USING 3D SCANNING FOR MODELING STÂNCEŞTI CHURCH, BIHOR COUNTY

UTILIZAREA SCANARII 3D LA MODELAREA BISERICII DIN STÂNCEŞTI, JUDEŢUL BIHOR

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Abstract **:** *The use of terrestrial 3D laser scanning devices is increasing in all surveying areas including topographic surveys and building recording. 3D scanning technology is an outstanding medium for rapidly generating reliable inventory documentation in civil and structural engineering as well as for architectural recordings, especially in the heritage field. This article discusses the process of 3D scanning, on scanning techniques, applicability and benefits of 3D scanning and detail as an example, 3D scan of a wooden church, in order to preserve it in a digital format.*

Keywords**:** *3D scanning, scanner, modeling, church*

INTRODUCTION

Introduction of 3D scanning

a. The scanning process: 3D scanning provides accurate and complete information about scanned objects, which visualize actual field conditions and design in accordance with these conditions, using specialized software. The scanner has the ability to record millions of points obtained on "walk" a laser beam on the object or area concerned.

b. Functionality

The purpose of a 3D scanner is usually to create a point cloud of geometric samples on the surface of the subject. These points can then be used to extrapolate the shape of the subject (a process called reconstruction). If color information is collected at each point, then the colors on the surface of the subject can also be determined. Coordinates X, Y, Z of the points made can be imported into CAD programs or 3D as clouds of points (point

cloud). Files containing 3D points recorded with a scanner can be viewed three-dimensional analysis as well as 3D models, with the option to measure distances directly on point cloud.

3D scanners are very analogous to cameras. Like cameras, they have a cone-like field of view, and like cameras, they can only collect information about surfaces that are not obscured. While a camera collects color information about surfaces within its field of view, 3D scanners collect distance information about surfaces within its field of view. The "picture" produced by a 3D scanner describes the distance to a surface at each point in the picture. If a spherical coordinate system is defined in which the scanner is the origin and the vector out from the front of the scanner is $\varphi=0$ and $\theta=0$, then each point in the picture is associated with a φ and θ (Schulz et. al. 2005). Together with distance, which corresponds to the r component, these spherical coordinates fully describe the three dimensional position of each point in the picture, in a local coordinate system relative to the scanner.

For most situations, a single scan will not produce a complete model of the subject. Multiple scans, even hundreds, from many different directions are usually required to obtain information about all sides of the subject. These scans have to be brought in a common reference system, a process that is usually called alignment or registration, and then merged to create a complete model. This whole process, going from the single range map to the whole model, is usually known as the 3D scanning pipeline.

c. Technology

There are a variety of technologies for digitally acquiring the shape of a 3D object. A well established classification divides them into two types: contact and non-contact 3D scanners. Non-contact 3D scanners can be further divided into two main categories, active scanners and passive scanners. There are a variety of technologies that fall under each of these categories (Leick, 1995).

I. Applicability of 3D scanning

a. Construction industry and civil engineering:

- Robotic Control: e.g., a laser scanner may function as the "eye" of a robot (Gordon et al., 2001).
- As-built drawings of Bridges, Industrial Plants, and Monuments
- Documentation of historical sites
- Site modeling and lay outing

- Quality control
- Quantity Surveys
- Freeway Redesign
- Establishing a bench mark of pre-existing shape/state in order to detect structural changes resulting from exposure to extreme loadings such as earthquake, vessel/truck impact or fire.
- Create GIS (Geographic information system) maps and Geomatics.

b. Reverse engineering

Reverse engineering of a mechanical component requires a precise digital model of the objects to be reproduced. Rather than a set of points a precise digital model can be represented by a polygon mesh, a set of flat or curved NURBS surfaces, or ideally for mechanical components, and a CAD solid model. A 3D scanner can be used to digitize free-form or gradually changing shaped components as well as prismatic geometries whereas a coordinate measuring machine is usually used only to determine simple dimensions of a highly prismatic model. These data points are then processed to create a usable digital model, usually using specialized reverse engineering software.

c. Cultural Heritage

These devices can be used for replication of a real object by means of 3D scanning and 3D printing. There have been many research projects undertaken via the scanning of historical sites and artifacts both for documentation and analysis purposes. The combined use of 3D scanning and 3D printing technologies allows the replication of real objects without the use of traditional plaster casting techniques that in many cases can be too invasive for being performed on precious or delicate cultural heritage artifacts.

c. Entertainment

3D scanners are used by the entertainment industry to create digital 3D models for both movies and video games. In cases where a real-world equivalent of a model exists, it is much faster to scan the real-world object than to manually create a model using 3D modeling software. Frequently, artists sculpt physical models of what they want and scan them into digital form rather than directly creating digital models on a computer.

d. Crime Scene Investigation

3D scanning allows forensic analysis and modeling information in a shorter time and with less effort than traditional measurement methods. The model obtained can be exported to specialized software for visualization, interpretation and determination of causes and events that took place.

