

**GCH 2017**  
Eurographics Workshop  
on  
Graphics and Cultural Heritage

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**September 27 – 29, 2017**

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## Preface

These are the proceedings of the 15th EG Workshop on Graphics and Cultural Heritage (GCH) 2017, held September 27-29 in Graz, Austria. The objective of the workshop is to introduce and showcase new techniques and applications for supporting Cultural Heritage information ranging from data acquisition, analysis and synthesis, 3D documentation, and data management, to new forms of interactive presentation and 3D printing solutions. GCH 2017 continues to provide a premier scientific forum to exchange novel ideas and techniques in research, education and dissemination of Cultural Heritage information, to transfer them into practice, and identify future research and application opportunities. To advance the dialogue between ICT and CH experts, GCH 2017 is organized in close cooperation with the Museumsakademie of the Universalmuseum Joanneum in Graz, providing opportunity for exchange between the ICT and CH domains.

GCH 2017 provides an exciting program. The workshop is started by a half-day tutorial on acquisition, analysis and presentation of CH content. The program includes tutorials on 3D Mass Digitization, presented by Pedro Santos and Constanze Fuhrmann; on results of leading current EU projects in the area, namely, 3D PITOTI presented by Christian Mostegel, and GRAVITATE presented by Michela Spagnuolo and Silvia Biasotti; and on digital presentation of archaeological artifacts in museum environments, presented by Markus Seidl. We are also delighted to include two keynotes by distinguished speakers: Michael Goesele of Technische Universität Darmstadt on Interdisciplinary Collaboration in Digitizing Cultural Heritage, and Sabine Ladstätter of the Austrian Institute of Archaeology on Perception and Reality in the archaeological site of Ephesos.

The technical paper program consists of a full and a short paper track. In each track, each paper was reviewed by at least three international experts in the field for technical quality and novelty, with final decisions made by the paper co-chairs in each track. In response to the full paper call, we received 17 submissions, from which 9 were accepted as full papers (full paper acceptance rate 53%), and 4 were accepted as short papers after discussion with the short paper co-chairs. In response to the short paper call, we received 22 submissions, from which 17 were accepted as short papers (short paper acceptance rate 77%). The selected papers are presented in seven exciting technical sessions on Presentation and Digitization; Acquisition and Analysis; Frameworks and Visualization; Presentation and User Experience; Retrieval, Classification and Matching; Projects, Tools and Case Studies; and Education and Creation.

This workshop would not have been possible without contributions by many persons. We thank all authors for submitting their work to GCH 2017 for review. We also thank the members of the GCH 2017 International Program Committee, who dedicated many hours of thorough reviewing and providing thoughtful reviews of great help for program formation and providing many constructive comments for submitters.

We thank the Event Chairs, Dieter Fellner and Bettina Habsburg-Lothringen for their guidance and continuous promotion of the event. We are very grateful to the GCH Steering Committee, especially Roberto Scopigno, for their experienced guidance of the organization. Also, we thank Roberto Scopigno in his role as Editor-in-Chief of the ACM Journal on Computing and Cultural Heritage to support the selection of GCH best papers and their invitation to submit extended versions to the journal. Bettina Habsburg-Lothringen and Pavlos Mavridis served as Tutorial co-chairs to form the tutorial program. Torsten Ullrich as local chair, Ingrid Preininger and Wolfgang Scheicher worked out the local arrangements for the event, including the social events and managing the workshop webpage. These proceedings would not have been possible without the great help of Stefanie Behnke of Eurographics who tirelessly worked with the paper co-chairs and local co-chair on the submission and review system, proceedings production and the EG registration process.

Finally, we cordially thank all our sponsors for supporting the event. Bettina Habsburg-Lothringen and our co-organizer Museumsakademie of the Universalmuseum Joanneum in Graz generously provided venues for the workshop talks and the reception of the social program in an amazing environment. Fraunhofer Austria provided resources and infrastructure to host the GCH web space. We thank Elsevier for their kind general event sponsorship. Finally, we thank the Styrian government for their kind support of our student stipend sponsorship program, enabling a number of young researchers to participate.

