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3D laser scanning of large objects using FARO laser scanner

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Abstract

This article focuses on the revolutionary scanning technology featuring the FARO non-contact point laser scanning system. Scanning is suitable for large objects with a working range of more than 300 meters. 3D laser scanner is one of the most advanced technology in the field of spatial information acquisition. The use of 3D scanners has a broad scope in many areas of construction, archaeology and digitization of cultural monuments. One of the main advantages of the technology is to target the actual state of the object and to quickly acquire the real data of the scanned object. Getting 3D models and virtual scanning of a scanned object are the benefits that make this technology exceptional.

Keywords: FARO, scanning system, scanner.

Introduction

Revolutionary technology in field of scanning is the FARO non-contact point laser scanning system. The system is designed for scanning large indoor and outdoor spaces. With a 330m working range, equipped with the GPS module and high quality sunlight filters it is suitable for usage within different industries. The system operates based on a radiating spot laser beam which fallout on a rotating mirror that breaking the beam at an angle of 90 degrees. In this way, space scanning is secured in the vertical direction. To ensure that the space is captured horizontally, the scanner rotates on the stand around its own vertical axis. The system communicates with the computer over the Ethernet network interface, whether wire or wireless. It also has its own touchscreen for easy operation without a computer and a memory card for data storage. The scanner uses a wavelength of 1550 nm and falls under Safety Class 1 [1].

Figure 3 Faro Scanner [2]

Scanning procedure:

- getting ready workplace for 3D laser scanning,
- setting up reference balls
- custom 3D scanning,

- processing scanned data,
- final modelling in the CAD system environment.

*Figure 2 Reference ball [*3]

External effects on scanning - Impact of the surface of the scanned objects on the scanning itself

MATERIAL	REFLECTIVITY / %
White paper	to 100%
Building wood (pine, clean, dry)	94%
Snow	80-90%
White walling	85%
Clay, limestone	to 75%
Printed news pepper	69%
Deciduous trees	approx. 60%
Coniferous trees	approx. 30%
Beach, desert sand	approx. 50%
Smooth concrete	24%
Asphalt with pebbles	17%
Lava	8%
Black neoprene	5%

Chart of material surfaces affecting the scan result [5]

Digitizing devices - 3D scanners

Digitization is possible through the scanning devices that allow the transfer of real three-dimensional objects into digital form. These devices are called 3D scanners.

The principle of most of them is based on sensing the surface of the object at discrete points. The digitized object is then displayed on the computer as many these points, al cloud of points. Scanners are differing from each other by the principle how to capture the subject's surface. The capture devices can be divided per whether the scanning technology is contact or contactless. Contact are 3D touch scanners and CMM stationary coordinate measurement systems. Contactless systems work most often on a laser or optic basis and create a dense network of points.

The choice of type depends mostly on the following requirements:

- accuracy of the match between the real and the digitized model,
- the time at which the object is scanned,
- maximum dimensions of the component,
- accuracy of the device.

Per the geometry scanning method, 3D scanners are divided into:

- coordinate measuring machines,
- measuring shoulders,
- optical,
- laser,
- destructive,
- X-ray, CT,
- magnetic resonance,
- ultrasound. [6]

Mechanical 3D scanners

The principle of the device is that the scanned object is physically "touch" by the tip that is hung on the mechanical arm. The arm has a sensor in each joint recording the rotation of the arm in this area. The position of the scanned point is obtained by evaluating data from all the joints of the arm. Before scanning, it is advisable to mark the points that need to be scanned on the component to obtain the exact digital image of the physical object. The number of

these points is depended on the complexity of the body and the required accuracy. Output from these devices is a huge number of points defined by 3D coordinates (x, y, z). With this method, you cannot get information about the texture of body surface. The disadvantage of the device is that the object needs to "touch" by the tip manually. This is one of the most time-consuming ways to get 3D models.

Optical 3D scanners

These scanners shoot the scanned object from several angles using an optical device. For every rotation that is transferred either manually or by means of a positioning device (stepper motor controlled by computer), the subject is essentially captured and the data is sent to the computer. Once the image is captured from all angles, the data is processed and the digitized model is created by the approximation method.

The quality of a digitized object can be affected primarily by the number of received frame (the more finer is sampling of the position, the higher match with the original). For the scanned data to be used, we must use a single-color background behind a scanned object (would to be contrast color with the object). If this principle were not followed, it would be very difficult, but not impossible, to separate the object from the environment (also known as masking). From the fact that the individual pictures are ordinary 3D photos, there are definite advantages and disadvantages of this device. The advantage is that information about surface of object (texture) is occupied in scanned data, so it is not necessary to artificially complete it. A major disadvantage is the creation of models by an approximation method because of the 2D images, the system cannot replicate slits and holes that are not transient.

Laser 3D scanners

The laser scanner works on the same principle as the sonar. The properties of laser beam are used. Scanning itself consists of sending a laser beam vertically against the subject, which bounces off and returns to the scanning device where it is evaluated. Evaluating the time elapsing between sending and returning the beam will give you information about the object's dimension in the direction of the beam movement. Information about surface curvature will result from the angle under which the beam returns to the device. By combining both basic information, the scanner gets the exact location of the point it sends to the computer. The output is a data set of polygons defining a body surface geometry. Unlike optical scanners, these scanners do not have a problem with recognizing not transient holes and protrusions. The advantage of laser scanners is their high precision. [4]

Conclusion

3D scanning technology is a simple, fast, and accurate method to transfer a real object to a virtual model. Scanning is a demanding process that depends on weather conditions, intensity of sunlight and on the structure of the scanned object. Creating many scans from different angles creates a more detailed 3D model of the scanned object. Once we have a 3D model created, we can use it to measure any dimensions, volumes, areas but also distances, etc. Using 3D scanning technology is primarily a time saving. It is important for a company to determine how much money will be placed on the device and how accurate results will be achieved with a specific scanner.

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