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Digital Heritage

Progress in Cultural Heritage: Documentation, Preservation, and Protection

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Cover illustration: Wall painting (end of 15th century) of the Virgin Mary, Orans between the Archangels Michael and Gabriel from the Church of the Monastery of Christos Antifonitis, Kalograia (on the apse’s conch) after it had been destroyed, following the 1974 Turkish invasion and occupation. Used with permission of the Ministry of Transport, Communications and Works, Department of Antiquities, Lefkosia, Cyprus.

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EuroMed 2018, the traditional biennial scientific event, was held in the capital city of Cyprus, the island which has always been a bridge to three continents going back to the origins of civilization. It is a place where the fingerprints of several ancient cultures and civilizations can be found, with a wealth of historical sites recognized and protected by UNESCO.

Several organizations and current EU projects (such as the H2020 Marie Skłodowska Curie RISE Fellowship project TERPSICHORE, the H2020 Marie Skłodowska Curie ITN CHANGES, the H2020 R&I Reflective 7 – INCEPTION, the H2020 COOP 8 CSA Virtual Multimodal Museum, the H2020 Reflective 6 CrossCult, the H2020 REACH, the Research Infrastructure DARIAH-EU ERIC and DARIAH-CY, the COST Action Innovation in Intelligent Management of Heritage Buildings [i2MHB], the H2020 Teaming Excelsior, H2020 Teaming Medstach, H2020 Twinning Athena and H2020 ERA Chair Mnemosyne) decided to join EuroMed 2018 and continue cooperation in order to create an optimal environment for the discussion and explanation of new technologies, exchange of modern innovative ideas, and in general to allow for the transfer of knowledge between a large number of professionals and academics during one common event and time period.

The main goal of the event is to illustrate the programs underway, whether organized by public bodies (e.g., UNESCO, European Union, national states, etc.) or by private foundations (e.g., Getty Foundation, World Heritage Foundation, etc.) in order to promote a common approach to the tasks of recording, documenting, protecting, and managing world cultural heritage. The 7th European-Mediterranean Conference (EuroMed 2018) was definitely a forum for sharing views and experiences, discussing proposals for the optimal attitude as well as the best practice and the ideal technical tools to preserve, document, manage, present/visualize, and disseminate the rich and diverse cultural heritage of mankind.

This conference was held during the second half of the EU Framework Programme, Horizon 2020, which is the largest in the world in terms of financial support on research, innovation, technological development, and demonstration activities. The awareness of the value and importance of heritage assets have been reflected in the financing of projects since the first Framework Programme for Research and Technological Development (FP1, 1984–1987) and continues into the current HORIZON 2020 that follows FP7 (2007–2013). In the past 35 years, a large community of researchers, experts, and specialists have had the chance to learn and develop the transferable knowledge and skills needed to inform stakeholders, scholars, and students. Europe has become a leader in heritage documentation, preservation, and protection science, with COST Actions adding value to projects financed within the FP
and EUREKA program and transferring knowledge to practice and support the development of SMEs.

The EuroMed 2018 agenda focused on enhancing and strengthening international and regional cooperation and promoting awareness and tools for future innovative research, development, and applications to protect, preserve, and document the European and world cultural heritage. Our ambition was to host an exceptional conference by mobilizing also policy-makers from different EU countries, institutions (European Commission, European Parliament, Council of Europe, UNESCO, International Committee for Monuments and Sites ICOMOS, the International Committee for Documentation of Cultural Heritage CIPA, the International Society for Photogrammetry and Remote Sensing ISPRS, the International Centre for the study of the Preservation and Restoration of Cultural Property ICCROM, and the International Committee for Museums ICOM), professionals, as well as participants from all over the world and from different scientific areas of cultural heritage.

Protecting, preserving, and presenting our cultural heritage are actions that are frequently interpreted as change management and/or change in the behavior of society. Joint European and international research yields a scientific background and support for such a change. We are living in a period characterized by rapid and remarkable changes in the environment, in society, and in technology. Natural changes, war conflicts, and man-made interventions and changes, including climate change, as well as technological and societal changes, form an ever-moving and colorful stage and pose a challenge for society. Close cooperation between professionals, policy-makers, and authorities internationally is necessary for research, development, and technology in the field of cultural heritage.

