ULTRAVIOLET FLUORESCENCE 3D MODELS FOR DIAGNOSTICS OF CULTURAL HERITAGE

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Abstract

This paper reports the procedure and results of 3D rendering applied to ultraviolet fluorescence documentation of artworks. A close range image system was applied, using ultraviolet radiation as source for subject investigation. In this way a complete 3D documentation of the conservation state was achieved by taking advantage by ultraviolet radiation. To test the applicability of this new procedure of documentation and investigation on artworks, a papier-mâché bust dated back to the beginning of 18th century, exposed in the Museum of Colle del Duomo in Viterbo, was chosen. The bust, representing the Pope Pio V is made of papier-mâché as support and of other superimposed layers made of gypsum, with a final layer of silver.

Keywords: 3D rendering, ultraviolet fluorescence, software reconstruction, papier-mâché bust, Colle del Duomo Museum

1. Introduction

The aim of this work is to apply digital 3D documentation based on close range image system, to investigate a papier-mâché bust by ultraviolet (UV) fluorescence. In this way it is possible to take advantage of information gathered by UV fluorescence photography but on the entire 3D model of the bust. This new experimental procedure is particularly useful in conservation because it makes possible a complete investigation of the surfaces of a 3D subject in a single file. The UV fluorescence technique allows for analysing the preservation state of the surface, the material losses, *pentimenti* and retouches, the presence of superimposed materials, the reading of faded paintings and so on [1, 2].

In order to test and apply this technique to a complex tri-dimensional object, a papier-mâché bust was chosen. The bust (dated to the half of the 18th century) represents the Pope Pio V (1504-1572) and at present is exposed in the Museum Colle del Duomo in Viterbo (Italy). This artefact was chosen also in relation to the availability of data gathered on the occasion of thesis based on the scientific investigation of a group of six reliquary busts in papier-mâché of Colle del Duomo Museum [3]. The bust (height 95 cm; width 74 cm and base 22 cm)

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still contains the relics of Saint Pio V in a cavity at the centre of the bust (Figure 1).

Figure 1. The reliquary bust of Saint Pope Pio V.

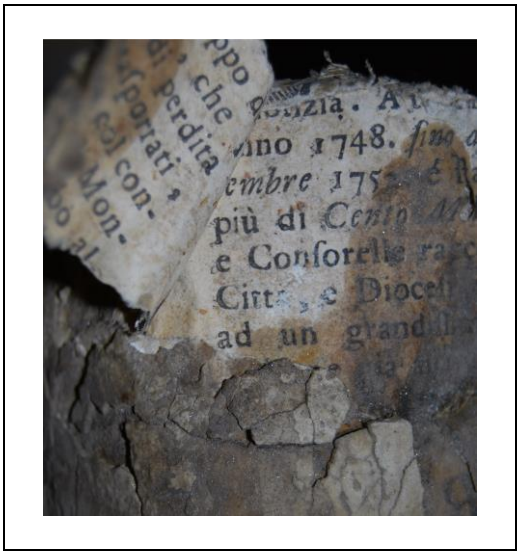

Figure 2. The date 1748 printed on the newspaper.

The analysis performed on the occasion of the above mentioned thesis allowed to investigate the execution technique and the materials used for creating the reliquary busts. The support of the busts is made of several layers of papier-mâché. In some points the newspaper used for obtaining papier-mâché is visible, due to losses of the external layers, revealing the date 1748 printed on the newspaper [3, p. 97] (Figures 2 and 3). The newspaper layers were then covered by linen and subsequently by gypsum and animal glue layers [3, p. 45-47]. Lastly, yellow ochre setting was applied then covered by silver, both in lamina and in powder. Some surface details were made with carbon black pigment.

Figure 3. The newspaper layers.

2. Experimental

The documentation of the bust was performed by digital photogrammetric system [4] by using UV sources. In particular, UV fluorescence photographs were taken using a Nikon D5300 camera and Philips PHLTUV36 tube lamps positioned at 45° as regards the surface to be examined. In front of the camera lens, the Kodak Wratten gelatine filter 2B (light yellow, absorbing the UV radiation under 390 nm) and 85B (amber filter) was placed in order to block the reflected UV and to attenuate the blue dominant typical of the ultraviolet photographs.

The 3D survey of the bust, by close range multi image system, was performed by applying the Agisoft PhotoScan software [4, 5]. This system uses automatic methods of extraction, identification of homologous points and orienting of digital image sequences in order to automatically determine the spatial structure of a scene by starting from a sequence of images without the necessity of supplying data related to the images or to the photographic conditions (Figure 4).

First, a 3D model was created by using visible light. In order to dimension the model, targets were inserted in the acquisition area. These targets have been

measured by total station [4]. For visible acquisition, 45 images were gathered with the Nikon D5300 digital camera, as previously explained (Figure 5).