MATERIALS AND METHODS

a. Scanning Methodology

For scanning, it was used a Leica C10 3D Scanner (L.G.H.L.).

Leica C10 scanner has the following specifications (main):

- scanning the objective with a speed of 50,000 points per second
- scan accuracy: 1 mm
- scan objective distance of 300 m

Establishing the control network:

The methodology typically used for terrestrial 3D scanning revolves around the time- honored use of prisms or targets. These are typically surveyed using conventional means, such as a Total Station, and then scanned with the laser scanner. Dimensional control is a primary concern when performing 3D imaging in the field. The likelihood of inadvertently introducing systematic errors into the data is very high should dimensional control measures be neglected.

A control network is a collection of identifiable points (visible or inferable) with stated uncertainties in a single coordinate system. An example of an inferable point is the center of a sphere, while not visible, can be obtained by processing suitable data. A control point may be derived from an object that is permanent or temporary. The purpose of the control network may include: monitoring/controlling data quality (e.g., controlling scale error, removing systematic error), registration, verifying the position of an instrument (drift), defining the extent of a measuring environment.

So, it was and it is necessary to create a control network. After the control network was created, the scanning process was started: the acquisition of images, targets and control points (Fig. 1, Fig. 2), the traverse and the full scanning (Fig.3).



Fig. 1 Stânceşti Church – Site map
(targets and control points)
Full dome image in True View Mode



Fig. 2 Stânceşti Church – Site map
(targets and control points)

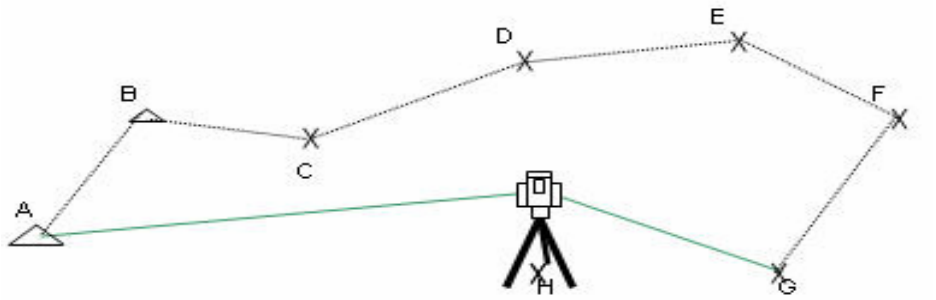


Fig. 3 Example of a traverse with a 3D scanner

Target acquisition and traverse

The five basic steps for performing a field setup are:
Definitions; Acquire Back-sight; Known Back-sight; Taking the Main Scan Detail Main Scan with Script Editor.

RESULTS AND DISCUSSIONS

a. Case study – scanning the Stânceşti church

b. Historical and Archaeological Background

The Wooden church Stânceşti, the subject of this study, is located in the city Stânceşti (ex Broaşte) of Bihor County, Romania. Is dedicated to "Sf. Ioan Gură de Aur" and is dated from 1752. It is of particular interest here is preserved in that part of paintings by “David Zugravul” at the Court of Argeş.

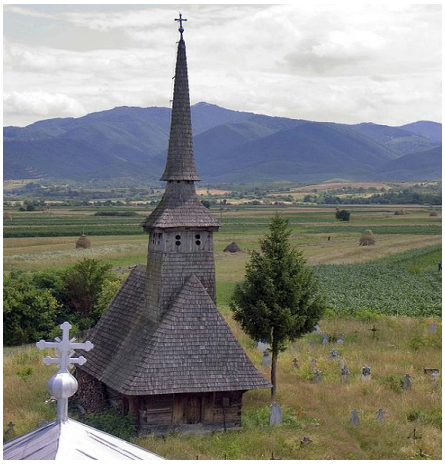


Fig.4. Stânceşti Church – general overview (2008)

In naos and the pronaos are kept several fragments of wall paintings and paintings on the iconostasis is believed to have been made around 1756. The church is declared a historical monument and is located on the new Romanian list of historical monuments under LMI code: BH-II-mB-01206 (Fig.4).

CONCLUSIONS

Benefits of 3D scanning are:

- ✓ data recording speed: reduces time and cost
- ✓ remote recording: increased efficiency and safety of topographic survey
- ✓ the high density of points provides topographic complexity lift
- ✓ the possibility to view in real-time of the objective 3D scanned
- ✓ increase effectiveness working with complex parts and shapes
- ✓ if CAD models are outdated, a 3D scan will provide an updated version
- ✓ replacement of missing or older parts
- ✓ increased accuracy and speed with which calculations are made for plans, elevations, sections, volumes and surfaces

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