AT THE INTERSECTION OF ART, ARCHITECTURE AND ARCHAEOLOGY: 3D VIRTUALIZATION AND CONTEMPORARY HERITAGE

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Abstract – We are at a global transition where disciplines from art to computer engineering intersect in the realm of global digital heritage. This has been facilitated by the development of desktop high-speed computing, inexpensive photogrammetry software, and digital photography. These technologies, and the tools to make them useful both in the lab and on the web, require the appropriate integration of technical skill, artistic license, archaeological background knowledge, and architectural realities.

INTRODUCTION

The documentation of archaeological sites, historic buildings, museums, museum collections, works of art, and other cultural heritage resources using 3D acquisition techniques is now mainstream practice in most areas of the world. The growing prevalence of on-line resources and inexpensive software have allowed students, amateurs, and many professionals the ability to collect data and create 3D models of a wide range of subjects, places, and landscapes. Photogrammetry in particular, has democratized the participation in 3D model development, and nearly every student of digital heritage, every laboratory and university with an interest in heritage, and every local, regional, and national government is now participating. With a complete photogrammetric kit, including DSLR camera, UAV, computer and software, now available for less than $5000, indeed, the basic acquisition of 3D data through photogrammetry has been truly democratized.

But moving beyond basic acquisition and processing into the realm of archaeological analyses, architectural reconstruction, and conservation: the science we can create from these data, requires a much larger investment. As Dr. Fabio Remondino (FBK) has recently argued so cogently, oftentimes the data collected by those not professionally trained, and the subsequent 3D models, are not useful for further analyses [1]. Problems of scale, camera settings, software settings, computing power, analytical training, and basic photographic skills are all important, but the lack of clear documentation of these attributes is equally problematic making them less useful for comparative analyses and conservation efforts [2, 3].

For many technical analyses, especially in conservation and architecture, more sophisticated data are needed. Terrestrial laser scanners, UAV-based LiDAR and high-resolution photogrammetry, and the computing power to process and preserve those data are far beyond the possibilities (and finances) of most individuals and labs, and require a significant amount of training. But spatial accuracies and geographic controls approaching 1-10 mm are not possible using basic photogrammetric kits when we try to digitize large monuments and sites. These technologies, and the tools to make them useful both in the lab and on the web, require the appropriate integration of technical skill, artistic license, archaeological background knowledge, and architectural realities. They also require a rigorous and detail workflow to produce results that are verifiable, accurate, and useful for further analyses [4].

DISCUSSION

At Global Digital Heritage, nearly 50 years of combined experience has created a workflow that has solved the problems of quality acquisition, data processing, visualization, and data access. But this is a dynamic process. Our methods integrate terrestrial and aerial photographs, terrestrial and aerial LiDAR, GIS, Google Earth, and other geospatial data and imagery. As new algorithms, software, hardware, and ideas are created, these are integrated into the workflow to create new opportunities for digital heritage and archaeology. Our general workflow has proven useful in many areas of our work (Figure 1). These are then transformed into videos, virtual reality, architectural drawings, orthophotos, and virtual reconstructions. Lastly, these are served on the web as raw data, as research tools, as sources of scientific analysis, and as the art of archaeology and architecture. Resulting from this work, we present three brief examples.