Scientific projects in the area of cultural heritage have received national, European Union, or UNESCO funding for more than 30 years. Through financial support and cooperation, major results have been achieved and published in peer-reviewed journals and conference proceedings with the support of professionals from many countries. The European Conferences on Cultural Heritage research and development and in particular the biennial EuroMed conference have become regular milestones on the never-ending journey of discovery in the search for new knowledge of our common history and its protection and preservation for the generations to come. EuroMed also provides a unique opportunity to present and review results as well as to draw new inspiration.

To reach this ambitious goal, the topics covered include experiences in the use of innovative technologies and methods as well as how to take the best advantage to integrate the results obtained so as to build up new tools and/or experiences as well as to improve methodologies for documenting, managing, preserving, and communicating cultural heritage.

We present here 97 papers, selected from 537 submissions, which focus on interdisciplinary and multidisciplinary research concerning cutting-edge cultural heritage informatics, physics, chemistry, and engineering and the use of technology for the representation, documentation, archiving, protection, preservation, and communication of cultural heritage knowledge.
Our keynote speakers, Dr. Ronald de Bruin, Director of the COST Association, Dr. Robert Sanderson (Getty Foundation), Prof. Craig Knoblock, USC Information Sciences Institute, Mrs. Diane Zorich, Director of the Smithsonian’s Digitization Program Office (DPO), Dr. Charalambos Chaitas, Executive Director for Arts, Heritage, and Education for the Public Investment Fund, Saudi Arabia, Mr. Joan Cobb, Principal IT Project Manager at J. Paul Getty Trust, Mr. Harry Verwayen, Executive Director of EU Digital Library Europeana, Prof. Koen van Balen, KUL, UNESCO Chair on Preventive Conservation, Monitoring, and Maintenance of Monuments and Sites, and UNESCO CHAIR Disaster Mitigation for Urban Cultural Heritage, Japan, Mr. Brigadier General Fabrizio Parrulli, Carabinieri for the Protection of Cultural Heritage Commander, Mrs. Nada R. Hosking, Director, Programs and Partnerships, Global Heritage Fund, and Mrs. France Desmarais are not only experts in their fields, but also visionaries for the future of cultural heritage protection and preservation. They promote the e-documentation and protection of the past in such a way that it is preserved for the generations to come.

We extend our thanks to all authors, speakers, and those persons whose labor, financial support, and encouragement made the EuroMed 2018 event possible. The international Program Committee, whose members represent a cross-section of archaeology, physics, chemistry, civil engineering, computer science, graphics and design, library, archive, and information science, architecture, surveying, history, and museology, worked tenaciously and finished their work on time. The staff of the IT department at the Cyprus University of Technology helped with their local ICT and audiovisual support, especially Mr. Filippou, Mr. Lefteris Michael, and Mr. Stephanos Mallouris. We would also like to express our gratitude to all the organizations supporting this event and our co-organizers, the European Commission scientific and policy officers of the DG Connect Mr. Albert Gauthier, Mrs. Adelina-Cornelia Dinu, the COST director Dr. Ronald de Bruin, the officers Mrs. Federica Ortelli, Mrs. Estelle Emeriau, the director general of Europeana Mr. Harry Verwayen, the Getty Conservation Institute and World Monuments Fund, the Cyprus University of Technology, the Ministry of Energy, Commerce, Industry and Tourism especially the permanent secretary and digital champion Dr. Stelios Himonas and Mr. Constantinos Karageorgis, the Ministry of Education and Culture and particularly the minister Mr. Kostas Champiaouris, the director of the Cultural Services Mr. Pavlos Paraskevas, the director of the Cypriot National Library Mr. Demetris Nicolaou, the Department of Antiquities in Cyprus, all the members of the Cypriot National Committee for E-documentation and E-preservation in Cultural Heritage, and finally our corporate sponsors, CableNet Ltd, the Cyprus Tourism Organization, the Cyprus Postal Services, and Dr. Kyriakos Themistokleous from the Cyprus Remote Sensing Society who provided services and gifts of kind that made the conference possible.
We express our thanks and appreciation to the board of the ICOMOS Cyprus Section for their enthusiasm, commitment, and support for the success of this event. Most of all we would like to thank the organizations UNESCO, European Commission, CIPA, and ICOMOS that entrusted us with the task of organizing and undertaking this unique event and wish all participants an interesting and fruitful experience.

