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3D Research Challenges in Cultural Heritage

A Roadmap in Digital Heritage Preservation

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3D Research Challenges in Cultural Heritage Applications

Preface

Recent research and development activities in 3D technologies have led to rapid progress with far-reaching impact in numerous applications spanning very diverse areas both for highly-skilled professionals – such as computer-aided design and engineering for digital factories of the future and advanced simulators for flight and surgical training – as well as for the general public now using 3D maps and enjoying 3D TV/cinema and computer games. In general, it has turned out that the handling of 3D data poses different challenges but also provides growth for new, exciting and innovative opportunities compared to more established media like texts, images or sound.

Some 3D technologies are already being used successfully also in the cultural heritage (CH) domain, especially in the area of digital libraries for cultural heritage like Europeana (www.europeana.eu) and the UNESCO Memory of the World. A workshop on these topics was organized by the editors of this volume at the International Conference on Cultural Heritage EuroMed2012 (www.euromed2012.eu) on the island of Cyprus in October 2012. This was the official event of the Cyprus Presidency of the Council of the European Union, bringing together specialists of different 3D technologies and cultural heritage areas to present recent advances and discuss the way forward. At this workshop, the idea for this volume originated, with the intent of gathering 3D research challenges for the digital cultural heritage domain. Contributions from renowned researchers in this specific area and workshop participants have been selected. The aim of this book is to provide an insight into ongoing research and future directions in this novel, continuously evolving field, which lies at the intersection of digital heritage, engineering, computer science, material science, architecture, civil engineering, and archaeology.

Overall, in our opinion, the chapters in the book reflect the following 3D Challenges in the CH Domain:

1. Transition of CH Objects from Real to Virtual,
2. Interplay of Geometry and Semantics for CH,
3. Organization of Large 3D Databases in CH,
4. Handling 3D Data in CH over the Internet and Mobile Devices,
5. Presenting CH Content in 3D to the General Public,
6. Contributing to the Research of CH Professionals,
7. Reconstruction of CH Objects from Virtual to Real and their 3D production and use.

1. The acquisition of virtual 3D computer models, typically using laser scanning technology but also using computer-aided design, raises various problems related to the huge number of objects that should be dealt with as well as their size, material, accessibility, etc.
2. The geometric description of a CH object in some computer-tractable form is clearly distinguished from the historical description of the build, meaning and purpose of a CH object, which has been studied for centuries in areas like architecture. The story telling and the mathematical model have to be suitably interwoven.
3. Once acquired, the large set of digitally available 3D objects must be properly organized with the right metadata to allow activities like exchange and comparison not just within one institution but Europe wide for example through libraries such as Europeana or even globally integrated in GIS systems and geo-maps like Google Maps.
4. The presentation/display of 3D CH objects for users who are not IT specialists, allowing them the use and even manipulation of such objects for practical activities, poses a lot of technical questions concerning 3D web browsers, mobile devices, etc.
5. CH in 3D content can be presented to the general public in a gripping, immersive setting, capturing people's attention. This necessitates, however, the easy development of animated 3D scenes and 3D authoring tools for interactive experiences, usable by specialists for the CH content who should not have to be very familiar with IT issues.
6. 3D technologies should also help CH professionals in their daily research work, for example, assisting – literally – in the search for missing pieces in archaeological settings.
7. New 3D printing technologies allow on the one hand, the detailed reconstruction of 3D CH objects in previously unknown fidelity in shape and material and on the other hand they are finally giving laymen viable options to turn available virtual CH models into tangible real entities. This can support real CH object exhibitions of previously unseen objects and assist in the repatriation of some of these replicas back to their origin.

Naturally some of the above mentioned challenges are very well-known from other 3D application areas but may have a different twist in the CH domain. The different issues are obviously interwoven which becomes apparent when studying the chapters of this book.

The paper by Santos et.al. provides very interesting information on the sheer volume of the task of scanning 3D museum objects (Challenge 1) but also on the development of 3D web browsers (Challenge 4). The text by di Benedetto et.al. discusses web and mobile visualization (Challenge 4). The relationship of geometry and semantics (Challenge 2) is considered by Havemann et.al. concerning procedural shape modelling and by De Luca et.al. for architectural elements. Tal considers in her chapter the use of mathematical shape analysis techniques in an archaeological setting that have become part of an IT-system for archaeologists (Challenge 6). 3D issues for the reconstruction of virtual heritage scenes

with large populations (Challenge 5) are the subject of the contribution by Thalmann et.al. Important lessons from the film industry, especially concerning the managing of digital assets (Challenge 3), are provided in the paper by Dodgson. The content creation (Challenge 5) is the focus of the chapter by Linaza et.al. Finally, 3D reconstruction (Challenge 7) is the topic of the contributions by Callet for a high-precision setting both in shape and material and by Neumüller et.al. for 3D printing, especially for wider audiences.

What is the way forward to further address these challenges? Another workshop at the next EuroMed2014 (www.euromed2014.eu) conference, again to be held in Cyprus in November 2014, will discuss future perspectives. The contributions in this volume show that substantial activities have been carried out in CH-related projects funded by the European Commission. The first worldwide fellowship programme funded by the Marie Curie Initial Training Network on Digital Cultural Heritage: Projecting our Past to the Future (www.itn-dch.org) is intending to train the next generation of young researchers also in 3D technologies for cultural heritage.

So in conclusion, a further challenge for the research community in Europe working on 3D technologies for cultural heritage is to systemically, creatively – and hopefully successfully – apply for funding for exciting new activities in the Horizon2020 Framework Programme. Simultaneously the European Commission should highlight cultural heritage applications in the new editions of the H2020 work program for the coming years.

Marinos Ioannides
Ewald Quak

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