CultLab3D – Fast and Economic, High Quality 3D Digitization of Cultural Heritage Artifacts

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Natural disasters such as the collapse of the historic archive in Cologne and the fire at the Anna Amalia library in Weimar remind us of the importance to digitally preserve of our cultural heritage. Currently the process of building 3D digitized virtual surrogates from existing Cultural Heritage resources often requires an investment of several thousand EUROs per object. Given the fact that several hundreds of millions of objects exist in Cultural Heritage institutions (more than 130 million alone in the collection of the Smithsonian), these costs and time efforts are simply prohibitive.

The Competence Center for Cultural Heritage Digitization at Fraunhofer Institute for Computer Graphics research is currently developing CultLab3D, encompassing fast and economic digitization technologies for a faithful, virtual reproduction of real world objects, which enable an automated, accurate and physically correct reconstruction of their geometry, texture and optical material reflectance properties. The used reconstruction techniques digitize objects using a variety of sensors and light-sources under controlled environmental conditions for comparable results of the highest quality.

Structured light is considered the most appropriate technique for fine grained geometry acquisition of many cultural heritage artifacts in museums today. The acquisition times grow with the size and the complexity of the objects, if the geometric resolution constraint is not relaxed. In addition a large share of acquisition time has to be dedicated to manually reposition the scanners.

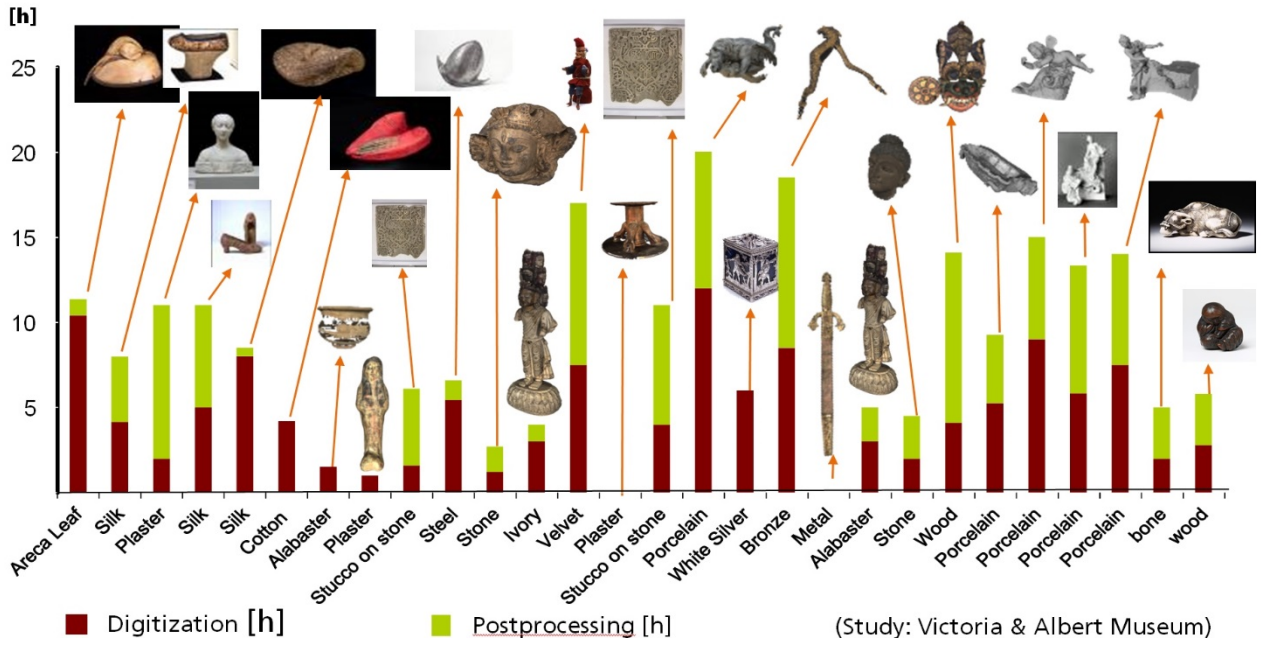

Figure 1: Digitization campaign conducted by the V&A Museum – more than 40 objects being scanned. Time varies between 5 and 20 hours for geometry and texture only – no complex material acquisition included. Scanner used: Breuckmann optoTOP-HE. Red bars indicate the acquisition time and green bars the post-processing time.