September 2018

Marinos Ioannides
Eleanor Fink
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Multidisciplinary Experiences of Virtual Heritage for the Documentation of Architecture and Archaeology Within the DigitCH Group - Digital Cultural Heritage Group

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Abstract. Here we address the roadmap of the Digital Cultural Heritage research group DigitCH group, which was set up in 2013 at the Department of Architecture, University of Florence. The aim of DigitCH group was to realize the link between scientifically validated methodologies and contents, innovative storytelling, and technological instrumentation. The spread of electronic devices has enabled rapid and easy technological fallout of research in the field of the acquisition-representation of the survey data expanding audiences and accelerating even an innovative approach to the whole knowledge of CH.

Among the objectives that the DigitCH group seeks to achieve is the strengthening of the concrete experience of visitors through the use of technological potential; this allows the promotion of CH in all categories of citizens and the renewal of approaches and languages through more active and interactive educational activities. Moreover, DigitCH aims to increase knowledge of CH gained through experience within bespoke digital environments. A selection of case histories from DigitCH shows how we have designed solutions that promote interactions within a broad context, aiming to establish a communication strategy that “opens the educational box” to the territory (to get in touch with the identity of the visited places), new languages (to foster the links between different kinds of cultural heritage: architecture, archeology, artistic heritage), and to a new public (to create a shared cultural habitat among different institutions).

Keywords: Virtual heritage · Architectural survey · Digital representation

1 Scientific Background

The New European Agenda for Culture [1] has recently entered its final phase of drafting and changes the vision for those involved in CH, including those engaged in the acquisition, dissemination, and valorization. The New European Agenda for Culture also changes the public debate; in particular, this vision does not consider CH as only a way to preserve the memory of the past but rather as part of an ecosystem. Within this new ecosystem, cultural policies must be connected to European research policies and digital innovation policies.
Briefly, the temporary framework that is emerging suggests that the new direction on which the European cultural policy will be set will be strongly connected with the other already active policies (health, environment, job, competitiveness and social cohesion) so that all work in synergy.

In this framework, it is evident how the field of Digital Cultural Heritage (DCH) can play a key role enhancing its characteristic of being from its origin at the intersection of Digital, Culture, Research. The current culture is formed with a continuous evolution that makes the formulation of strategies for the activation of knowledge very complex, especially if we refer to a “significant” knowledge (we borrow the concept of “meaningful learning” of Ausubel and Novak): the knowledge produced through networks of relationships between people and contents that, using different languages and even distant from each other, makes it possible to re-contextualize the meaning of each experience in a novel way. In this sense, we can build a bridge between contents from humanistic knowledge and high-tech fruition if we work by choosing as a working method the contamination between fields of similar knowledge and a multidisciplinary approach: a bridge that benefits from tangible and intangible CH in a mature and evolved way [2].

2 Strategy, Goals and Program of DigitCH Group

This premise represents the strategic thread of the Digital Cultural Heritage-DigitCH group, which has operated from within the Department of Architecture of the University of Florence since 2013, engaging the research group coordinated by the author in the dissemination of architectural and archaeological cultural heritage by strong synergy between knowledge of the investigated assets and sustainable use of technology for their fruition.

