Journal of Cultural Heritage 13 (2012) 210–214

Available online at ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en

Case study

3D preserving XVIII century barroque masterpiece: Challenges and results on the digital preservation of Aleijadinho's sculpture of the Prophet Joel

Beatriz Trinchão Andrade , Caroline Mazetto Mendes , Jurandir de Oliveira Santos Jr. , Olga Regina Pereira Bellon*, Luciano Silva

IMAGO Research Group, Universidade Federal do Paraná (UFPR) P.O. Box 19092, CEP 81531-980, Curitiba, Brazil

ARTICLE INFO

Article history:
Received 8 March 2011
Accepted 4 May 2011

Keywords:
3D digital preservation
3D image acquisition
3D modeling
Computer graphics
Image processing

ABSTRACT

We present our recent efforts in the digital preservation of a set of baroque sculptures made by Antônio Francisco Lisboa, known as *O. Aleijadinho*, which is an important American baroque artist. The set was made in the beginning of the XIX century and is composed of 12 near real sized sculptures, hand-carved in soapstone. These sculptures represent 12 of the 16 prophets from the Holy Bible and are part of a UNESCO World Heritage Site. Our group has been collaborating with UNESCO in a project that aims to preserve all these statues. We hereby present our initial efforts, consisting of the 3D digital preservation of the Prophet Joel sculpture. We developed a complete 3D digital preservation pipeline composed of four main stages: data acquisition, 3D reconstruction, texture generation and 3D model visualization. By evaluating our results in this first sculpture, we discuss the improvements we conceived before applying our pipeline in the remaining ones. Finally, we present the 3D model of the Prophet which registers the sculpture's current state and will be used in restoration, research and educational activities. We believe this contribution may be useful to guide further research on similar scenarios, showing how to avoid some practical mistakes and achieve good results.

1. Research aims

The aim of this work is to describe our experience during the 3D digital preservation of an important Brazilian baroque statue which is part of a UNESCO World Heritage Site. This statue is the first of 12 to be preserved and presents several challenges, such as its difficult location and large size. In order to digitally preserve it, we developed and applied a complete pipeline that ranges from data acquisition to 3D model visualization on web browsers. We compare different techniques and present the problems and challenges we faced during this task, the solutions we found, and how we are improving our pipeline in order to preserve the remaining statues. The resulting 3D models of the statue may be used in several different ways. For example, it may help its physical restoration, be used in remote visualization and obtaining information about the original statue.

2. Experimental

Outdoor-located heritage sites are a challenging problem when digital preservation is concerned. Besides the problems of being exposed to natural weathering, they are not always easily accessible and frequently may not be moved. Also, they are susceptible to degradation due to aging or even vandalism, requiring important preservation measures.

Many works in the literature focus on the 3D digital preservation of indoor and outdoor heritages [1–5]. These works have been exploring innovative techniques to digitalize and extract new information about the heritage, generating realistic 3D models. Amongst these works, we stress the Michelangelo's Davi [1], the Buddha of Kamakura [2] and ancient Egyptian artifacts [3].

We have been working with digital preservation since 2002, with the development of a method to combine 3D images of archaeological objects [6,7]. Subsequently, we developed a reconstruction pipeline that focuses on the 3D digital preservation of cultural and natural heritage [8,9], generating precise 3D models that have been used to preserve assets from several institutions (e.g., a Curitiba Metropolitan Art Museum and Natural Science Museum) [10]. In, we proposed a refinement of this pipeline where high-resolution images are used to generate higher quality textures, and applied it on the preservation of artworks from UFPR's Archaeology and Ethnology Museum. The resulting 3D models are available at our 3D Virtual Museum (http://www.imago.ufpr.br/Museu/en_index.html), which allow realistic interaction with the models [11].

We have been collaborating with UNESCO in a project that aims at preserving Brazilian baroque sculptures made by artist Antônio

* Corresponding author. Tel.: +55-041-33613683; fax: +55-041-33613205.
E-mail address: olga@ufpr.br (O.R. Pereira Bellon).

