

MAPPING LACUNAE FOR RETOUCHING PAINTINGS WITH COMPUTER GRAPHICS SOFTWARE

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Abstract

The objective of this paper is to present a workflow procedure to support the graphic recording of the operations performed during the retouching process involved in paintings. In this particular context, an orthophotography of a portrait painted on canvas from a university museum collection was used in Blender, a free and open-source 3D creation software suite. Blender uses an important metric coordination value, provided by the 3D workspace software that allows the areal characterization and numeric identification of each surface loss. The step-by-step procedure adopted to document and map lacunae in this artwork for subsequent retouching, is described.

Keywords

Documentation;
Graphic recording;
Retouching;
Painting;
Ortho-image;
Blender.

I. INTRODUCTION

In conservation and restoration documenting all the actions executed on artworks through a graphic recording is essential. The same applies in paintings regarding the exact location of the operations carried out on the pictorial surface. In the condition report, the tear areas, traces of abrasion, overpaints, fillers, cleaning spot tests, areas of sampling (e.g. cross sections) and analysis spots (Raman, XRF, colorimetry, FORS, among others), for example, should be recorded ^[1]. The registration of paint losses is also one of the tasks that should be performed ^[2]. For the digital registration of losses, several computer programs can be used to register either vector (e.g. AutoCAD, Adobe Illustrator, Inkscape, etc.) or raster (e.g. Photoshop, Gimp, etc.) archives. However, a coordinate system is necessary for mapping. Concerning the available types of digital documentation, several non-conventional applications, such as

geographical information systems (GIS), have enormous potential and can be used in the field of Conservation ^{[3][4][5]}.

The aim of this work, based on the portrait of Professor António Vicente Ferreira (figure 1) painted by Álvaro Perdigão in 1944 ^[6], is to present the workflow procedure to support the graphic recording of some operations in conservation and restoration, in particular during the retouching phases. The painting belongs to the Museum of Civil Engineering, of the Department of Civil Engineering, Architecture and Georesources of Instituto Superior Técnico, in Lisbon. The method begins with a photogrammetric process ^[7] to acquire an ortho-image of the painting. In a second phase the work is fully performed with Blender, the chosen 3D modelling software. The vector

graphic operation occurs prior to the conservation treatment.

Blender is an open-source and free software and an all-in-one tool with useful capabilities for documenting cultural heritage. It is a multi-purpose computer program in the areas of 3D modelling, rendering, simulation, video editing, game creation, infographics schemes, scientific illustrations, virtual environments, exporting to several formats (including vector and 3D printing files), and animations, among other capabilities ^[8].

I.1 Orthophotography or ortho-imagery

Ortho-images are well-known in geographic mapping representations. An ortho-image is a digital dataset and can be used in geographic information systems as a layer to support the

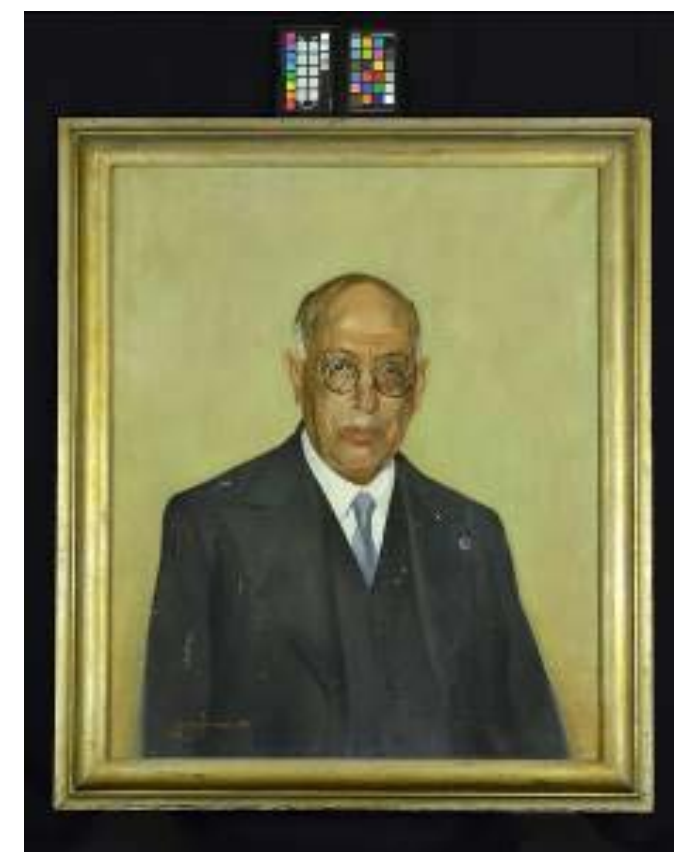


Figure 1 - Photograph of the portrait of Professor António Vicente Ferreira with a calibration chart.