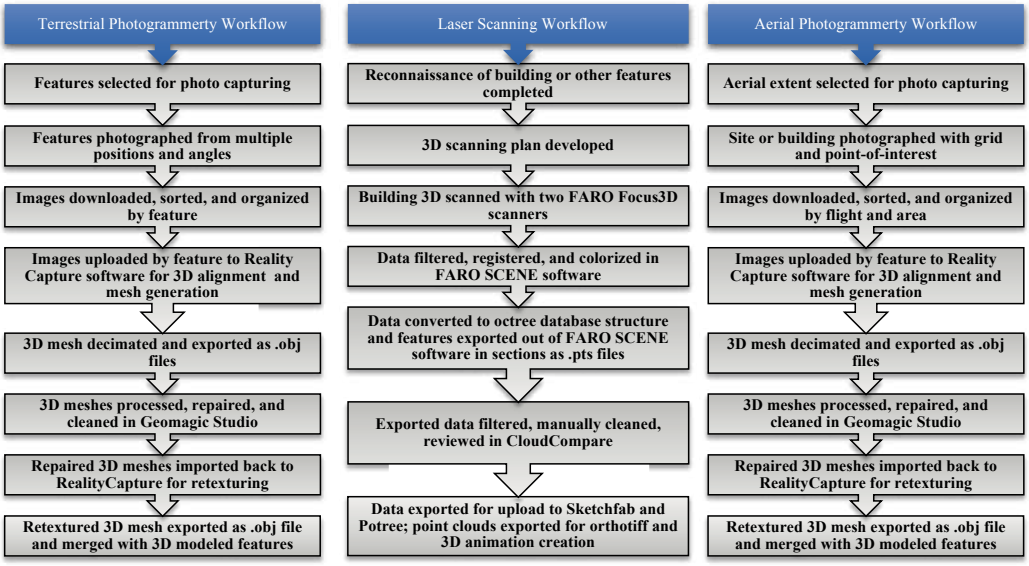

Figure 1. the Global Digital Heritage workflow.

The first is the integration of terrestrial laser scanning and aerial photogrammetry at the Castillo de Los Vélez, in Mula, Murcia, Spain. This is a late Medieval castle built on the ruins of a massive Islamic fortification. Our goal here was to create an accurate model for the community of Mula so that they could begin the restoration and make plans for making the castle accessible to the public. This project required the integration of 227 terrestrial laser scans of the interior, and 2900 photos of the exterior to create the integrated model of the complete structure (Figure 2).

