

The implications of free 3D scanning in the conservation state assessment of old wood painted icon

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Abstract. The present paper presents the conservation state and the making of a 3D model of a XVIII-th century orthodox icon on wood support, using free available software and cloud computing. In order to create the 3D model of the painting layer of the icon a number of 70 pictures were taken using a Nikon DSLR D3300, 24.2 MP in setup with a Hama Star 75 photo tripod, in loops 360° around the painting, at three different angles. The pictures were processed with Autodesk 123D Catch, which automatically finds and matches common features among all of the uploaded photographs in order to create the 3D scene, using the power and speed of cloud computing. The obtained 3D model was afterwards analyzed and processed in order to obtain a final version, which can now be use to better identify, to map and to prioritize the future conservation processes and finally can be shared online as an animation.

1. Introduction

During the last few years, the modern investigating and examination techniques have played an important role in the conservation and preservation of old paintings. In order to carry out initial researches of the cultural heritage object, several noninvasive examination methods can be performed (optical microscopy, scanning electron microscopy). However, none of these methods provides data on the geometric shape and metric analysis of the object surface. This gap in the initial optical examination of an artwork can be filled with optical 3D scanning [1].

In the last decade, the 3D examination technique was introduced in the examination processes of cultural heritage, which allowed restorers a more in depth and variable examination opportunity. Due to equipment limitations, the scanning technique was mostly used in the case of structures and sculptures until now [2].

New improvements in the field of 3D scanning has now allowed us to create 3D models of the painting surface, models that can be used to study the conservation state of the painting layer, to observe the planar surface changes that can take place after a consolidation processes, or (in the case of more accurate scanning) even to create three dimensional reproductions through new 3D printing techniques [3-7].

Although the technique involves a certain investment in scanning apparatus and data processing technology in order to obtain accurate and printable 3D copies of the painting surfaces, there are other



cheaper options for obtaining a 3D scanning of a painting for study and conservation purposes. One of these options involves using the free available Autodesk 123D Catch software to create your 3D models using your own 360° pictures of the painting.

The paper wants to present the process of obtaining a 3D copy of a XVIII-th century icon obtained through the above mentioned software, without any costs what so ever. The purpose of this paper is to encourage restorers to use new examination techniques, to share their 3D models obtained through various scanning techniques with the cultural heritage community and not only, and to prove the easiness to obtain a 3D proof of their work.

2. Icon presentation and conservation state

The painting taken into study is a XVIII-th icon, done in egg tempera on a lime wood support, part of the Arheoinvest laboratory collection. The lime wood support (L= 45cm, W= 38cm, h= 2cm) is made out of three wood panels, kept together by two back crossbeams. The wood support was covered with a canvas, in order to ensure its resistance and to restrict the dimensional modifications caused by humidity variations. A thick layer of ground was applied on the canvas, which served as an appropriate surface for painting.

The icon depicts the *Virgin Mary*, holding baby Jesus in her arms, one of the most well know orthodox iconographic representations (figure 1).

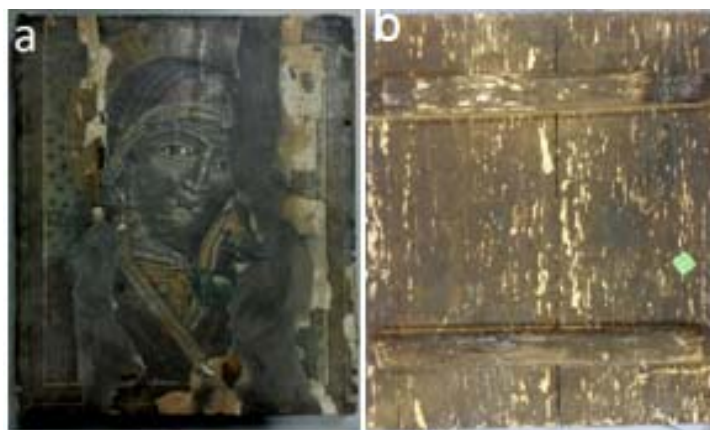


Figure 1. *Virgin Mary with baby Jesus* icon: a) Front; b) Back.