Figure 2 - During the characterization of colour and spectral acquisition with FORS.

creation of other data. They are essential for producing maps of the Earth's surface, such as city maps, that require the correction of the image geometry and scale. Such images have uniform scales, correction of the inclination perspective and the effects of parallaxes produced by the optical equipment. Acquiring and producing an ortho-image is critical to measure true distances in surfaces and mapping the events on the space. According to principles advanced in panel paintings [9], the same system was applied in the present case-study to the pictorial surface. The ortho-image was obtained using a photogrammetric method, which consists of making measurements from photographs (multiple records).

1.1 Mapping lacunae with Blender

Mapping lacunae in paintings should always be done with vectorial drawings. Some graphic maps,

frequently in usage in Conservation and Restoration or in technical studies, are made with raster drawings, with Photoshop® or similar software. However, such scope is limited. To obtain a current and regular recording of the pictorial layers and surface, it is better to create a vectorial record because it allows the interoperability of the data between software.

Just like other 3D software, Blender has the ability to create solids, planes (polygons), points, etc. The workflow presented in this paper started with polygons under the image of the pictorial surface (ortho-image).

Blender can also be applied to substantiate technical and analytical studies of Cultural Heritage assets. In this case study, Fiber Optics Reflectance Spectra (FORS) (figure 2) was used. This equipment obtains the spectral information on a given spot of the painting concerning its reflectance properties in the 300 to



Figure 3 - Screenshot of the photogrammetric project in Agisoft Photoscan® software with the photographs taken in mosaic grid.

1000 nm range. In Blender, 12 points of FORS readings were mapped on the surface layer, registering their positions and values.

2. METHODS

The method was applied in two main steps: the first with photogrammetric procedures to obtain a plane model of the artwork and the second with vectorial drawing to build up features related with the lacunae.

2.1 Orthophotography

To produce the ortho-image, a software named Agisoft Photoscan® [10] was used. This photogrammetric software is widely used to produce 3D models and also to acquire terrain information with unmanned aerial vehicles (UAV).

The photogrammetric software works with the upload of a set of photographs acquired in sequence



Figure 4 - Render image produced with Blender software that simulates a virtual gallery.

around the painting or in strip lines. To obtain good results it is necessary to apply the best practices in photography. In this project, a tripod, two light sources with softboxes to provide diffuse light, and a DSRL camera NIKON D3200 (24 MP) equipped with a CMOS sensor and a lens AF-S NIKKOR 18-55 mm were used. All the images were obtained with the same value of focal length (23 mm), low ISO value (100) and aperture (F/8). The resolution of the photographs is 6016x4000 pixels, approximately 12 MB, and was saved in JPG file format. The vibration reduction (VR) of the lens was in switch off mode.

In this museum project, the photographs acquisition was similar to what would be used for aerial photogrammetry, scanning the surface in strip lines, with a high overlapping of photographs, between 60% and 70%. The set of records (57 positions) is an aggregate of organized images in a mosaic (figure 3).

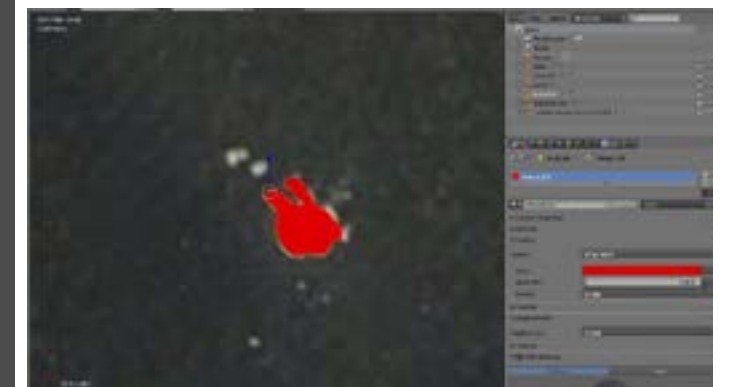


Figure 5 - Screenshot of Blender workspace during the editing process.

After processing the data, the result obtained was a 3D model. On this basis, one of the functions of the software to generate an ortho-image could be used. Two types of images in orthophotographic view of the painting were acquired: the first in low resolution, in JPF file format (8057x9416 pixels) with 11.4 MB, and the second in high resolution, in TIFF file format with 345 MB. For the next phase of the project, with Blender software, the JPG file was sufficient to map the lacunae.

2.2 Mapping the lacunae with Blender software

The mapping process with the 3D modelling software Blender (v. 2.78) began with the upload of the ortho-image in the project. Then, the object was oriented in X, Y, Z axes, and the map scale was updated to display proper distances at the centimetre scale.

If the option consists in uploading

the 3D model produced by the photogrammetric software, it is necessary to import the OBJ file format and respective texture (JPG file format). This sort of procedure is very useful to create virtual scenarios (figure 4), to produce infographics schemes or to make animation movies. However, in the current project on mapping losses, only the JPG image and 2D file as a plane were needed.

