematyce (zgodnej z literaturą) tego typu urządzeń. Dodatkowo w artykule przedstawiony jest sposób jak rozwiązać problemy mogące pojawić się przy skanowaniu niektórych gatunków drewna.

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