

III INTERNATIONAL MEETING ON RETOUCHING OF CULTURAL HERITAGE

POSTPRINTS

2015

An abstract graphic in the bottom left corner consisting of overlapping, semi-transparent shapes in yellow, green, orange, red, and blue, creating a vibrant, layered effect.

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IX

**HERITAGE DOCUMENTATION AND 3D
RETOUCHING OF VIRTUAL OBJECTS**

IX. HERITAGE DOCUMENTATION AND 3D RETOUCHING OF VIRTUAL OBJECTS

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Abstract

In this paper we present some results of the use of digital documentation techniques for the characterization and analysis of Cultural Heritage. The used tools (geographic information systems, digital photogrammetry and computer graphics software) allow us to explore new forms of recovery of digital documentation.

The typology of objects where these technologies may be applied is diverse, from public artworks to objects integrated into a museological context.

For the performed exercises, which were presented in RECH 3, were given as examples objects from the urban parks in the city of Porto, from the National Museum of Soares dos Reis, from the Major Seminary of Our Lady of the Conception of Porto, from the Church of the Holy Spirit in Évora, and from private collectors, among others.

The results show that through current digital techniques it is possible to document and characterize in a hyper-realistic manner the surfaces of the works, analyze the degradation phenomena with high accuracy, annotate technological evidences, develop virtual scenarios with infographic profile, reconstruct missing elements of objects, and even make chromatic reintegration on 3D objects.

In practice, the actual virtualization works with digital photogrammetry and with recent techniques of computer processing that provide a handy tool for the documentation of heritage works. This kind of virtualization is a strong alternative to documentation made with laser scanning, often costly. Nonetheless, photogrammetry data capture always requires a high technical accuracy in the photographic acquisition and long post-processing elaboration to develop the 3D models.

Keywords

Heritage Documentation; Geographic Information Systems; Photogrammetry; Computer Graphics; 3D retouching.

1. INTRODUCTION

Documentation of Cultural Property is not a recent subject: the interest and the need to make documentary records, with the most diverse techniques, has always been present in the heritage studies context. However, what has distinguished the models applied to documentation is always the reflection of practices of coeval technologies. Today, after the unequivocal implementation of computer-based technologies, the development of digital records is a reality.

This article references the use of three types of digital tools for the characterization of heritage interest objects: (i) geographic information systems (GIS), (ii) photogrammetry, used for creating 3D models, and (iii) computer graphics software.

The goal of this paper is to present and discuss the role of these low-cost technologies (some might be even cost-free) in heritage documentation and post-processing work with virtual chromatic reintegration.

1.1. Geographic Information Systems (GIS)

In 1999 in Rome, under the auspices of UNESCO, an important event dedicated specifically to the use of geographic information systems (GIS) in Cultural Heritage, the Gradoc, was held [1]. Since then, multiple studies have been developed: during the 2000s several projects in the international context with GIS in Cultural Heritage were promoted [2]. There is a number of open-source software for desktop computers that have contributed to the spread of mapping technologies (e.g. GRASS; QGIS®; gvSIG,

KOSMOS, among others) as well as a strong implementation of trade license programs, such as ESRI's ArcGIS®. Also, several web-based applications have been playing an important role in mapping (e.g., Google Earth, Mapbox): although such web-based applications are not directed to advanced spatial analysis, many have capabilities that allow their use in the documentation of cultural items, enabling to easily identify and locate places and objects in the territory (Google Earth, Google Maps, Open Street Map; Mapbox, among others).

1.2. Photogrammetry Software

Photogrammetry is a well-known technique [3] [4] [5] [6], especially in built heritage context [7]. Recently, there has been a huge increase in this technology in particular with hyperrealistic 3D models processed by the cloud server. Given the recent evolution of algorithms, the creation of 3D models is very fast, because the actual process does not need camera calibration or marking homologous points between photographic pairs. At present, and after some specific technical care in the photographic acquisition, the process is fully automatic. The most common designation for 3D models production with photographic resources is often called a "Structure From Motion" (SFM) or "image-based surface reconstruction" [8]. In this project for making 3D models, the Python Photogrammetry Toolbox (PPT) [9] and a beta version software, Memento from Autodesk®, newly named Remake were used [10].