According to an extensive study of the Victoria and Albert Museum (Fig. 1) conducted in the framework of the European research project 3D-COFORM, the 3D acquisition of moderately sized objects requires 5 to 20 hours with state-of-the-art structured light acquisition techniques for geometry and texture alone – without considering view dependent reflectance properties.

Through progress in 3D acquisition and automation technologies, its economic use for mass digitization of cultural heritage artifacts is within reach (Fig. 2).

Figure 2: CultLab3D – Fast and economic, high quality 3D digitization of cultural heritage artifacts.

Millions of cultural heritage artifacts populate our museums and about 90% still await discovery in museum archives. The 3D Documentation of cultural heritage artifacts represents a huge market potential which is largely unexplored and presents the following opportunities:

- Arbitrary availability and concurrent access to digital surrogates of cultural heritage artifacts for art historians and scientists.
- Use of digital surrogates in cultural heritage institutions for exhibition planning, documentation and acquisition planning.
- Virtual presentation (combined with new forms of presentation technologies, such as hybrid exhibitions) as a means to increase attractiveness.
- Physical surrogates based on digital 3D models.
- Substitute loaning of cultural heritage artifacts by digital surrogates avoiding damage from transport, insurance fees and legal issues.
- Reusability of historically correct 3D models in gaming and film industry as well as for architectural reconstruction.

But there is more to it. A 3D digitized cultural heritage artifact is typically composed of geometry and texture data, yet without being semantically enriched with provenance data and its relation to further artifacts as well as with multi-media documentation, it is of very limited practical use.

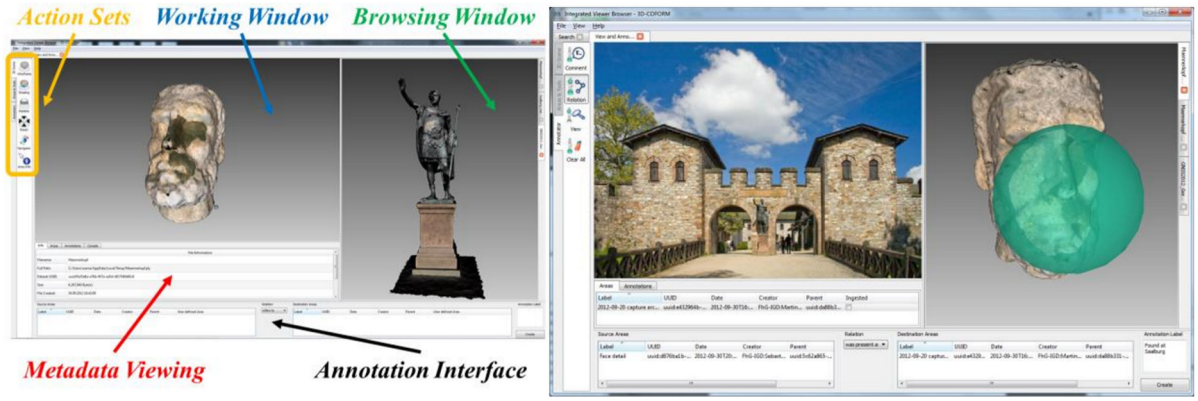

Figure 3: General Graphical User Interface of our semantic enrichment tool, divided into 5 different sections – relation annotation between Maennerkopf bust and the Saalburg fort, represented by an image of its main entrance.

Therefore the digital representation of an artifact should consist of a geometric structure, accompanied by an annotation to associate semantics and context with its geometry or parts of its 3D shape. The idea of representing semantically structured information and knowledge as well as creating links between the data has increasingly gained popularity, driven by the Semantic Web technologies. Within the current research on annotations, most examples of structured information include semantic models for describing the intrinsic structure of the 3D shape. Some already proposed models for describing the provenance (life-cycle) of digital 3D shapes in the Cultural Heritage domain.