The conservation state of the icon is very poor, both the wood support and the painting layer being affected by several deterioration and degradation processes.

Approximately 20% of the painting layer has been already lost, while the rest of the painting layer suffers from longitudinal and mosaic cracks, extensive detachments, blackened areas, chromatic modifications [8] etc. The gaps are mostly located where the three panels are joined together. These severe cracks were mostly likely caused by the dimensional modifications (especially shrinkage) of the three wood panels, as a response to the environmental variations of humidity [9-13].

The painting layer also presents areas that suffer from thermal cornification and oxidative dirt gathering, deterioration processes that were favored by the fact that the icon was exposed though its liturgical purpose, to heat sources (candles, lamps etc.) (figure 2a-f).

The wood support suffers from a xilophagic attack (inactive for the moment), its effects being visible in gaps, on the back and on the sides of the panels (tunnels and fly holes). Due to this, the resistance of the support has severely decreased, leading to cracks and loss of material, especially on the sides and corners of the panel [14-15].



Figure 2. Deteriorations and degradations of the painting layer: a-b) dirt deposits, deep gaps; c) dirt deposits, deep gaps, xilophagic attack; d) dirt deposits, detachments; e) deep gaps; f) detachments, dirt gatherings.

A thin layer of ground, covered with color, was applied on the back of the support at a certain point in time, in order to reduce the influence of humidity (figure 3 a-d). Nowadays, this protective layer also has gaps and detachments. The fact that the icon was exposed to concentrated heat sources had also affected the support, severe burning marks can be observed in picture 3b.

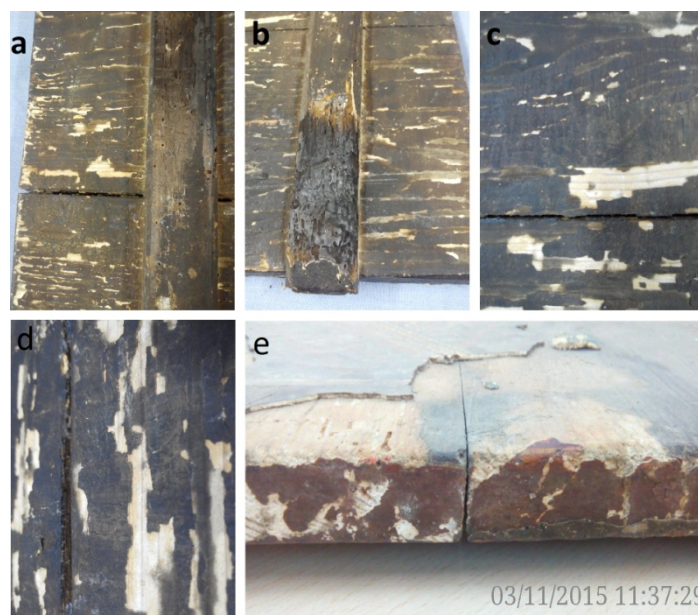


Figure 3. Deteriorations and degradations of the support: a) Dirt deposits, wood components distancing from each other; b) burn marks, dirt deposits; c) Dirt deposits, wood components distancing from each other; d) crack along the wood fiber; e) fly holes, wood components distancing from each other.

3. Experimental part

In order to obtain the required set of photos, a Nikon DSLR D3300, 24.2 MP was used in setup with a Hama Star 75 photo tripod. A number of 70 pictures were taken from all around (360°) the center of the painting layer of the icon, at approximately the same distance, without using the flash of the camera. A constant source of light was used, in order to avoid any changes in the lighting condition of the painting. The photos were then uploaded into the Autodesk 123D Catch software to be processed in order to obtain the 3D copy of the painting layer of our icon. The software automatically finds and

matches common features among all of the uploaded photographs in order to create the 3D scene, using the power and speed of cloud computing [16].