Tobias Schreck and Tim Weyrich  
GCH 2017 Full Paper Program Chairs

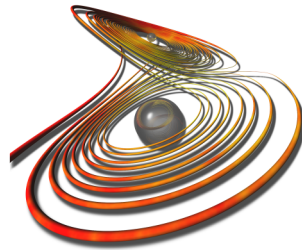
Robert Sablatnig and Benjamin Štular  
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## Keynote

### **Digitizing Cultural Heritage - Challenges, Pitfalls and Opportunities for Interdisciplinary Collaboration**

*Michael Goesele*

#### **Abstract**

Digitizing artifacts has traditionally been an expensive labor- and/or hardware intensive process. With the tremendous progress made in photogrammetry, vision and graphics during the last one to two decades this has changed significantly. Modern approaches are able to faithfully reconstruct individual objects or whole scenes with low effort using casually captured images. I will demonstrate examples for such approaches in this talk using my own research and systems developed by research groups worldwide.

While this creates tremendous opportunities for interdisciplinary collaboration with the cultural heritage field, such collaborations face also tremendous challenges. These include the language barrier between the fields, different publication strategies and the under-appreciation of interdisciplinary work in general. I will discuss these challenges from the perspective of a computer vision and graphics researcher and will share my insights on pathways towards truly fruitful interdisciplinary collaborations leading to mutual benefits for all parties involved.

#### **Biographical Sketch**

*Michael Goesele* heads the research group Graphics, Capture and Massively Parallel Computing in TU Darmstadt's Department of Computer Science. After receiving his Ph.D. from the Max Planck-Institute for Computer Science and Saarland University in Saarbrücken, Germany, he spent two years as a Feodor Lynen fellow of the Alexander von Humboldt Foundation at the University of Washington in Seattle, WA, USA before he moved to TU Darmstadt. One main focus of his research is on 3D scene reconstruction from general input data - such as images from online photo collections - and photo-realistic rendering approaches built on such reconstructed models.

## Keynote

### Perception and Reality in the archaeological site of Ephesos

*Sabine Ladstätter*

#### Abstract

Archaeology is increasingly being confronted with the expectation of creating a copy of the past. This particularly is the case with visualizations that can ultimately only be a portrayal of perception, however, never of reality. Behind the image there is always a model of a cultural and historical construct that is subject to permanent processes of change. By taking account of this dynamic it is necessary to clearly differentiate between the acquisition and management of data and their processing in order to create a buffer for interpretations and also be able to quickly react to new scientific results.

Based on the example of Ephesos, one of the largest cities of classical antiquity and also one of the best known archaeological sites of the present, the management of cultural heritage information will be illustrated and put up for discussion. Issues regarding the collection of data, its management and long-term archiving as well as public accessibility and legibility will be addressed. In the case of reconstructions and visualization the question will be raised whether and if yes, how the depiction of a historical process can succeed through snapshots. As a result of the scientific discourse an impressive change in perspective - also in the visualization of the city - has come about which was almost exclusively conducted from the perspective of the architecture. Only in recent years have archaeological results contributed to the ability of presenting the city as a lived space including ecological processes and social interactions.

#### Biographical Sketch

*Sabine Ladstätter* studied Classical Archaeology, Prehistory, Protohistory and Ancient History at the Universities of Graz and Vienna, culminating in a Master's degree (University of Graz) in 1992 and a Doctoral degree at the University of Vienna in 1997. Between 1997-2007 she held the position of Research Assistant at the Institute for the Cultural History of Antiquity at the Austrian Academy of Sciences, where she focussed on the Terrace Slope House 2 at Ephesos, and the early medieval period at Carnuntum. After her Habilitation at the University of Vienna in 2007, on the theme "Studien zur ephesischen Keramik von hellenistischer bis byzantinischer Zeit" ["Studies in Ephesian Pottery from the Hellenistic to the Byzantine Eras"], she moved to the Austrian Institute of Archaeology, the directorship of which she assumed in 2009. At the same time, the directorship of the excavations at Ephesos was assigned to her. Awards for Scientist of the Year in 2011 in Austria, and for the best popular scientific book in Austria in 2014, are proof of her engagement in the areas of scientific communication and public outreach. She is a member of the German Archaeological Institute and of the Archaeological Institute of America, as well as numerous national and international scientific and editorial boards, and is a referee for leading research promotion institutions. Guest professorships at the Ecole Normale Supérieure de Paris (2016) and Stanford University (2019) underscore her engagement in the fields of education and teaching, also attested by her supervision of academic degrees at a variety of European universities. Sustained by an interdisciplinary research approach, she is involved with economic- and landscape archaeology, as well as with the documentation and preservation of archaeological cultural heritage.