We propose the Integrated Viewer Browser (IVB) (Fig. 3) developed within 3D-COFORM as an interactive semantic enrichment tool for 3D CH collections. It is fully based on the CIDOC-CRM schema supporting its sophisticated annotation model and represents a first approach to a 3D centered and distributed annotation tool taking into account aspects about layout designs, interaction metaphors, and workflows in real professional environments.

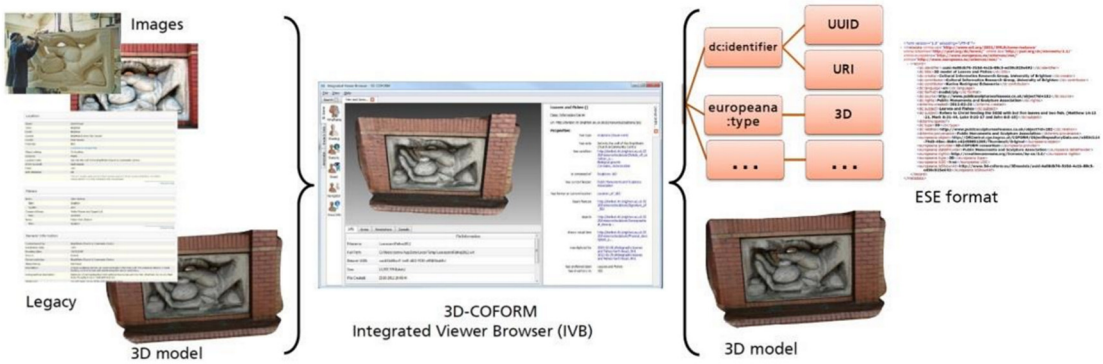

Figure 4: Annotating 3D artifacts with IVB and export to Europeana.

Artifacts handled by the IVB can already be accessed through Europeana, the European Digital Library Portal (Fig. 4, Fig. 5). The IVB enables fusion and annotation of a variety of multi-media context information from different sources belonging to a digitized 3D artifact, consolidation of all pieces of information and export of the datasets to Europeana using its ESE (Europeana Semantic Elements) metadata format, a Dublin Core-based set of fields with 12 additional specific Europeana elements to display records appropriately.

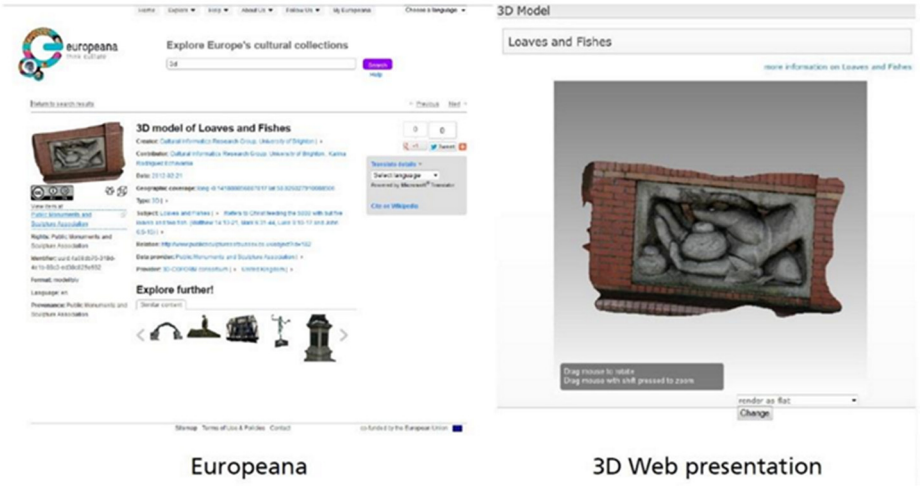

Figure 5: Data record in Europeana and link to interactive 3D presentation in browser using HTML5 with X3DOM and WebGL.

Concluding, the CultLab3D technologies under development try to address the full pipeline from fast, economic and high quality 3d digitization to classification, annotation and export of artifacts to Europeana, fostering a strategic approach towards mass digitization of the millions and millions of cultural heritage artifacts in need of documentation and preservation.