4. Results and discussions

The process of uploading the pictures to the cloud and their computing through feature matching varies according to the number of picture (70 being the max number that can be used) and their properties (dimensions, quality etc). The obtained 3D model allowed us to establish first of all the point from where the photos were taken and if a certain angle or detail of the painting was not taken into examination.

In our case, the 70 pictures can be divided into three sets that were taken 360° around the center point of the painting, at three different angles, in order to ensure sufficient information on each part of the surface. The sets of photos were done in a continuous manner without interrupting the process, without changing the lighting and most importantly, without moving the object (figure 4).

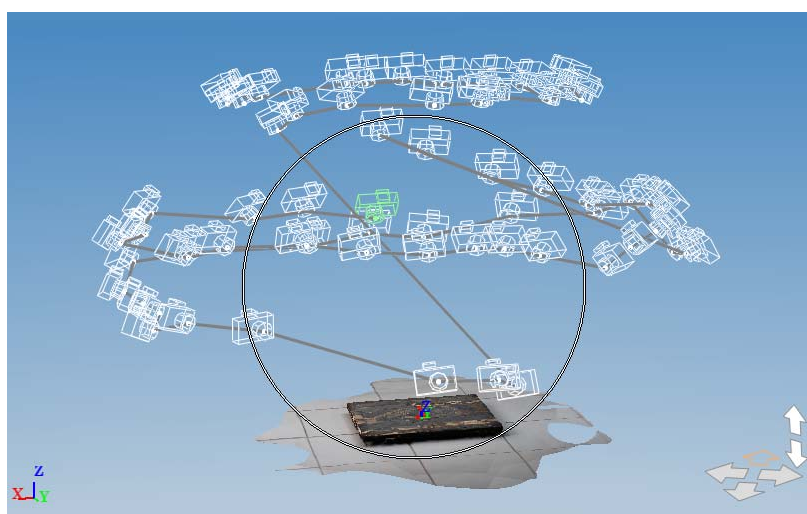


Figure 4. The three loops of photos, taken at three different angles.

The fact that the 3D model can be created using cloud computing represents one of the reasons that this or a similar scanning technique should be used more often by the restorers. The curators or restorers aren't required to invest in computing technique or to employ a specialist in order to obtain a workable 3D model.

The photos circle radius was diminished with each loop (first loop is the largest, while the last loop has the smallest radius), for the same reason already mentioned, but also to ensure that no shading problems would obscure details of the painting layer (figure 5).

After ensuring that the quality of the pictures and 3D model obtained is accurate, the process of examining the painting layer can begin. The viewer can now observe through simple navigation around the 3D model the deterioration and the degradation of the painting layer, without exposing the object to further manipulation or light sources (figure 6a-c). The 3D model can also be observed as a structure. This can help the exact mapping of the detachments and deep gaps of the painting layer (figure 6d-f). The mapping process can then help curators and restorers in evaluate the conservation state of the painting and to prioritize future interventions [17].

The same gaps and detachments can be observed at different angles and magnifications, in order to determine their dimensions and high/depth.