Our guidelines aim to encourage innovative information models and are aimed at achieving objectives based on four axes:

- Experiencing the slow beauty of cultural heritage: when we talk about tourist fruition of CH, DigitCH works to prevent the “tourist selfies” and tourist consumerism; this means inducing more mature ways of visiting and means to promote tangible CH not so much for its abstract beauty but for the slowness and depth resulting from its birth and evolution over time; this produces encouragement for every visitor to approach culture in a direct and emotionally involving way;
- Activate the museum as a factory of knowledge: when we talk about museums we use museographic language to introduce further levels of knowledge on the conception-gestation of the artefact (art as techne) and induce engagement of new public, promoting an “information architecture” that favors the transformation of the museum from a depository to a place to explore one’s own creativity;
- Reinforcing the link between the artifact and its context: to promote a truly meaningful cultural experience it is necessary to foster a deeper knowledge of the provenience of the artifacts, of the authors and of the communities of origin: this is one of the main prerequisites for a really wide knowledge of the contents and with a positive impact on the communities involved.
Maximize the accessibility: the overall information architecture of the DigitCH work program has been principally expressed through the representation of the investigated artifacts so that they are more physically accessible, accessible in contents, and accessible in the space-time line; the general aim of the DigitCH Program, created to facilitate the “smart” fruition of architectural and archaeological heritage (whether museumized or not) through computer-based information architectures, focuses on updating the traditional methods of public dissemination by adding to the original contexts some “information devices” represented by multiple material and immaterial conformations with variable accessibility to the objects themselves.

Already in 2008, the Icomos Charter for the Interpretation and Presentation of Cultural Heritage Sites [3], and then in 2009, the London Charter for Computer-based Visualization of Cultural Heritage [4], gave the scientific community the problem of rigorous definition of contents, methodologies, and results for the correct proposal of cultural products aimed at public dissemination.

The subsequent application about the archaeological heritage [5] - represented by areas, remains and finds- is also based on the seven principles established in 2011 by the International Principles of Virtual Archeology [6], aimed at defining guidelines and best practices in this specific field.

Based on these principles, in 2010, DigitCH began experimenting with the use of low-cost techniques of 3D survey and representation for the documentation and dissemination of the cultural heritage.

The research activity’s program has focused on four main lines:

1. keeping on the critical balance aspects of the scientific context: to realize cultural contexts that can be used collectively and not limited to technical virtuosities individual, DigitCH operates aiming at the use of Surveying and Representation as tools and not as a scope of the process;
2. to work according to rigorous scientific standards in the measurement and representations for visual reconstructions and contents based on the detailed collection and systematic analysis of historical and environmental data; it means to disseminate contents strictly validated in historical terms and far from easy “special effects”;
3. experimenting with the theoretical and applicative model on different scales, including urban context to architecture, to archaeological areas, to mobile finds;
4. to achieve greater diffusion and impact of the work by using only entry-level technologies, low-cost or open access hardware and software, and rapid procedures.

In all three cases - in the documentation of the urban landscape, in architecture and in archeology - the group has therefore worked to increase public understanding by avoiding imaginative reconstructions and working to obtain results deriving from a process of logical interpretation based on multidisciplinary work and collaboration between architects, archaeologists, art historians and ICT experts.

In the last 10 years, a new approach to CH communication has emerged based on the use of scientifically reliable metadata [7, 8]. Today, such metadata can be easily activated using an operating chain Survey-Representation-Visualization - Communities of the data that digitalization has strongly integrated and speeded.
Using high-definition 3D models of archaeological finds, for example, presents the undoubted added value of a series of advantages linked to the possibility of visual and perceptive contact (or in some cases, even of the interaction) with an object unavailable in time or in place or not accessible for conservation reasons; this allows, for example, to present the find at a much larger scale, thereby revealing details otherwise not visible to the naked eye [9].

This methodological and instrumental approach [10] enabled DigitCH to create systems of “interactive heritage” in an increasingly flexible manner, where the LS has been progressively joined by the SFM: in particular, the availability of photo modelling has allowed multidimensional data to be used for innovative cultural communication strategies - and according to multidimensional outputs in advanced results, which today has a very wide range of devices and languages, from 3D reconstructions and animations to Augmented Reality, to Virtual Reality and immersive, to virtual scenes.