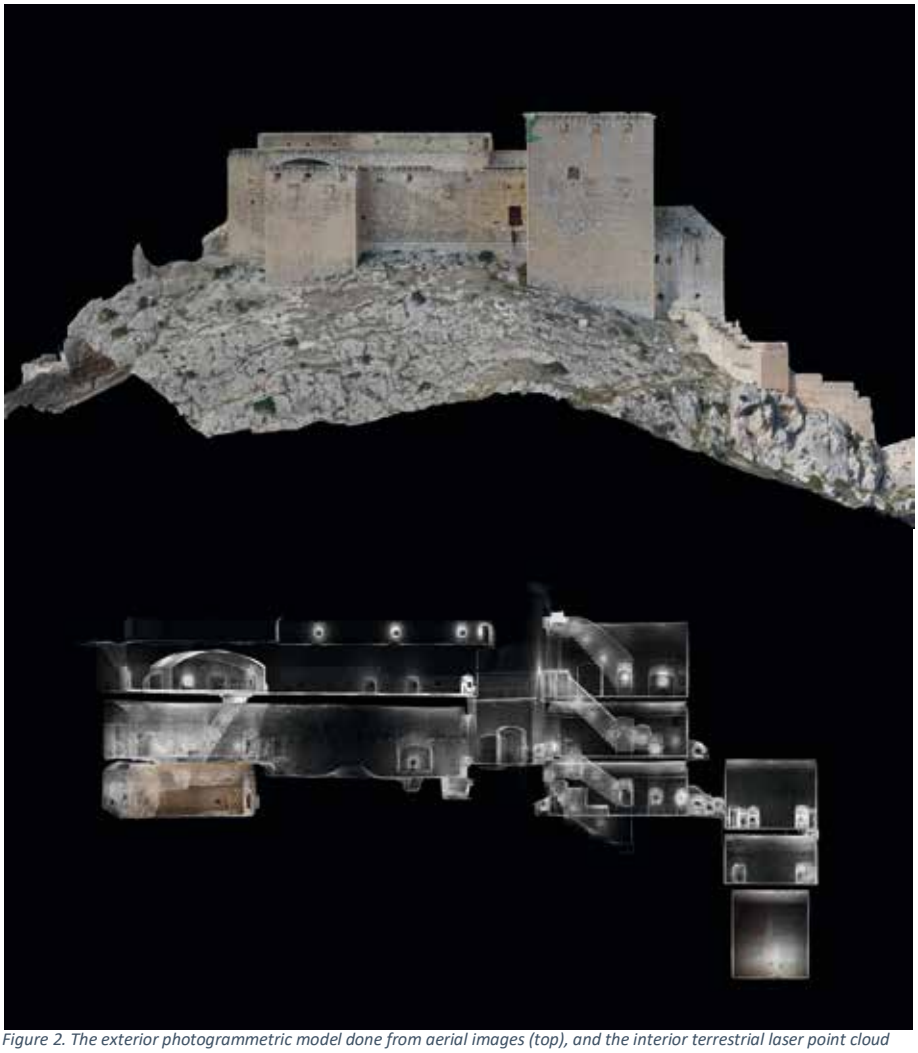

Figure 2. The exterior photogrammetric model done from aerial images (top), and the interior terrestrial laser point cloud (lower) done with Faro laser scanners.

Our second example is the Medieval castle of Alhama, also in Murcia, Spain. While 108 scans and 2450 aerial photos were done here in order to create a result much like the site in Mula discussed above, here we used an additional technology. DStretch is a rapid image enhancement software used for paintings, originally designed to detect and document rock art [5,6]. In this example, high resolution photos were taken of poorly visible paintings on the walls of the Medieval tower. Using DStretch, these paintings become vivid and accessible to researchers (Figure 3).

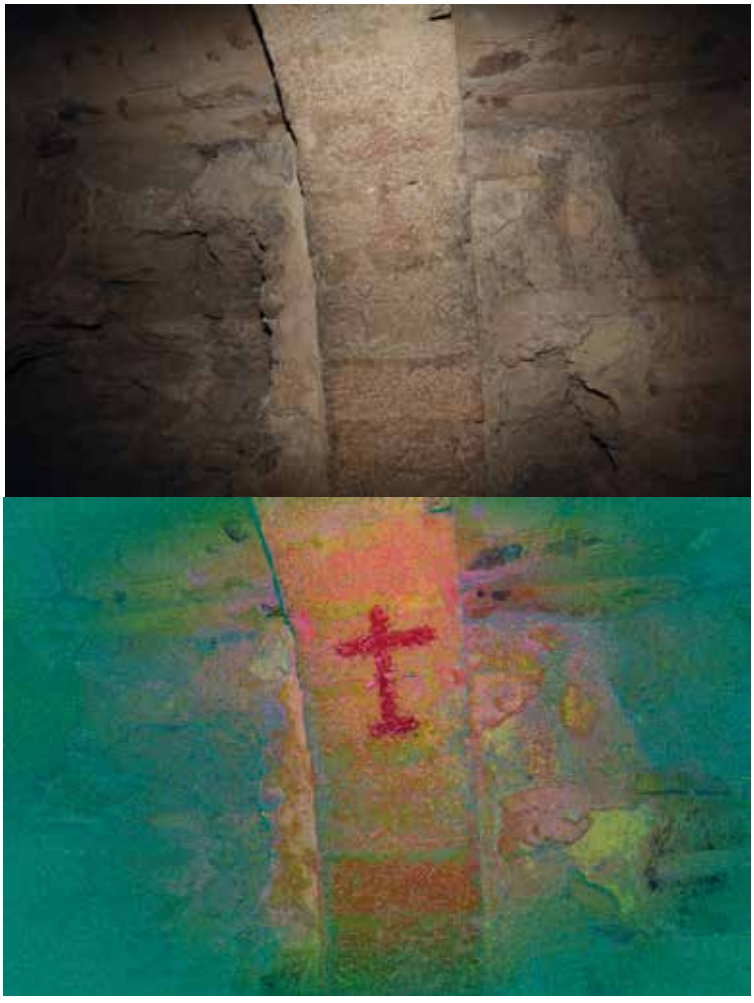

Figure 3. Christian art on the walls of the tower of the Castillo de Alhama, in Alhama de Murcia, Spain. DStretch was used to enhance the digital images .

In a third example, we are scanning Roman archaeological features within the Museo Arqueológico Los Baños in Alhama de Murcia, Spain. In this example we scanned an archaeological excavation preserved in the museum, and then completed the 3D model. This is an example of fine-tuning the output in order to create a powerful visualization of the features, and then upload the data to online presentation (Figure 4).

