3D-COFORM: Making 3D documentation an everyday choice for the cultural heritage sector

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Abstract

This paper provides an overview of the 3D-COFORM project which began in December 2008 and aims to advance the state-of-the-art in 3D-digitsation and make 3D-documentation an everyday practical choice for digital documentation campaigns in the cultural heritage sector.

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1. INTRODUCTION

The 3D-COFORM project aims to advance the state-of-the-art in 3D-digitsation and make 3D-documentation an everyday practical choice for digital documentation campaigns in the cultural heritage sector. The project addresses all aspects of 3D-capture, 3D-processing, the semantics of shape, material properties, metadata and provenance, integration with other sources (textual and other media); search, research and dissemination to the public and professional alike. A strong technical research program is complemented by research into practical business aspects: business models for exploitation of 3D assets, workflow planning and execution for mass digitisation, socio-economic impact assessment; and the creation of a Virtual Centre of Competence in 3D digitization. The VCC-3D will act as a catalyst in enhancing the sector's capacity for mass digitization of 3D assets – the tangible artefacts of the physical cultural heritage of the world. The 3D-COFORM consortium brings together 19 partners to form a world class team on 3D-digisation complemented by an equally prestigious group of Cultural Heritage organizations, with the Victoria and Albert Museum as a full partner and collaborations from the Louvre, the Florentine Museums authority the Museum of the Imperial Forums in Rome; World Heritage Sites in Cyprus and the Staatliche Museen zu Berlin. The consortium also contains organizations tasked at a national level with helping museums move in these directions. C2RMF, the research arm of the French National Museums and CULTNAT the digitization body for cultural and natural heritage funded by the Egyptian Government. All these institutions have a declared intention to develop their 3D-digitisation capability in order to move forward on the integration of these assets into the infrastructure that is being enabled by initiatives such as Europeana (the EDL).

2. 3D ACQUISITION

In the area of acquisition the project follows two major strands. First, the web-based 3D-reconstruction techniques for immovable objects as well the 3D-digitisation process of moveable regular objects based on available laser digitisation technology will be extended towards automatic and user friendly rapid digitisation (in-hand digitisation) of 3D-shape. In addition to 3D-shape colour and reflectance properties of the objects will either be digitized as well or the user will get the possibility to map these data from other sources in order to produce high quality representations of the artefacts. Second, we are developing new approaches for image-based reconstruction which will give use the ability to digitise shape, reflectance properties and if necessary spectral colour of artefacts, e.g. gems, jewellery, etc. for which current techniques are not effective, in one acquisition step.

Since the 3D shapes of many 3D objects are already available, 3D-COFORM will also develop techniques for reflectance acquisition for these objects from multiple views of the same known surface. We will deal with all levels of surface reflectance ranging from simple texture maps to full 6D Bidirectional Texture Functions (BTF). This way low cost acquisition of reflectance data will be possible. Last but not least an important goal of 3D-COFORM is the acquisition of spectral reflectance data from CH objects. To come up with a rapid acquisition device we plan to capture only a sparse sampling of the spectral reflectance data and to interpolate the remaining data from this sampling using efficiently acquired RGB data as constraint. From the very beginning of the project we have extended and deployed current tools to support digitisation projects undertaken with major cultural heritage institutions in order to develop operational processes and business solutions for operationalisation of mass digitisation of 3D assets at low cost.

3. 3D ARTEFACT PROCESSING AND ANALYSIS

Several efforts need to be undertaken to underpin the development of tools which are capable of recording, processing, analysing, manipulating and exploiting descriptions of 3D-artefacts which embody integrated descriptions of 3D-object semantics (metadata, provenance data). The approach will be the design of processing tools (following the successful experience of EPOCH's MeshLab tool) together with the design

of libraries offering data representation schemes and algorithms, which will be used in the development of other COFORM tools. Basically two ways exist to assign semantics to an acquired 3D dataset, namely by shape analysis (segmentation of the raw data into meaningful parts and pieces), or by establishing the correspondence to an informed reconstruction of the same scene. Both ways are being pursued in 3D-COFORM.