1.3. Digital Representation and Computer Graphics Software

Computer graphics is another area that has driven significantly heritage dissemination and exploitation, either from the use of 2D imaging programs (Photoshop®, GIMP, Inkscape, among others) or the full development and applications of 3D technologies. Within the production of three-dimensional models, this is a significant development area in virtualization for the animation, cinema and digital games industries. The same software is also used for the recreation of ancient scenarios and sites, in the archaeological context. Some commercial software are well known, such as 3D Max Autodesk®, while Blender (with a GNU General Public License) has the potential to revolutionize the contemporary digital documentation in cultural heritage, as it is one of the programs with greater utility and versatility in computer graphics, from the simple chromatic reintegration of objects, to the development of virtual scenes [11].

Computer graphics have the ability to contribute for the development of scientific based museological contents and museographic utilities [12] [13], such as the recreation of virtual museums, the production of representations with didactic interest to illustrate objects (Figure 1) and design animation for educational tools.

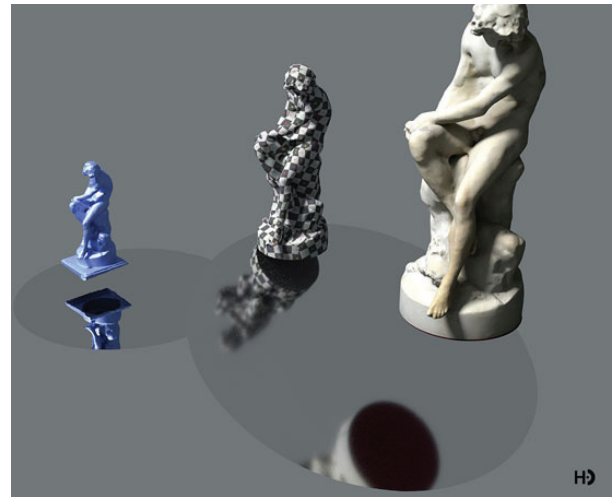


Figure 1. 3D model of representation of the marble sculpture “Desterrado”, from the National Museum of Soares dos Reis, in Porto.

2. METHODOLOGIES

In the specific context of the presentation made in RECH3, several examples ranging from geographic information systems (Figure 2) to various photogrammetric 3D models (Figure 3) and some virtual reconstructions (Figure 4) were discussed. In it, the goal was to describe applications within the chromatic reintegration of virtual objects. Thus, initially the chromatic reintegration of the resulting images (2D views) is presented, while a later phase dedicates to the 3D reintegration.



Figure 2. Aerial view of the distribution of public art in the Crystal Palace Gardens in Porto.



Figure 3. Representation of a scene with a photogrammetric object (Angel Messenger, Irene Vilar).



Figure 4. Creative composition with 3D objects belonging to the gardens of the Crystal Palace, Porto.

2.1. Chromatic reintegration of images

The chromatic reintegration of 2D images is made using digital editing and image processing. In it, Photoshop® is the most commonly used commercial product [14]. Regarding free programs, GIMP is the most widespread tool. For digital image processing the software named ImajeJ [15] is also one interesting option to explore in heritage documentation. It is written in Java, which allows it to run on Linux, Mac OSX and Windows, in both 32-bit and 64-bit modes. ImageJ and its Java source code are freely available and in the public domain.

In the reintegration using Photoshop®, two main tools are possible to use: the brush (tool and

pencil tool brush) and the stamp (clone stamp tool). To determine the color, the eyedropper tool can be chosen. Besides the tools indicated, many other editing functionalities can be used, such as the magnetic lasso and the magic hand tools, which highlight selection areas (Figure 5).



Figure 5. Some examples of image-editing tools in Photoshop®.

2.2. Reintegration of 3D objects

Blender software was used in the post-processing of 3D objects [16]. After importing the photogrammetric model (import obj.) and respective texture (material > color > texture image), chromatic reintegration is done by picking the interaction panel dedicated to “texture paint”. If the object has a texture, it can be reintegrated directly in the model. Then it is possible to select the type of brush, and in color space choose a color (Figure 6).