3 Nine Cases Study by DigitCH Group

3.1 Architecture

Title: Ponte Vecchio in 3D: The architectural survey for the visualization of the post-war reconstruction of the Florentine historic center

Where and when: Florence historic center, 2008–2011;

Description: In 1944, the Nazis retreating from Florence mined and they blew-up the bridges over the Arno and a substantial part of the area of the historic center surrounding the Ponte Vecchio. The research is aimed at producing visual documentation for the knowledge and disclosure of this very special urban piece between the Piazza della Signoria and the Ponte Vecchio.

Outcome: The production of this 3D model represents a tool for the reconstruction of the relationship between project and building, as well as a communication tool to allow tourists to better understand the place; consisting of an easy-to-consult 3D model. Data were collected from the integrated survey and traditional graphic elaborations, as well as the 3D models of the area.

Financing: the research has been funded by University of Florence in Research programs 2009, 2010.


Title: Project Augmented Reality Tbilisi-ARTbilisi

Where and when: Tbilisi, Georgia, 2013;

Description: The project represented the first application of Augmented Reality for documentation and spreading of assets selected from Georgian architectural and archaeological heritage [11]. In 2013 no tools were available for tourists and professionals to investigate the city, except for a few traditional guides, without the sufficient information such an important architectural and archaeological heritage merits.

Due this needing, the Italian-Georgian research group developed ARTbilisi - a multidisciplinary project involving archaeology, informatic engineering, and media arts
- designed by the Italian-Georgian research group to make it possible to visit the Old Tbilisi and the National Archaeological Museum of Georgia in a more in-depth and innovative way. ARTbilisi provides a demo of educational apparatus to show how AR can be used to know info and the educational contents.

Financing: University of Florence, Tbilisi State Academy of Art, Ministry of Culture and protection of monuments of Georgia.


Title: FIrenze Mura-FIMU Project

Where and when: Florence historic center, 2016;

Description: The ancient city walls of Florence represents the theme of the Project FiMU [12], with a focus on the survey and digital representations. The short segment of walls we can visit today is the result of the overlapping of traces and circuits that have been, the leading sign of the urban form, up to the caesura of the XIX century, when the entire segment on the north side of the river has been demolished and replaced by boulevards, interspersed with squares designed around the ancient doors.

Outcome: DigitCH has carried out architectural LS surveys, producing 2D drawings and 3D models as tools for visiting the wall circuit and its valorization.

Financing: the project has been funded by University of Florence in Research programs 2014, 2015.


Title: FlorenceImagingMap

Where and when: Florence historic center, 2016;

Description: This research intends to map the material and immaterial characteristics that are profoundly changing the place investigated; through architectural surveys and digital representations (LS survey, 2D and 3D models intended for interactive use), we studied the transformations that an important part of the center of Florence - very representative of its genius loci- faces for some years, due the pressure of tourism mass, the risk of trivialization of places and their image consumption.

Outcome: FlorenceImagingMap, which is still in progress, has given output in the homonymous platform in progressive Web App format: to operate from the website makes it easy to work while the interface from mobile app facilitates intuitive use and promotes the collaborative construction of the repository.

Financing: the research has been funded by University of Florence in Research programs 2015.

Title: Yerevan Virtual Heritage Project

Where and when: Yerevan, Armenia, 2017;

Yerevan Virtual Heritage is a didactic research project realized in cooperation between DigitCH and National University of Architecture and Construction of Armenia, Department of Theory of Architecture.

Today the church of Katoghike Tsiranavor Church of Avan has no roofing and is one of the oldest examples of a tetraconca church with cylindrical niches on the diagonals in Armenia: the workshop entitled “The enhancement of the Armenian architectural historical heritage: surveys and representations of the Avan church in Yerevan” has been held meaning the architectural survey as a tool for the reconstruction of its original shape.

Outcome: The project is ongoing. Architectural surveys have been done by SFM and drone, and digital 2D drawings and 3D models have been produced.