We will develop tools for knowledge-aware segmentations, which may be geometry-driven or based on subshape matching or through the detection of (self-) similarities of the model (e.g. to detect repetitions and ornament patterns). At the technical level, we will investigate the relationships between ontological standards (METS, CIDOC-CRM), provenance data encoding and de-facto standard geometric representations (X3D, Collada), endorsing both 3D graphics and Digital Libraries perspectives and following the EDL emphasis on a Digital Library spanning a much wider spectrum of artefacts than the traditional text based sources.

4. SEARCHING AND BROWSING

Shape-based search. The status of the shape-based search is not consolidated; further research is needed to increase robustness of 3D searching algorithms. However, this research would justify a project in itself, with a more focused and specific partnership. The 3D-COFORM approach is rather different: instead of focusing research on the specific 3D shape-based algorithms, our major concern will be how to integrate the two searching modalities (text-based and shape-based). This is an aspect neglected so far and extremely important in applications such as cultural heritage; to have a real impact in cultural heritage professional daily work, searching instruments should be able to offer an integrated interface to both search specification and visual presentation of results. It should be able to mix any type of request (shape- and text-based) in the specification of the query; as well, it should be possible to sort and present results obtained by this integrated queries.

5. VISUAL BROWSING AND ANALYSIS.

New systems are required to support radically new ways to deploy visual browsing and inspection features to the user community. This means that our focus is not limited to overcoming current 3D technological limitations (i.e. how to manage huge 3D models; how to improve visual presentation accuracy) but will also focus on the other issues mentioned above (easy integration of 3D and other media, easy authoring, cooperative management, effective GUI, etc.).

6. 3D ARTEFACT SYNTHESIS

The first step in order to improve the situation will be to separate the scientifically based structural reconstructions from photo-realistic models for public dissemination: For scientific reasoning, the decorative artwork is counter-productive, because it occludes the essential. For photo-realistic imagery, the model is more important than the reasoning behind it. Second, a high-

level standard representation for historic reconstructions is needed, that allows bidirectional linking to and from each "part" of the model. This uses a geometric markup to distinguish a part of the model.

This part can then be annotated (semantic enrichment) and, equally important, it can be referred to by external documents. Third, some sort of database as historic content management system that provides the spatio-temporal context for all individual reconstructions (geo-referencing + time), that manages multiple hypotheses, and it can interface and synchronize with other such databases. Furthermore, the database should be capable of exporting the model data in a standard 3D format, as a basis for the decorative artwork and the laborious DCC workflow that follows in order to produce scientifically justified, accurate, yet high-quality photo-realistic 3D-reconstructions of historic sites. And last, but not least, easy-to-use, reliable software tools will be needed to let CH professionals use all of the described functionality in their daily work without causing frustrations. Any scepticism and reservations against using 3D-technology can only be overcome when the benefits of using it are clear.

7. THE BUSINESS CASE FOR 3D

The 3D technology is only part of the story. In order to achieve the goals of making "3D-documentation an everyday practical choice for digital documentation campaigns in the cultural heritage sector" it is necessary to establish the business case for doing so. 3D-COFORM has a dedicated business strand which has looked at such issues. During the first year of collaboration with the technical strand, the Business Strand has designed business processes for using digitisation tools and planning of initial tools testing and deployment experiments. Conducted initial deployment experiments with maturing existing tools together with CH institutions. Identified a methodology for strategy and socio-economic impact evaluation. And analyzed business models to generate input and help shape business models for the Virtual Competence Centre-3D.

8. THE VIRTUAL COMPETENCE CENTRE 3D

The 3D-COFORM Virtual Centre of Competence in 3D (VCC-3D) will be established during the project to promote and further the role of 3D digital assets within the broader EDL context. It will provide independent advice on 3D digitisation technologies including geometry, materials and shape semantics; integrating metadata (including provenance) and legacy sources with 3D assets; mass digitisation business processes and workflow planning; business models for exploitation of 3D digital assets; tools for assessing socio-economic impact of investment in 3D digital assets.