Approaches for 3D Digitalization of Cultural and Historical Sites

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Abstract: In the presented paper is examined the need for digitalization of cultural and historical sites. Approaches for 3D digitalization by using 3D scanners and photogrammetry are presented. A 3D printing of digitalized objects is accomplished. The photogrammetry method is examined and used as a possible solution for the digitalization and creation of 3D models. The models can be explored by visually impaired people. A monument from the Cultural and Historical site of Bulgaria is 3D digitalized and 3D printed by using a drone, photogrammetry software, and 3D printer.

Keywords: 3D DIGITALIZATION, 3D MODELLING, 3D PRINTING, CULTURAL-HISTORICAL SITES, PRESERVATION

1. Introduction

The preservation of cultural and historical monuments, buildings, objects, sites, etc. nowadays is an actual and interesting topic. By using different approaches, preservation and digitalization is affordable and can be used for different purposes. The most important is that nowadays the world loses the cultural-historical monuments faster than they can be digitalized [1]. Another one of the purposes is presenting the content of cultural-historical sites to visually impaired or blind people, which will allow them to explore the monuments, to increase their quality of life. Thus it allows exploring sites all over the world without leaving your home.

Photogrammetry is an affordable way to digitalize monuments, buildings, etc. The main feature of photogrammetry is that it starts from 2D image analysis to find 3D shape information even if the approach used is sometimes different. Initially, the goal of photogrammetry is to measure the position of a set of 3D points. The main purpose of photogrammetry was for cartographic purposes. Therefore the technique is related to achieving the best access to metric accuracy. More precise and expensive methods are 3D laser scanning technologies [2, 3, 4, 5].

The paper presents a 3D digitalization method and 3D printing of Vasil Levski monument, a national hero, and a fighter for Bulgarian freedom.

2. State of the Art

Nowadays the technologies provide a wide range of types of digitalization such as 3D scanning, 3D modeling, photogrammetry, etc.

By using 3D modeling techniques, the team has expertise in 3D digitalization. Part of the authors of Prof. Karastoyanov team – head of Embedded Intelligent Technologies and SMART LAB, together with the team of Prof Virginio Cantoni – head of department Computer Vision & Multimedia Lab from Pavia University took part in the exhibition “Pavia. The Battle. The Future – 1525-2015, Nothing was the same again” organized as a satellite event of EXPO 2015 in Milan. Seven famous medieval tapestries were shown as tactile plates to visitors including the visually impaired who could touch them, shown in fig. 1. The tactile tile has a Braille annotation in the characters, as well as a legend for the annotation. As well as characters from the tapestries were extracted as 3D models, which were again introduced to visually impaired and blind people, shown in fig. 2 [6].

3. Methods and Means

Another approach for 3D digitalization of cultural-historical sites is by using 3D scanners. The SMART LAB team uses a 3D scanner Creaform VIU Scan, shown in fig. 3 for the digitalization of small objects of cultural and historical sites. The scanner has the following parameters: 18 000 measures per second, geometry resolution of 0.1 mm, accuracy up to 50 μm, graphic resolution from 50 to 250 DPI, 24 bit sRGB, depth of scanning – 30 cm, output formats .ma, .dae, .obj, .x3dz, .x3d, .zpr, .wrl, etc.
Technical specifications include 300 x 450 dpi resolution, 0.1 mm layer thickness, and 203 x 254 x 203 mm (X, Y, Z) dimensions of the maximum printed object. The input data file formats supported are STL, VRML, PLY, 3DS, FBX, ZPR. [6].

4. 3D Digitalization by Using Photogrammetry

Using photogrammetry for generating accurate and detailed 3D imaging models is a great and relatively affordable option, also are provided tools for this method, aiming to be used by a wide community of users at a limited cost. Different types of processing tools or acquisition procedures based on the type of object to be investigated (assessment of geometry, texture, spacing, shape complexity, etc.) need to be considered. The Photogrammetry definition states that: Photogrammetry is an art and science to determine the position and shape of objects in the photographs [2, 3, 5, 7, 8, 9].