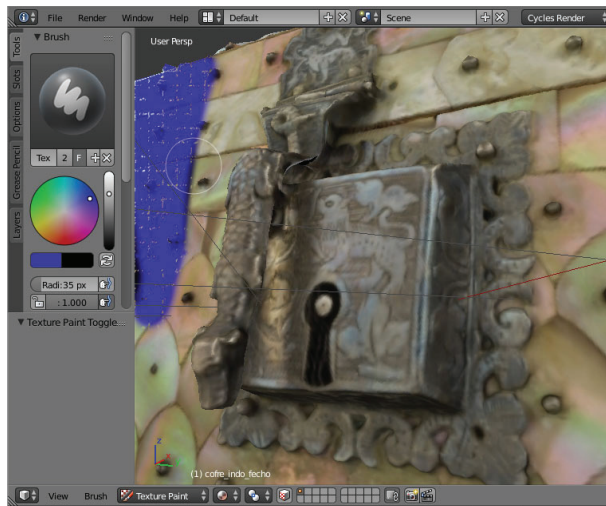


Figure 6. Snapshot of a Blender session for chromatic reintegration with brush, in mode system “texture paint”.

It is important to note that if the object has no texture, it should be created, in order to make the chromatic reintegration of the object. As in 2D editing with Photoshop®, the main tool is the brush clone. With this tool it is possible to reproduce all varieties of colors present in the object. It is possible also to control the brush size, determine the radius in pixels and an application strength.

For understanding the methodology is presented a table which compare type of work, software class and work time (table 1).

Operation	Software	Class	Work time
Sculpture photo acquisition	None	Photography	2h
Mapping a Public Art Collection	Mapbox	WebGIS	3 h
Produce a 3D model of one sculpture	PPT or Memento (Autodesk)	Photogrammetry	4h
Create a virtual scene	Blender (Cycles)	Computer Graphics	5h
Render a virtual scene with animation	Blender (Cycles)	Computer Graphics	7h-12h

Table 1. Relation between main operations and software's.

3. RESULTS AND DISCUSSION

The techniques presented in the paper are used for colour retouching. Some of the problems related to colour reproduction is the colour accuracy of the photographic image acquisition. For that reason is important to have in mind the correct adjustment of photographic parameters, such as the white balance, field of view, exposition time, among others [17].

The colour reproduction of 3D models depends of knowledge and skill of operator, in particular in scenes that contain more than one object, where we have multiple sources of lighting and the objects are non-uniformly illuminated [18] [19] [20].

In this project, results with the intersection of documentation technologies (GIS, photogrammetry and 3D modeling) were

achieved. It was also demonstrated that, independently of the size of the objects, any type of object can be documented, in a macroscale perspective or in detail.

Regarding the chromatic reintegration tools, both in 2D images and 3D objects, the main tools are the paintbrushes and clone tools. In both cases, despite the low difficulty level, appropriate training is required to edit the images and post-process the models. As with most software, attention should be given to the learning process in the context of specific training. Although it seems easy, learning should be structured so that the results can be achieved. Otherwise, as with real paintings, image distortion may occur during virtual reintegration.

Such representations may be associated with evidence of technological objects as well as their degradation phenomena and pathologies.

In future work, 3D animations with hyper-realistic scenarios are probably the next frontier of documentation, where the virtual and the real world are entailed. Independently of the techniques used to acquire data for the objects under representation, chromatic reintegration is essential to increase the best results, especially for virtual reconstructions. But, even in digital processing, the colour reconstruction is always a non-original addition. For accurate scientific works “less retouching is more” and the possibilities is always unlimited.

4. CONCLUSIONS

All documentation areas referred to in the text, associated to geographic information systems, photogrammetry and computer graphics, have been in application for several years in the cultural heritage context. More recently, advances in computing technologies have enabled the development of high-definition models, extending the application of the tools to a level of detail beyond a simple registry of the objects.

With the recent modern photogrammetry it is possible to produce automatic mode models with high degree of realism. Moreover, to register these 3D models in virtual environments, there are countless possibilities for the representation of cultural objects with their photographic textures.

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