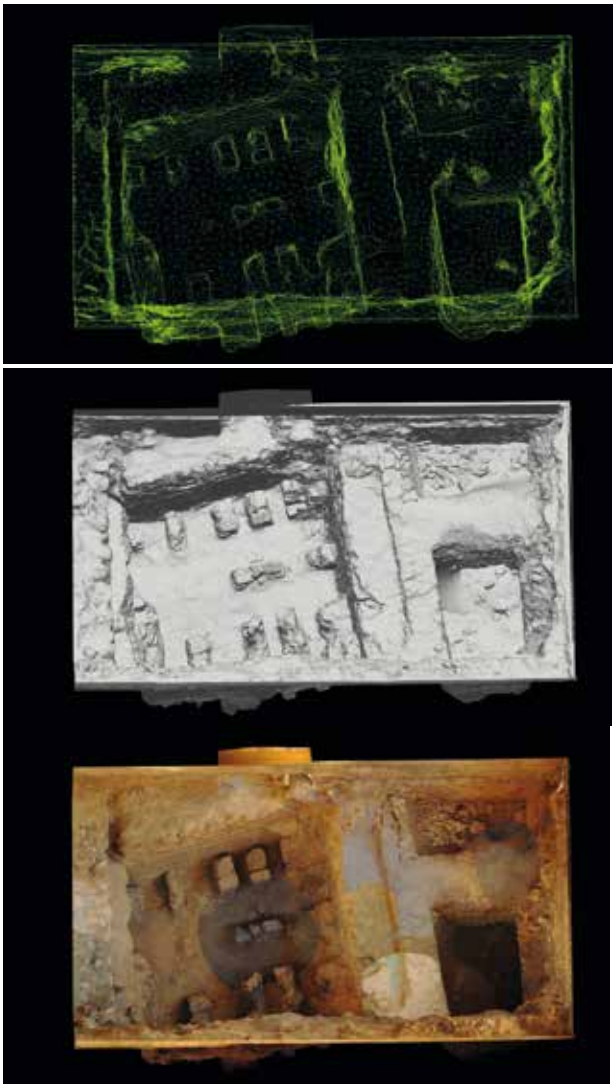

Figure 4. Figure 4: Model creation for a portion of the Roman Bath in Museo Arqueológico Los Baños in Alhama de Murcia, Spain. Top – wire-frame mesh; center – un-textured mesh; lower – textured mesh.

SUMMARY

Global Digital Heritage (GDH) is a not-for-profit, private research and education organization dedicated to documenting, monitoring, and preserving our global cultural and natural heritage. We use digital visualization, 3D virtualization, geospatial informatics, and open access solutions to provide digital data and 3D models to governments, regional institutions, museums, local scholars, and the public. A key element of our mission is the democratization of science-we make all data freely available to the world in support of cultural heritage, heritage management, education, public access, scientific research, and to support of the digital humanities.

We believe that many nations, local and regional museums, and universities have specific and spectacular places, monuments, and museum collections that are critical to the global scientific agenda. While these are often recognized for their heritage value, they are underutilized in science and research because of distance or because the scientific community does not know they exist.

We use virtualization technology to digitize entire collections, entire museums, and entire archaeological and paleontological landscapes. We make virtual repositories available to any student, any child, any scientist or any enthusiast anywhere in the world at any time. We create online analytical tools to democratize education and research through global analyses and exploration. Our virtual repository approach allows for the scientific analyses of places, monuments, and collections on a global scale, and provides a means to highlight the importance of those collections to their communities.

In the face of an increasingly hostile world, a global landscape where conflict and natural disaster are destroying our shared heritage at an accelerating rate, we provide 3D digital services to document and preserve places and specimens critical to our global heritage. We do this for free. We then return all of the data and results to the host institution or regional/local authorities who can do anything they wish with the materials.

ACKNOWLEDGEMENTS

We thank all the municipalities for access to their facilities, and for this presentation, especially the administrations of Mula and Alhama de Murcia, as well as the territorial archaeologists, José Antonio Zapata Parra and José Baños Serrano who helped us at all times and whose daily work is essential for the conservation of the heritage of the Murcia region. We especially thank the General Directorate of Cultural Assets of the Region of Murcia. Funding for Global Digital Heritage is provided by the Hitz Foundation.

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