## Tutorial

### Mass Digitization for Museum Installations

*Pedro Santos and Constanze Fuhrmann*

#### Abstract

The demand for efficient 3D digitization methods applicable to cultural heritage is increasing. 3D technologies and post-processing tools are now widespread, including also techniques for acquisition and presentation of content. However, the capturing and computation of 3D virtual models from artefacts in large quantities still remains a challenge. With first 3D workflows in practice in several institutions, there arises a need for new technologies to cope with appropriate processing and handling of 3D data, including e.g. techniques for semantic enrichment, efficient storage, and long-term preservation of 3D models.

In the context of large-scale digitization, there is therefore significant need for research related to topics such as: 1) improved acquisition processes, e.g., including optical material properties; 2) 3D-centered and web-based annotation systems for object classification and metadata enrichment; 3) technical solutions for long-term storage and standardized data formats; and 4) 3D visualization and 3D printing technologies.

In this session at GCH, we want to continue our discussion started at GCH 2016 among practitioners and researchers on the challenges in the four areas mentioned above, aiming to better implement and make use of 3D mass digitization in the long term. We would further like to identify and prioritize challenges and opportunities, eventually compiling a research and development agenda to shape future work in this area.

#### Biographical Sketch

*Pedro Santos* has been Head of the Competence Center for Cultural Heritage Digitization since 2012. Before he was Deputy Head of the Department of Industrial Applications, today Department of Interactive Engineering Technologies. In the course of various projects in the field of digital preservation of cultural heritage objects and of the increasing demand for mass-scale 3D digitization in this field, his department develops the world's first approach for fast, economic, and automated 3D digitization of cultural heritage with emphasis on capturing optical material properties. Pedro Santos, who has been researcher at Fraunhofer IGD since 2002, studied computer science at the University of Darmstadt and the Technical University of Lisbon. At present he is also attaining his PhD on the subject of "Fast, economic, and automated 3D digitization of cultural heritage" at Technical University Darmstadt. During his professional career he was involved in the development of the first immersive CAD modeling systems to be used for the early stages of product development as well as in the design of "see-through head-mounted displays", mobile applications in augmented reality and optical, marker-based and markerless tracking systems.

*Constanze Fuhrmann* has been working as researcher with the Competence Center for Cultural Heritage Digitization since 2014 and has many years of professional experiences in heritage preservation and conservation as well as in programme and project management in the fields of culture and research policy. Most recently she was scientific officer with the Fraunhofer Office Brussels / Sustainability Network and Cultural Heritage where she was responsible for EU research projects and funding, EU lobbying initiatives and advocacy work related to cultural heritage. She is trained as a conservator and holds a Master's degree in art history, cultural studies and history at the Technical University and Humboldt-University Berlin/Germany as well as a Master of Science in sustainable heritage at the University College London. Her final theses focused on preservation and management topics, e.g. on "Public-Private Partnerships: a suitable option for heritage management?" and on "Preservation of post-war architecture in New York City".

## Tutorial

### The 3D Pitoti Project - Preserving Cultural Heritage From Kilometer to Micrometer

*Christian Mostegel*

#### **Abstract**

In this talk, we showcase our outcome of the ambitious 3D-PITOTI project, which involves a multidisciplinary team of over 30 scientists from across Europe. The project focused on the 3D aspect of recording, storing, processing and visualizing prehistoric rock art in the UNESCO World Heritage site in Valcamonica, Italy. The rock art was pecked into open-air rock formations thousands of years ago and has an inherent 3D nature. The goal of the project was not only to preserve the fine details of these unique rock engravings themselves, but also to capture them in a geographic context using a multiscale representation of the whole region. After a project overview, we elaborate the challenges of 3D reconstruction across vastly different scales, from a valley wide reconstruction down to individual peckings on the rock surface. Within this context, we showcase our contributions for autonomous 3D reconstruction with drones and scalable surface reconstruction from vast point clouds, which cover an area of several  $km^2$  with up to  $50\mu m$  resolution.

#### **Biographical Sketch**

*Christian Mostegel* is a finishing PhD student at the Institute of Computer Graphics and Vision (ICG) at Graz University of Technology. In 2014, he was awarded as a “Best Student Paper Award - Finalist” at the IEEE International Conference on Robotics and Automation (ICRA). His research is focused on 3D reconstruction from 2D images and includes autonomous drones, machine learning, multi-view stereo and surface reconstruction. Currently, he is interning at Amazon Prime Air, Graz.