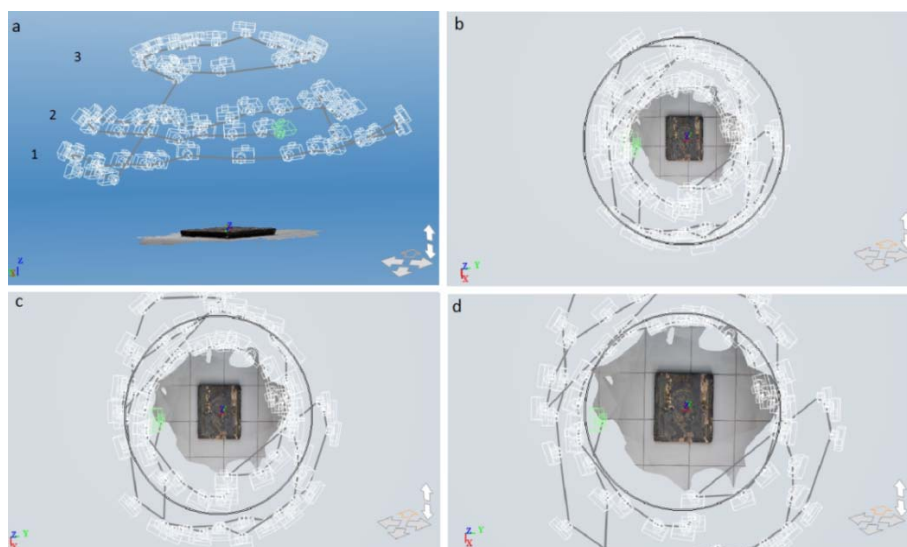


Figure 5. The radius of the three loops: a) general view of the three loops; b) radius of the first loop; c) radius of the second loop; d) radius of the third loop.

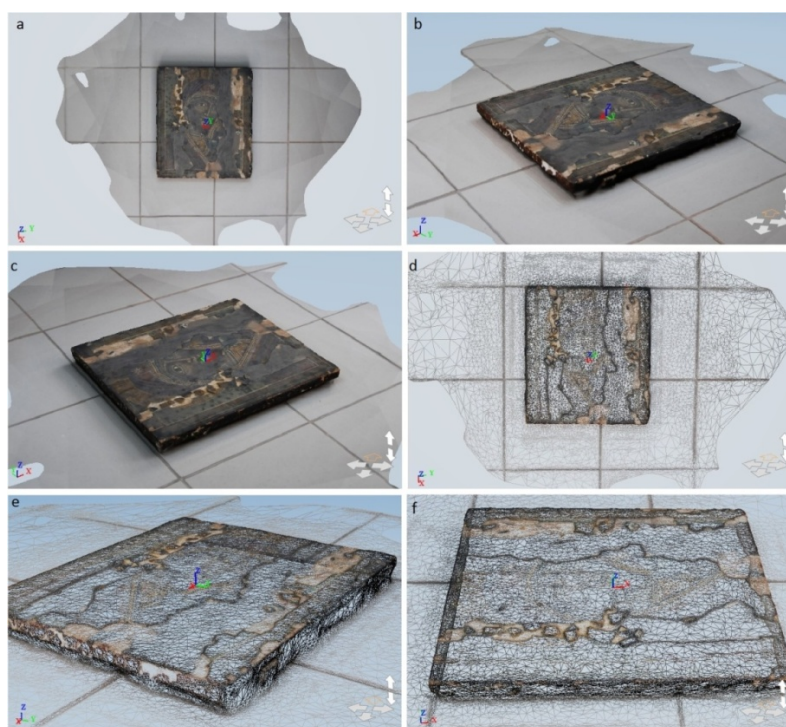


Figure 6. The obtained 3D model of the icon: a-c) front and sides; d-f) front and side structure.

In order to improve the aspect of the final 3D model, the background can be removed (figure 7a-f). The model can also serve as a digital testimony of the conservation point of the painting at a certain point and a comparison base after a period of time or after a restoration process. Using another feature of the program, the 3D model can be presented as a animation, which can be then directly shared online on the restorers YouTube account. This can be the next step in making people aware on the conservation problems of cultural heritage paintings and can also serve as a communication channel between specialists, allowing them to inspect the painting remotely and to offer their professional opinion.

The fact that some the 3D models created through Autodesk 123D Catch can be used after as examples by the software company is another way to share the conservation problems of a painting with people that are not cultural heritage specialists.

