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3D COLOUR LASER SCANNING CONFERENCE:

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ABSTRACT SUBMISSION FORM

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Title of the Paper: Towards a Complete Digitisation of Post Byzantine Icons

Theme : General applications of 3D scanning in the museum sector

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ABSTRACT

Among the technological advancements in recent years the emergence of 3D colour laser scanning holds a prominent position. The opportunity for simultaneous acquisition of both three dimensional surface geometry and colour information data offered by laser scanning systems is deemed invaluable for a variety of both scientific and industrial applications. The non-destructive nature of 3D laser scanning, in combination with its high accuracy and versatility, renders it a highly applicable technique for the domain of cultural heritage. Indeed, in recent years, many artefact digitisation projects have been completed. The digital 3D data produced were utilised not only for archival and exhibition, but also for the production of more information and meta-information, mainly based on the morphological characteristics of the objects. Nevertheless, the application of 3D digitisation is still considered to be in an early stage and thus it is critical to conduct additional systematic experiments concerning several aspects of the specific domain in order not only to determine its applicability but also to identify its limitations and possible extensions.

In this paper, we applied 3D colour laser scanning on a post Byzantine religious icon. The art of Byzantine iconography is intertwined with the Orthodox Christian culture and is encountered in churches, monasteries as well as in private abodes. In the present study we used a 36 x 48 cm icon dated back to the 19th century. It is a representative example of the art of that period, in terms of dimensional proportions, use of materials and painting technique. The surface exhibits various defects such as flaking, detachments of the paint layer, cracks and splits in the wooden support while the panel itself also presents substantial warping. The object's very nature introduces many challenges in respect to the given limitations of laser scanning. Contrary to western religious art, the Byzantine technique – inherited onto post Byzantine art as well – required the resulting painting surface to be as smooth as possible. Hence, we questioned the application of three dimensional scanning on such a surface and whether or not it would be able to yield a satisfactory amount of information regarding the actual surface relief and the form or direction of the brushstrokes. Moreover, the digitisation of morphological characteristics was combined with additional colorimetric measurements as well as micro-XRF measurements for surface point-wise chemical composition data.

The three dimensional digitisation of the artefact was performed with a colour point laser system (Arius 3D Foundation Model 100). The system is capable of acquiring both geometry and colour information from the same laser spot (3.5 mW) as it utilises white laser technology (three laser sources, approximately corresponding to red, green, blue spectral sources). It is capable of capturing 3,000 points per second and offers a resolution of 0.1 mm and an accuracy of measurement of 0.05 mm. A total of 43 scans were acquired parallel to the long side of the icon for the complete coverage of the object. The data acquisition phase was performed within a total of approximately 16 hours. The total number of points captured was 97,111,356 over an area of 0.4 m^2, with an approximate overlapping of 50% between concessive scans. The given amount of overlapping is considered adequate for the Iterative Closest Point (ICP) algorithm that has been used to merge the partial scans and was deemed necessary due to colour mismatching by reflection and saturation caused by the angle at which the icon was scanned. The data processing required an additional 56 hours to be completed. The resulted model is composed by 32,639,543 colour points.

Furthermore, colorimetric data were acquired using a CM 2600D Konica Minolta Spectrophotometer. The aperture used was 3mm in diameter and the instrument was operated in both SCI and SCE mode (secular component included / secular opponent excluded). A total of 40 sample areas were chosen on the painted surface in such a manner as to ensure a sufficient amount of data for each different colour found in the icon. The results were compared against the RGB values of the corresponding areas on the 3D model. Finally, a micro-XRF system (direct tube excited XRF system with Mo tube operated at 30kV) was employed to acquire 44 measurements

directly from the panel's surface (non – destructively) to determine the elemental composition of the existing pigments and underlying layers.

One of our main goals was to outline the technical challenges presented during the digitization process, due to the specific requirements of the object (size, surface reflectivity, possible colour saturation due to surface attributes, etc). Documenting and addressing these problems is an important step towards facilitating future attempts to digitize a similar object.

Examination of the surface relief of the model revealed several features of interest, some of which undetectable with conventional methods of observation, including a number of incisions performed by the painter in order to outline the figures on the preparatory layer. Moreover, it was noted that the warping of the wooden panel was indeed captured in the 3D model. A colour-coded elevation level contour map was computed to better understand the overall shape of the object.

Finally, we attempted to incorporate the acquired XRF compositional data onto the 3D model via an experimental custom ActiveX Plug-in, 3DArCAD. Presently, the software is platform dependant, requiring MS Windows, using a browser able to execute embedded ActiveX applications as well as the presence of OpenGL and GLUT (DLL libraries). The application is intended as a tool for the remote study of the artefact, allowing users from various fields (archaeologists, conservation scientists, historical researchers, museum curators, the general public) to view and manipulate a 3D digital version of the object, enriched with several levels of additional research data, depending on one’s particular interests and background.