3D-Reconstruction of the Complex Stuccoes from Patrimony Buildings

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Abstract. The paper deals with 3D scanning techniques and instruments to survey the complex stuccoes from the architectural building Nanu-Muscel from Bucharest. EXAscan Portable 3D Laser Scanner has been used to exploit the advantages of the 3D surveying techniques and produce digital models and other geometric representations useful for the protection of historic architectures and a correct solution for their restoration. After the parameterization, the scanning of two stucco-objects surface yielded to a network of points. The program analyzes the points and joins them, so the final result being the scanned object in electronic format (digitized), by "Digitized Shape Editor" module in the Catia program. The not useful surfaces have been removed and for the symmetrical reconstruction the mirroring operation was applied.

Keywords: 3D Scanning, Stucco, EXAscan Portable 3D Laser Scanner**.**

1 Introduction

1.1 General Aspects

The house of Professor Ion Nanu-Muscel, built in Bucharest, Romania, in neo-romantic style with Art Nouveau accents, is a piece of art belonging to bourgeoisie and aristocracy of Romania at the end of the 19th century and the first half of the 20th century (Addison & Alonzo, 2006). The building contains fascinated façades of colossal pilasters, the statuary group made up of two piles of gypsum that support a baroque shield, which is supposed to be the monogram of the owner, the façade decorations with laurel leaves and garlands, which frames a bunch of symbolic objects: a violin, a bow, a bow with arrows, Figure 1. The house belonged to the Commercial Academy, being donated in 1940 by the Nanu-Muscel widow to shelter retired school teachers and students. Later, the Communist regime gave up the house of other institutions. The entrance is

protected by a forged iron curtain, with fluid lines, reminiscent of the Art Nouveau style, and the door wears a complicated iron work. The interiors, with a decoration for the exterior, were decorated with stucco ceilings (a ceiling was a cassette), a curved wooden staircase with wrought iron railing, precious wooden parquet. Now, the building is in a peccary state, and a complex conservation/restoration operation is necessary. This is the reason of this paper, to obtain 3D results to produce orthoimages, maps and sections of the monument and to check the quality of historical surveying. After the digitization of the historical material, a polynomial best fitting transformation was applied in order to correctly overlap this material with the respective modern products, in good agreement with the literature's reports (Bosche & Haas, 2008).

Fig. 1. General view of the stucco part

The whole 3D scanning system entails the three-dimensional digitization, virtual information processing, archiving and management, illustration and reproduction (Brătescu, 1977). Three-dimensional scanning (3D scanning) is known from more than 15 years as 3D digitizing, which is a process that uses a contact or non-contact digitizing probe to capture the objects form and recreate them in a virtual workspace through a very dense network of points (xyz) as a 3D graph representation (Datta, 2001). There are known two types: 3D scanning contact and non-contact. Non-contact 3D scanning can be further divided into two categories: active scanning and passive scanning. The contact mode refers to the mechanical contact of the surfaces while non-contact technologies (without mechanical contact) use optical sources, laser or a combination of the reproduction of the scanned surface (Fontana, et al., 2002). The article presented the 3D surveying and modeling of the archaeological area of Nanu-Muscel building from Bucharest complex monuments.

2 Experimental Part

2.1 Materials

For our experiments, we received from the restorers two stucco pieces (Figures 2 and 3) that have been investigated from analytical point of view (the results will be reported

in other papers) and have been scanned with EXAscan Portable 3D Laser Scanner to reconstruct the initial design.

Fig. 2. Object 1 of the stucco

Fig. 3. Object 2 from the stucco

2.2 EXAscan Portable 3D Laser Scanner

EXAscan is a mobile 3D Laser scanner which scans pieces of different sizes, with different geometries: 25,000 measurements / s, scan resolution of 0.2 mm, accuracy of up to 0.040 mm (0.0016 inch), depth of field: ± 150mm (± 6 inch), volumetric accuracy (with MaxSHOT 3D) of minimum 0.020 mm + 0.025 mm / m (0.0008 inches + 0.0003 in./ft), VX elements software, CATIA V5, V6. The EXAscan offers an increased resolution and accuracy for your digitizing needs, 3D scanning projects with extreme precision and accuracy, unique options not available with any other scanner on the market advanced technology and feature, easy to use, Figure 4.

Fig. 4. Scaner 3D CreaForm Exascan

3 Results and Discussion

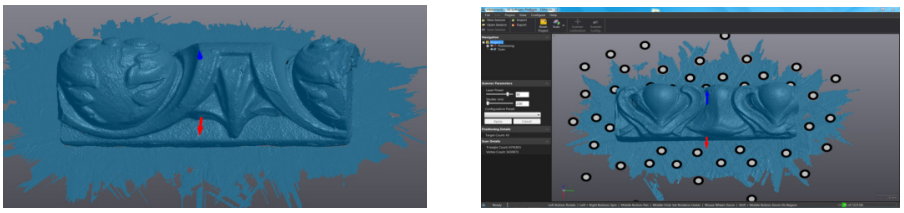
3.1 Inspection

The EXAscan laser scanner is the perfect inspection tool for analyzing and reporting geometric dimension and tolerance (GD&T). The EXAscan can help for scanning and measuring of objects of any sizes in various environments. After the scanner is configured, the reference points are scanned. They have the role of keeping the scanned object in a fixed position in 3D space (Pieraccini, Guidi, & Atzeni, 2001). The next step involves parameterizing the scanning procedure, choosing the resolution, optimizing the

limits, optimizing the precision, automatically filling the holes and removing the isolated surfaces (Remondino & El-Hakim, 2006).