For digitization to preserve monuments and sites of cultural and historical heritage, as well as to create 3D models, it is necessary to carry out a methodology.

• Selecting a suitable digitization site;
• Use of appropriate imaging techniques;
• Technique setup - using drones - flying speed, shooting interval, radius, height, etc.;
• Processing of the data obtained from the technique (photos, videos);
• Selecting the right software to create 3D models from 2D images;
• Image processing in software for photogrammetry;
• Processing the obtained 3D model;
• Preparation for 3D printing;
• 3D printing.

The last two steps of the methodology are to create 3D models that can be provided for example to disadvantaged people (visually impaired or blind) who cannot enjoy the rich cultural and historical heritage, except by “seeing” the object by tactile perception.

5. Experimental Results

Following the established methodology and using a drone in synergy with software for photogrammetry is 3D digitized a monument of cultural and historical heritage in the town of Lovech, Bulgaria. On the monument is the fighter for freedom of Bulgaria - Vasil Levski, shown in fig. 6. The monument was opened on 27 May 1964 and it is the largest and most impressive monument of Vasil Levski. On a 5-meter granite, pedestal stands a height of 9 meters high and a mass of 10 tons, a sculptural and architectural monumental figurine of Vasil Levski. The total height of the monument is 14 meters. Under the figure with brass, letters are written "Vasil Levski (1837 - 1873). If I win, I win for the whole nation, if I lose - I lose only myself". The monument is part of the coat of arms for 40 years, and a symbol of the city. It is located in the Varsha Architectural and Historical Reserve. The construction of the monument was accomplished thanks to the head of the Education and Culture Department of the People's Council of the People's Republic (Lovech) Genoveva Sirkova, which in 1959 submitted a proposal for its construction with the motivation that the city is the capital of the great Apostle and the most of his time he spent in Lovech [10].

The dimensions of the monument are impressive, the use of stairs and specialized techniques for reaching and digitizing with a 3D scanner makes the task labor-intensive, expensive, and risky. For this reason, a drone and photogrammetry were used.

More than 200 photographs from different angles, heights, and positions of the monument were made to achieve the goal. An exemplary position of the pictures is shown in Fig. 7. Also, additional photos are taken from the top.

In fig. 8 is the 3D reconstructed object model. The reconstructed model is prepared for processing. After the editing and additional modeling, the monument is cleared of unnecessary details such as trees, shrubs, and others. The next step is preparing for 3D printing shown in fig. 9.
By using the methodology, digitizing, 3D printing the model is an incredible way offered by modern technology. This way of presenting monuments of cultural and historical heritage enables these objects to be scaled and given to the hands of blind users. On the other hand, these models can be implemented in the teaching process, to be used in schools for teaching. The printed model is shown in fig. 10.

This innovative method for 3D presentation of cultural and historical sites by 3D models for the disadvantaged (low-sighted or visually impaired) targets a societal challenge: “health and quality of life, cultural and historical heritage, ICT”. By using this method and scaling the large monuments will allow the visually impaired people to explore them.

6. Conclusion

In conclusion, it can be said that with advancing and developing the technology of the drones, their cameras, on the other hand, imaging and photogrammetry software, their use in synergy is a relatively easy, affordable, and inexpensive way to digitize monuments, buildings, and objects of cultural and historical heritage. The methodology allows the use of these objects by disadvantaged users (visually impaired or blind). In this way, this group of people is allowed to learn about the cultural and historical heritage, to improve their quality of life, and to continue exploring the wonders of the world.

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References


Fig. 6. Monument of Vasil Levski

Fig. 7. Example distribution of images, taken with drone

Fig. 8. 3D digitalized site of Vasil Levski

Fig. 9. 3D Edited model

Fig. 10. 3D printed object from cultural-historical site of Bulgaria
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[6] V. Cantoni, D. Karastoyanov, M. Mosconi, A. Setti, CVML and SMART LAB at the Exhibition (Pavia. The Battle. The Future – 1525-2015 Nothing was the same again), Monography in English and Italian, 2016