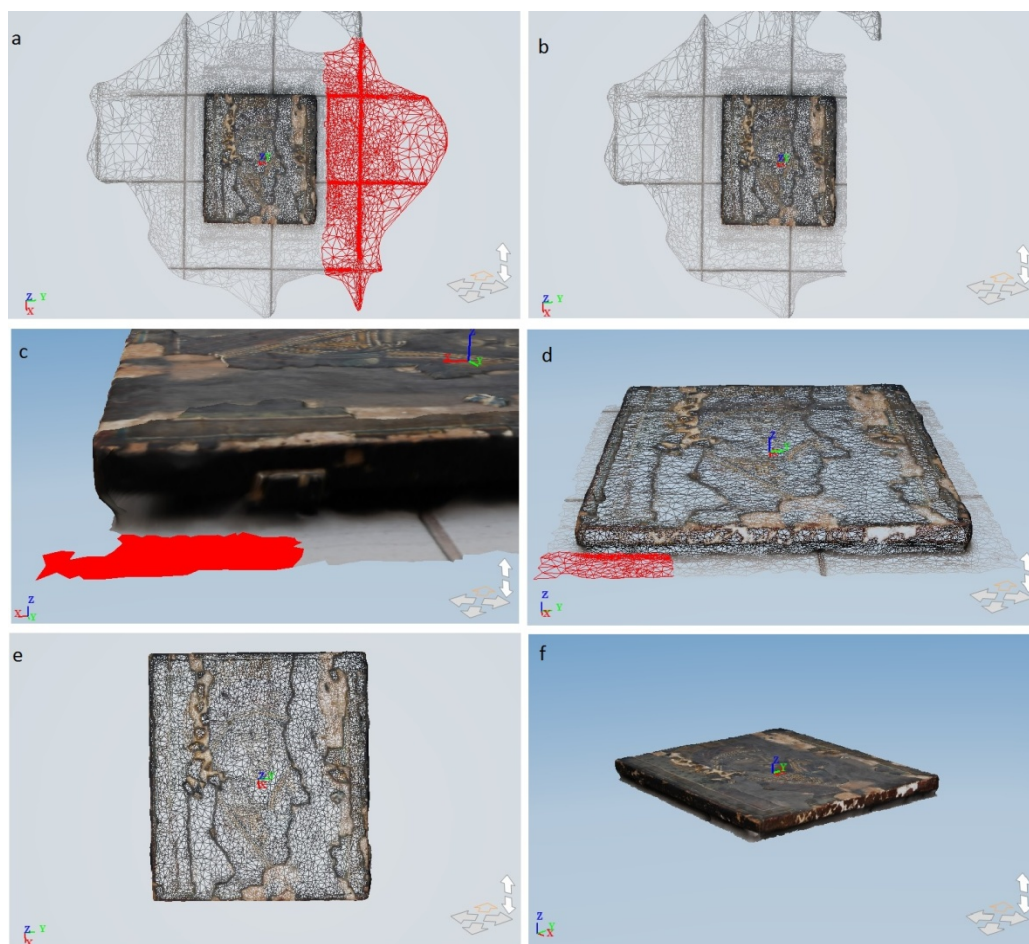


Figure 7. Stages of background removal.

The obtained and processed model can also be used to create a 3D print of the painting. In order to do this, the digital model created in Autodesk 123D Catch should be processed using free software, Meshmixer, to improve its characteristics.

5. Conclusions

The *Virgin Mary with baby Jesus* icon, part of the Arheoinvest laboratory collection, was used as part of an attempt to create a free 3D model of a painting. A number of 70 pictures were taken from all around (360°) the painting layer of the icon, at approximately the same distance, and were then uploaded into the Autodesk 123D Catch software to be processed through cloud computing, in order to create a 3D model of the icon. Navigating around the 3D model, the viewer can now observe the deterioration and the degradation of the painting layer, without exposing the object to further manipulation or light sources. This can help the exact mapping of the detachments and deep gaps of the painting layer, in order to prioritize the required conservation steps. The obtained 3D model can then be share online as an animation between specialists, allowing them to inspect the painting remotely and provided advices and change opinions.

The fact that the 3D model is easy to obtain and doesn't require significant investments should be an incentive for all restorers to apply a more technological and modern approach to the process of painting restoration.

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