

Digitization and 3D Scanning of Historical Artifacts

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Abstract. Protection and preservation of our cultural and literary historical and documentary heritage are particularly relevant today. The paper presents methods for creating digital resources of historical artifacts related to the Balkan war. Special attention is paid to the process of 3D scanning of objects. The methodology will be used in building an electronic archive and Virtual Museum.

Keywords: Digitizing, 3D scanning, Historical Artifacts

1 Introduction

The objectives of this project¹ are the preservation and promotion of Bulgarian heritage and the provision of information about them in a new reality of the digital society.

Objective of the project is digitizing various documentary collections and artifacts related to the Balkan wars and the creation of electronic records and various public events and publications to promote in Bulgaria and Europe, the events during this historical period for the country. Various cultural and scientific institutions: historical and military museums, libraries, universities and institutes of Bulgarian Academy of Sciences are involved in the project. Team that carries out the project consists of various specialists: historians, librarians, museum curators, photographers, mathematicians and computer scientists. Collections include documents, notes, research papers, reports for the Balkan Wars (1912-1913) period, various merchandise and weapon collections in other museums in the Balkan region. Project will be implemented through:

- Investigation and study of photos, letters, books, paintings and other artifacts kept in special funds of archives, libraries, galleries and museums in Veliko Tarnovo and Bulgaria;
- Digitalization of historical artifacts and development of 3D digital model of some items;

¹ Project “Digital archive of documentary heritage of the Balkan Wars” – funded by the Bulgarian Fund for Scientific Research, more specifics at [www-address: http://www.math.bas.bg/vt/balkanwars/balkanwars.htm](http://www.math.bas.bg/vt/balkanwars/balkanwars.htm)

- Creating a common electronic archive of documentary heritage through digitization and processing of specimens found, construction of bibliographic and full-context databases and presenting them on the Internet;
- Preparation and printing of publications and the European Conference on Balkan wars;
- Development of a travelling retrospective of recently excavated and examined documents Balkan War and its Internet version;
- Presentation and dissemination of project results. And published some digital artifacts in EUROPEANA.

2 Digitalization of Historical Artifacts

2.1 Digitalization Process

Modern technologies have changed the way archives deliver information and made possible new services that were unimaginable a few years ago [1, 2, 4].

Digitizing or digitization is creating an object, image, sound, document or a signal (usually an analog signal) by a discrete set of its points or samples. The result is called "digital presentation" of the object.

Some methods of digitalization used in project:

Digitalization process

- TEXT, PHOTO (*photographing documents*) – Photographing documents and images is preferred because of the speed of digitization, accessibility and relatively good quality of the received digital copies;
- TEXT, PHOTO (*scanning with flat scanner*) – The system actually represents - a scanning device which is connected to a personal computer with appropriate software components for performing the scanning process;
- VIDEO, AUDIO (*digitizing analog video and stream*) – The process of digital video and audio recording is done with the system that operates in real time. This is analog playback device according to media digital recording. To perform digitization are needed adequate equipment and appropriate software process management;
- 3-DIMENSION IMAGING – (*3D scanning*) – Process of 3-dimensional scan is performed with a suitable system, such as the object is scanned by all the visible sides and then specific software build a full three-dimensional representation.

Specific requirements related to digitizing text, audio and video for Balkan Wars project are described in [3].

3 3D Scanning of Historical Objects

3D scanning is a new way for protection and promotion of cultural heritage material. 3D digital recordings have more information about the volume, shape and structure of the surface of the object from the classic photo shooting.

The purpose of 3D scanning is to create a point cloud of geometric shapes, to reconstruct the surface of the scanned object. These points not only carry information about the spatial positioning but also have colour information and in some cases information about the material of the surface of the object. Most systems for 3D scanning require multiple scans at different positions of the object in order to build a complete 3D digital model of the object.