## Tutorial

### Similarity Assessment for the Study of Fractured Artefacts in Cultural Heritage: the GRAVITATE Example

*Michela Spagnuolo and Silvia Biasotti*

#### Abstract

Digital manipulation and analysis of tangible cultural objects has the potential to bring about a revolution in the way classification, stylistic analysis, or refitting of fragments is handled in the cultural heritage area. 3D modelling and processing allow handling 3D digitized objects as if they were physical, and semantic models allow for a rich documentation of many different aspects of artefacts or assets of any complexity. In this context, the tutorial will focus on methods for reasoning on the similarity among digitized assets, targeting the re-unification, re-assembly and re-association of broken/fractured artefacts, in the context of the work done in the European project GRAVITATE. The need for computational means to evaluate similarity will be discussed with the illustration of the performances of state of the art methods, with the goal to highlight the potentiality and open challenges for the computer graphics community. The results will be exemplified also with demos of the GRAVITATE system.

#### Biographical Sketch

*Michela Spagnuolo* is Research Director at CNR-IMATI-GE, where she is leading the activities on Advanced techniques for the analysis and synthesis of 3D shapes. Her research interests include geometric and semantic modelling of 3D objects, computational topology for the analysis of shapes, method for the evaluation of similarity at the structural and semantic level. She authored more than 130 reviewed papers, is associate editor of international journals in Computer Graphics (currently, *The Visual Computer* and *Computers & Graphics*). She is member of the steering committee of Shape Modeling International, EG Workshop on 3D Object Retrieval and EG Workshop on Graphics and Cultural Heritage. In 2014, she was nominated Fellow of the Eurographics Association.

*Silvia Biasotti* is a researcher at CNR-IMATI, Genova, Italy. She received a Ph.D. in Mathematics and Applications (2004) and a Ph.D. in ICT (2008), both from the University of Genova, Italy. Her research interests include the study of topological-geometrical descriptions of 2D and 3D models and shape similarity based on structural descriptions. She is involved in the creation of benchmarks for 3D object retrieval and geospatial data analysis: she has been in charge of several tracks of the SHape REtrieval Contest (SHREC) and was responsible of the IQmulus Processing contest 2013-2016. She authored more than 80 scientific peer-reviewed contributions and delivered specialistic courses at several international venues, among them Eurographics2014 and SIGGRAPH2012. Finally, she is in the Programme Committee of several international conferences, e.g., Eurographics2017, SMI2017, EG3DOR'17, GCH2017, S+SSPR2016.



## Tutorial

### Digitally Enhancing Museum Experience & Understanding of Archeological Artefacts

*Markus Seidl*

#### **Abstract**

Digital artefacts can enhance the museum experience and computational analysis can improve the understanding of archeological artefacts. The first aspect targets the general public, whilst the latter mainly targets domain experts. In my presentation I will include both aspects by showing on one hand a strand of multi-touch tabletop applications for museums developed by our group and on the other hand the usage of computer vision techniques for the computational analysis of petroglyphs. The digital tabletop applications have mostly been designed and developed for young target groups and were exhibited e.g. in the Prunksaal of the Austrian National Library, the Triennale Design Museum in Milano and the Museum of Archaeology and Anthropology at Cambridge University. Currently we are investigating the inclusion of the visitor's own devices in the digital ecosystems of museums. In the second part I will present methods that aim at supporting the classic documentation pipeline for rock art. I will show approaches for surface segmentation, shape classification and pecking style analysis of petroglyphs based on 2D and 3D images thereof.

#### **Biographical Sketch**

*Markus Seidl* is professor for media technology at FHSTP. He is heading the Media Computing research group and serves as managing director of the Institute for Creative Media Technologies. He is working on the technical aspects of interactive systems. His main research interest is media processing including 3D and image processing, pattern recognition and content-based retrieval. He has acquired and led several national and international research projects. Currently, he is leading the project MEETeUX dealing with enhancing the museum experience with digital artefacts. Earlier, he contributed the FHSTP part to the successful EU proposal 3D-PITOTI in which he was work-package and task leader for the developments of automatic 3D retrieval techniques. Markus studied Computer Science at the JKU Linz, the University of Vienna, and the Vienna University of Technology, where he received his Master's degree and his PhD, both with highest distinction. He was selected to present his master thesis at the Epilog of the Vienna University of Technology where he received the Microsoft Sponsorship award for his master thesis dealing with pattern recognition in historic film material. For his PhD he was working on the computational analysis of 2D and 3D visual data of petroglyphs.