1296-2074/$ – see front matter © 2011 Elsevier Masson SAS. All rights reserved.
doi:10.1016/j.culher.2011.05.003

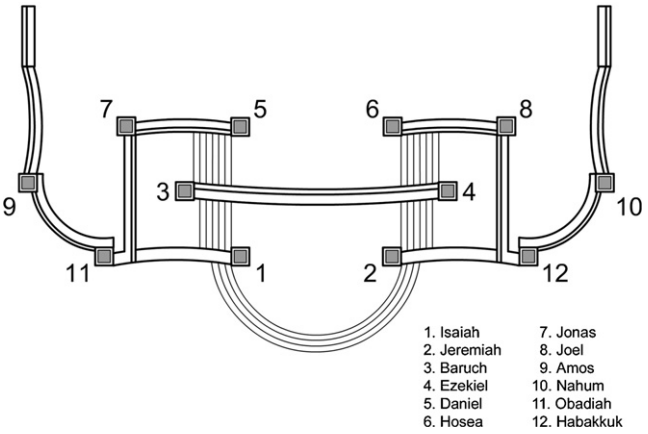

Figure 1. Bom Jesus de Matosinhos Sanctuary: parvis plant with the Prophets' location.

Francisco Lisboa, known as *O. Aleijadinho*, who is considered one the most important American Baroque artists. These sculptures are located in a sanctuary in Minas Gerais, Brazil, and are included in the UNESCO World Heritage List. The sanctuary was build during the XVIII and XIX centuries and is composed of a church, a parvis and six stations regarding Christ's life and death [12].

We focus on the preservation of artworks located at the parvis. This place contains 12 near-natural size sculptures of Old Testament Prophets and its plant is illustrated in Fig. 1. More information about the sanctuary can be found at UNESCO Website (http://whc.unesco.org/en/list/334). The sculptures are carved in soapstone and located outdoors, having been found to be damaged due to two main reasons: the soapstone is a soft material, so there is a large amount of inscriptions and degradation caused by vandalism; it is susceptible to a lichen that erodes the sculptures.

Removing the sculptures and replacing them by copies is a polemical question as there is not a consensus among specialists and the community strongly opposes to it. Also, the sanctuary sustains the local economy, attracting tourists from all over the world. Therefore, UNESCO and National Historical and Artistic Heritage Institute (IPHAN) have been developing projects to preserve them. Besides, the physical preservation and restoration, they aim at the digital preservation of the sculptures.

This work presents our efforts in the 3D digital preservation of the Prophet Joel, which is the first of the 12 to be preserved during this project. We use our pipeline for 3D digital preservation, composed of stages that range from the data acquisition to the 3D visualization of the resulting 3D models. In the 3D reconstruction stage, we compare different state-of-the-art techniques and evaluate their performance on our data. The main goal of our pipeline is to generate realistic 3D models with precise geometry and detailed textures. The resulting 3D models will be used to document the sculpture's current state and also in educational, research and simulation activities.

2.1. The digital preservation of the Prophet Joel

2.1.1. Data acquisition

Our data acquisition system is composed of a laser scanner (Minolta Vivid 910), a digital camera (Canon EOS5D) and two spotlights (Fig. 2(a)). The first device captures range and color images while the camera captures high resolution color images. We developed a software to better manipulate the scanner and the camera simultaneously, so we can operate both of them from a computer. This software enables a faster capture of the data and includes some resources we needed, like plane detection [13].

Figure 2. Data acquisition stage: (a); equipment used for data acquisition; (b): use of a platform to capture the Prophet's top.

The sculpture is fixed and located on a corner of a parapet. At one side it measures around 60 cm from the ground plane, while at the other it measures about two meters. The statue is two meters high, so we had to capture data in different ground levels. We performed the whole process of data acquisition at night as the sun light interferes with the range image acquisition. All the equipments were moved to cover different viewpoints. This way, we collect the images in 3 days using no platform on the first day and two different platform heights in the latter days (Fig. 2(b)).

2.1.2. 3D reconstruction

We used a 3D reconstruction method mainly composed of four stages:

(1) registration;
(2) mesh integration;
(3) hole filling and;
(4) mesh generation.