There are a variety of technologies to digitally recreate the shape of the 3D object. Classification of 3D scanners starts with a division into two types - contact and non-contact. Contact 3D scanners use probe to touch the surface of the object to determine the distance and hence the shape of the object. Non-contact are divided into two main types: active and passive. Passive scanners are capturing multiple images of an object and according to them, determine distances and spatial location of individual points on the surface of the object. Active 3D scanners use radiation of some kind of light, sound, ultrasound etc. and offset the effects of this radiation, which can determine the distance to certain points of the object or its form.

We use technology "structured light" for 3D scanning [6, 8].

3.1 Structured Light 3D Scanning

Technology for 3D scanning using a structured light uses light with certain patterns and according to captured impact of this model of the object is defined its shape and spatial positioning of the various items of its surfaces [7, 9]. The positioning of the light source (projector), the camera and the object is schematic in the form of a triangle defined by positional parameters. This example can be seen in Figure 2. By projecting a series of known pattern onto an object and measuring the deformation of those patterns with a camera, the position in space of each pixel can be determined through triangulation calculations. Triangular calculations are performed by specialized software, taking into account the position of the light source (projector), camera trapping effects of lighting schemes and reflection from the surface of the scanned object. These calculations are performed in parallel for each pixel within the camera producing a depth map or "point-cloud". Figure1 shows vertical black and white lines designed by the projector and captured by the camera angle.



Fig. 1. Pattern of the light emitted and reflection from the object

3D scanning system using structured light consists of a projector, a digital camera and a computer system.

Basic methodology of 3D shooting is as follows:

- **Positioning System** – is important and is a key point in the calculation of spatial location of points on the surface of the scanned object;
- **Calibration of the system** – also important for constructing a 3D digital model;
- **3D scanning of the side/part of the side** – scan the visible part of the object. To obtain a complete 3D digital model of the object, all visible parts should be scanned separately;
- **Digital processing** – processing the received 3D images and combining them into a comprehensive 3D model and obtain the appropriate digital formats.

3.2 3D Scanning of Historical Objects

For 3D scanning of cultural objects we use "structured light" technology with DAVID SLS-1 system [5]. Figure 2 shows the system working. Technology "structured light" requires certain conditions of controlled light and background environment.



Fig. 2. Working process of 3D "structured light" scanning with DAVID SLS-1 system

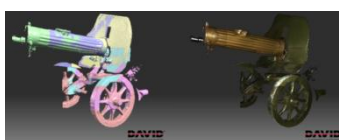
For an example of 3D scanning and digital processing we will show part of a 3D image of the gun "Schwarz-loze". The example shows six different 3D scans (Figure 3a) (total of thirty four scans for complete coverage of the subject). Also is given their consistent "assembly" (Figure 3b), a complete 3D image of the assembled six views with color separation for each individual scan (Figure 3c) and views from different perspectives (Figure 3d).



a) 3D scans of different surface of object



b) Construction of 3D model



c) An individual scans and a complete 3D image



d) Views from different perspectives of 3D model

Fig. 3. Construction of a 3D digital model from multiple scans

To build a complete 3D digital model of the example of Figure 3, we captured thirty four individual appearance of the artifact. After scan and construction of the 3D model we add indexing textual data and the model is archived. We index the text content of the object: name, type, digitizer, date, author, archive / library number, innkeeper, brief description, copyright, etc. necessary and explanatory data, This metadata is collected by different specialists from partner cultural and historical organizations: historians, librarians etc. and processed by mathematicians and computer scientists. This is explained in details in [3]. Because of the specifics (file format - OBJ) of digital model and the inability to examine without special software, we transform it to PDF or HTML format with embedded flash 3D images.

4 Conclusion

Digitization of paper and museum collections as a means of protection is one of the priorities in the development of Bulgarian libraries and museums. The prerequisites for this process have long been available - these are rapidly increasing number of Internet users in the country, the development of technology, more and more difficult preservation and protection of the growing paper and Museum Fund.

Results of the project will be used in various research areas: political and cultural history, history of literature, art history, and archival science will increase the opportunity for interdisciplinary research in these areas.

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