3.2 Scan the Object and Results Processing

After the configuration, the object need to be scanned is placed at the center of the reference points and the scan operation takes place (the reference points are scanned), which involves scanning the surface of the object with the laser on the scanner (Ruther, et al., 2009). The result of the operation is a network of points (Shih, H.J., Lin, & Liau, 2007). The program analyzes the points, joins them, the result being the scanned object in electronic format (Figure 5).



a b

Fig. 5. The capture from programme scanner (VX-elements): (a) object 1; (b) object 2

The processing was done using the "Digitized Shape Editor" module in the CATIA software (Varady, Martin, & J., 1997). A series of operations were performed to obtain the 3D reconstructed object. The first step was to remove the unusable surfaces. The initial surface, imported from EXAscan software, was removed the scanned surface which is not important for the final object.

Fig. 6. The shape obtained after removing the not useful surfaces

After this operation is easily to see that the project is closer to the real object (Figure 6). The next applied step was to symmetrical reconstruct the object using mirroring operation. Thereby, the missed part of the stucco was reconstructed and so, our object is complete (Figure 7).

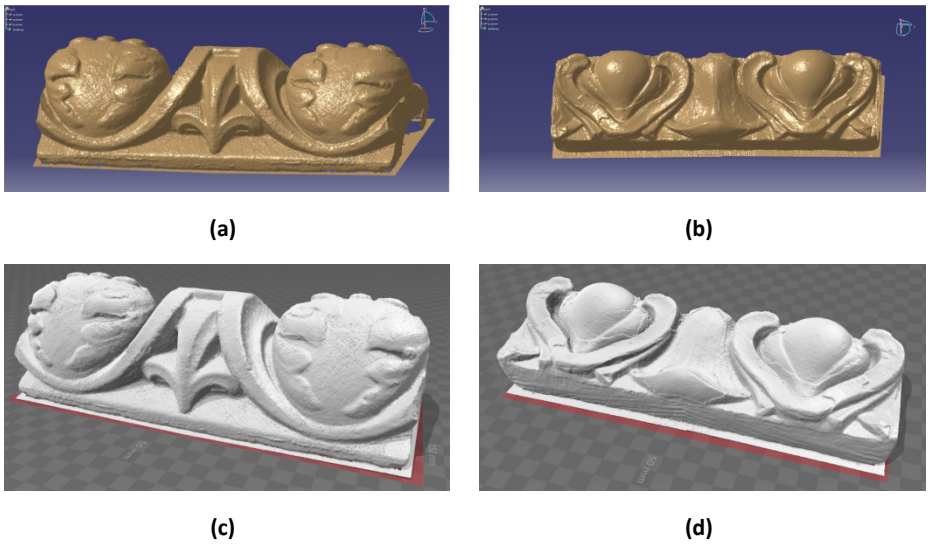


Fig. 7. The reconstructed objects after mirroring operation:

As could be observed, this program analyzes the points and joins them, so the result being the scanned object in electronic format (digitized), by "Digitized Shape Editor" module in the CATIA program. The not useful surfaces have been removed and for the symmetrical reconstruction the mirroring operation was applied.

The software used for the presented stuccoes give an informative virtual experience on the historical monument's details, obtained by using a laser scanner.

4 Conclusions

EXAscan Portable 3D Laser Scanner has been used in this paper to exploit the advantages of the 3D surveying techniques in order to produce digital models of the historic architectures, offering a correct solution for their restoration, for heritage details. The final results have been scanned in electronic format (digitized), by "Digitized Shape Editor" module in the CATIA program. The unusable surfaces have been removed and for the symmetrical reconstruction the mirroring operation was applied.

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References

Addison, A., & Alonzo, C. (2006). The Vanishing Virtual: Safeguarding Heritage's Endangered Digital Record. In T. K. Kalay (Ed.), *Proceedings of New Heritage: Beyond Verisimilitude* (pp. 36-48). London: Routledge.

Bosche, F., & Haas, C. (2008). Automated retrieval of 3D CAD model objects in construction range images,. *Automation in Construction*, 499-512.

Brătescu, G. (1977). *Personalităti ale stiintei: mic dictionar*. Bucharest: Editura Stiintifică si Enciclopedică.

Datta, S. (2001). Digital reconstructions and the geometry of temple fragments. *The Proceedings of the 2007 international conference on digital applications in cultural heritage* (pp. 443-452). Tainan: Tainan : The National Center for Research and Preservation of Cultural Properties.

Fontana, R., Greco, M., Materazzi, M., Pampaloni, E., Pezzati, L., Rocchini, C., & al., e. (2002). Three-dimensional modelling of statues: the Minerva of Arezzo. *Journal of Cultural Heritage, 3*(4), 325-331.

Pieraccini, M., Guidi, G., & Atzeni, C. (2001). 3D digitizing of cultural heritage. *Journal of Cultural Heritage*, 63-70.

Remondino, F., & El-Hakim, S. (2006). Image based 3D Modelling : A Review. *The Photogrammetric Record, 21*(115), 269-291.

Ruther, H., Chazan, M., Schroeder, R., Neeser, R., Held, C., Walker, S., & al., e. (2009). Laser Scanning for conservation research of African cultural heritage sites: the case study of wonderwork cave, South Africa. *Journal of Archaelogical Science, 36*, 1847-1856.

Shih, N., H.J., W., Lin, C., & Liau, C. (2007). 3D scan for the digital preservation of a historical temple in Taiwan. *Advances in engineering software, 38*(7), 501-512.

Varady, T., Martin, R., & J., C. (1997). Reverse Engineering of Geometric Models -- an Introduction. *Computer-Aided Design, 29*(4), 255-268.

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