The drawing of several gaps was made in "edit mode" extruding points around the lacunae area; this resulted in a polygon defined by segments and nodes (figure 5). Then, it was necessary to make a polygon with all points. The new element consisted in one object with a unique ID (characterized as loss unit). All drawn losses could then be organized in groups or in one group with a hierarchy and organization system.

The cartography was made after the manual work of editing all polygons (losses). The final output was not

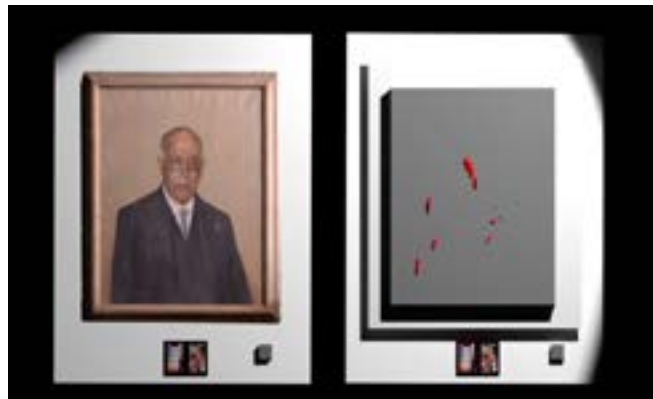


Figure 6 · Cartographic map of lacunae and vulnerability areas of the pictorial surface.



Figure 7 · During color retouching with “texture painting” clone tool.



Figure 8 · Main region of the painting after the color retouching process (left side) and “UV map” and respective texture of the 3D object (photogrammetric model) (right side).



Figure 9 · An overview of 3D model painting useful for on-line visualisation in the Sketchfab® platform and repository of museum objects.

only a map of losses, but also a map of original and non-original paint. Moreover, such a cartography resulted also in a map of risk displaying the most vulnerable areas of the painting (figure 6).

3. RESULTS AND DISCUSSION

This workflow with an ortho-image, generated with a photogrammetric software, and vectorial editing of lacunae with a computer graphics software allowed to accurately identify all gaps in the painting. Each lacuna, after the manual drawing, acquired an identification number to match a lacunae unit. The total number of lacunae in this painting is 22 and there are 14 regions with abrasion. Besides a straightforward localization of the gaps on the whole surface, according to the adopted color scheme (lacunae of red color over a plane grey ground), the cartographic map also allowed to

quantify the percentage of losses, which amounts to 1.9%.

By guaranteeing an automatic calculation, Blender as a tool proves also essential because it allows an objective, reliable, reproducible, and extremely fast and friendly quantitative assessment. This type of evaluation is central to both diagnosis and intervention because it provides a secure expertise as to the degree of authenticity of the artwork; it establishes precisely the defective chromatic areas, their shape and distribution; it contributes to the cost estimation involved in the inpainting process, be it digital or real in the work itself.

Another possibility that Blender offers is, in fact, the virtual retouching. This kind of operation is widely applied with photo-editing software, with 2D images. It can also be made directly in the 3D model, in the imported photogrammetric object or even in the 2D image. The operation is made with the well-known clone tool (figure 7).

It is worth emphasizing the added value of digital color retouching, for its absolute reversibility and its benefit as an independent and didactic support that, together with the real painting, can promote its better understanding (figure 7 and 8).

After generating a cartographic recording of lacunae, each 3D project can always be adjusted or consolidated with more data. This is fundamental to understand the scope of 3D projects in Cultural Heritage and of the Conservation and Restoration technical studies. As an example, an online 3D model for virtual visualization was also produced in this project. The virtual platform Sketchfab® was used to this end [11]. The platform hosts a 3D repository and a collection of some 3D museum objects. The analyzed painting is one of them, thereby becoming a powerful public awareness medium regarding Cultural Heritage concerns [12] (figure 9).

It is also necessary to refer the large potential of virtual scenarios and infographic strategies with 3D modelling techniques. The tool can also be used to communicate in Heritage Documentation, using 3D modelling techniques of the industry of films and games. This means that the documentation techniques and procedures in Cultural Heritage meet effectively the computer graphics knowledge area. Here, a simple presentation of a virtual scenario was made with the mapping of analysis spots (FORS) on the museum painting (figure 10).

4. CONCLUSIONS

The use of current computer graphics (CG) tools in Cultural Heritage is starting to get attention from the community of conservation and restoration professionals. It is important to refer that CG software is not a substitute for GIS or CAD

systems, but a possibility to promote infographic illustrations, like those of cartographic products, for three-dimensional objects. About the GIS software and CG software available nowadays, it is possible to work with standard files and export files to ensure the interoperability within project data. In the future, with the massive amount of information acquired in conservation-restoration operations,

it is critical to create comprehensive databases for the data associated with each artwork, enabling the storage of all information from conditioning reports, conservation and restoration interventions, laboratory and analytical reports, as well as the graphical documentation produced for the object. Noteworthy is also the potential of graphical documentation to produce and register spatial analysis and risk maps of the artworks.



Figure 10 · Virtual scenario made with Blender. The image informs about the location of analysis spots with FORS system.

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