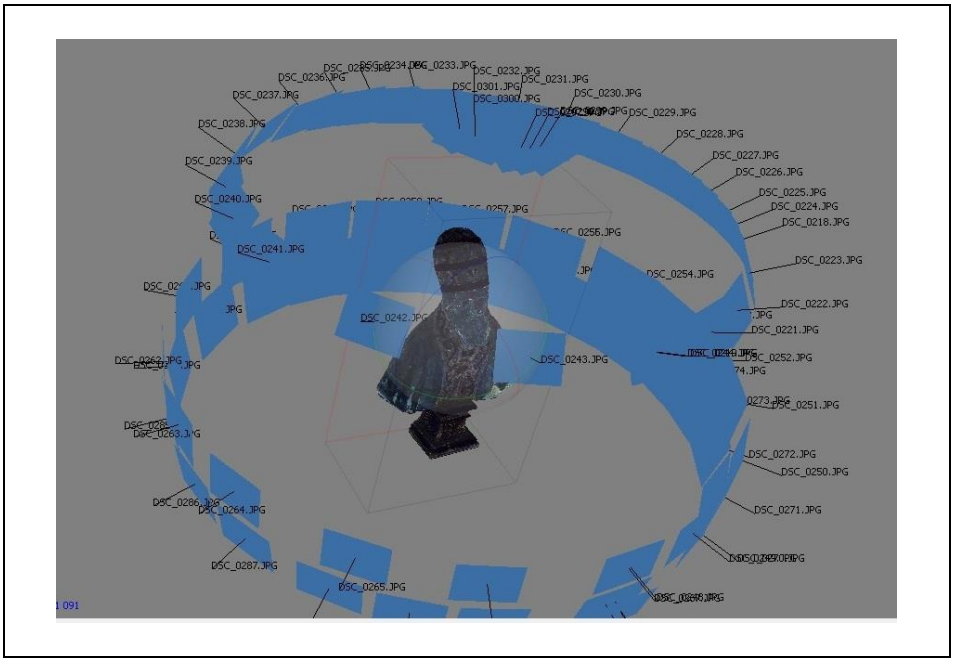

Figure 4. The Agisoft PhotoScan software.

Figure 5. Image acquisition under visible lighting.

The software identified 10.539 homologous points on the 45 photograms and it created a dense cloud made of 4.814.485 points and a 3D model made of 962.896 faces.

The same procedure was repeated with the UV radiation; the software identified 59.561 homologous points on the 75 photograms and it created a dense cloud made of 6.849.517 points and a 3D model made of 1.381.091 faces. For UV radiation, the images were gathered with the Nikon D5300 digital camera, with these shooting parameters: F-stop f/5.6, exposure time 5 sec., ISO-100 sensitivity, focal lens 35 mm.

3. Results and discussion

The UV model obtained after images elaboration is shown in Figure 6. Different kinds of fluorescence can be observed. Intense orange fluorescence is visible on the wood base that supports the bust, on the stole volutes and on the papal tiara. This kind of fluorescence can be associated to shellac, a natural resin widely used for final protection of sculptures and models [5, 6]. Shellac was probably used as final protective varnish for silver lamina.

Figure 6. UV 3D model of St. Pope Pio V bust.

A pale yellow fluorescence can be observed in different parts of the bust, in area lacking of the silver lamina. This fluorescence can be associated to the pigment binder of the layer under silver. The yellow colour under UV of this binder allows for supposing the presence of siccative-oil. The distribution and

extension of these yellow fluorescent areas supplied information on the silver losses and on the lacunae of the surface. In the light of a possible future conservative intervention on the bust, this information is particularly relevant for conservators to address the surface mapping and the subsequent operative activities.

By simply rotating the model, a light blue fluorescence is visible on the white setting layer. This fluorescence can be associated to the animal glue mixed with gypsum to obtain the setting layer for painting and found by spectroscopic techniques used to characterize the component materials of the bust [3, p. 89].

4. Conclusions

In this paper a new documentation system was presented, based on close range image acquisition of UV fluorescence applied on a papier-mâché bust representing the Saint Pope Pio V and dated to the half of 18^{th} century.

The results obtained in this study demonstrated the high potentiality, at relatively low costs, of the UV documentation on a 3D model. In fact, it had been possible to carefully investigate the conservative status of the surface of the bust by simply rotating the 3D model generated at the end of the elaboration process. So, without using a lot of images of the different sides of the 3D object, but with a single interactive file, also in pdf format, it was possible to map the UV fluorescence responses of the surface and to hypothesize the material nature. In the light of a future desirable conservative intervention, the information obtained by the 3D UV fluorescence model will be certainly highly useful for the conservators.

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