3.2 Archaeology

Title: Project Baratti in 3D

Where and when: Archaeological Park of Baratti and Populonia; Archaeological Museum of Populonia, Piombino, Tuscany, 2007–2013 and 2015, respectively;

Description: Fufiluna was the only Etruscan city born on the sea, in front of the Tuscan Archipelago, and was an important and rich city because of its iron production and position adjacent to important trade routes in the Mediterranean Sea.

From the VII century B.C., the most powerful families of Populonia build the Monumental Necropolis, a complex of tombs so rich in luxurious grave goods that were called “the tombs of the princes”.

Outcome: The Monumental Necropolis consists of a large number of tombs that were surveyed and represented in 2D drawings and 3D models between 2007 and 2013; then, to virtually “relocate” the finds from the necropolis – exhibited in the Archaeological Museum of Populonia and in the National Archaeological Museum of Florence – in 2015, we undertook the first campaign for the documentation of two burial sets, to realize reconstructions by metrically reliable 3D models [13].

Financing: the project has been funded by UE POR 2007 and University of Florence in Research programs 2014.

Title: Project A museum in every sense


Description: This project favored an innovative approach to museum communication, thinking of it as a place of true social inclusion: the storytelling system was born to reverse the traditional approach of many Italian museums – “forbidden to touch” – perpetuating an old concept in which more emphasis is placed on the sacralization of the finds than on the promotion of what they can teach.

Outcome: The project uses the techniques of virtual heritage, applying low-cost techniques to ensure greater involvement of the public through the construction of installations consisting of interactive reproductions of the three emblematic finds of the museum of Populonia (see also the Baratti in 3D Project): the precious Anfora di Baratti, the Tomb of the Chariots, and the mosaic on the marine scene. Working in cooperation with archaeologists, museum curators, and electronic engineers, DigitCH has realized an informative architecture [14–16] where the visitor “queries” to the object that answers: each of the three replicas, made in 3D models by rapid prototyping, has six touch-sensitive points that activate visual and vocal devices that provide information about the three artifacts.

Financing: the project has been funded by UE POR 2013- Regione Toscana.


Title: The Castellum aquarium of Poggio Murella in 3D

Where and when: Manciano, Tuscany, 2016;

Description: This virtual heritage project is aimed at documenting an important artifact currently in a state of neglect, with the goal of triggering subsequent enhancement initiatives. The cistern looks like an imposing stone and brick construction, surveyed by DigitCH for the first time in all its characteristics, whose size and position indicates the possible presence of a typical III century B.C. villa, of which today the Castellum remains the only permanence. The preserve has a volume of approximately $11 \times 35 \times 5$ ml and is made of many kinds of opus. Today, the state of disrepair makes it impossible to walk on the original level and to appreciate the vaults.

Outcome: After the acquisition of morphometric data (carried out through SFM with topographical survey), we produced 2D drawings and 3D texturized models for the Virtual Tour, thereby making the artifact understandable through texts and visual contents. The virtual tour was created as a responsive, multi-channel fruition system (accessible from desktops, laptops, totems, tablets, and smartphones).

Financing: the project has been funded by the Municipality of Manciano and University of Florence.

Fig. 1. Synopsis of the study cases of the DigitCH group related to architecture.
Fig. 2. Synopsis of the study cases of the DigitCH group related to archaeology.
Title: Vani Virtual Heritage

Where and when: Vani, Tbilisi, Georgia, 2017;

Description: Vani Virtual Heritage is a didactic and research project undertaken jointly by Italian and Georgian groups in 2017, in cooperation with Tbilisi State Academy of Arts, Media Arts Department; the workshop “The enhancement of the Georgian archaeological heritage: surveys and representation of remains and finds from Vani” has been conceived to prepare the first modern documentation of the important archaeological heritage of Vani, the ancient capital of Colchis;

Outcome: This project realized surveys of the remains and finds in the Vani Archaeological Museum and the National Archaeological Museum of Georgia in Tbilisi and is in the progress of producing 2D and 3D representations.

Financing: University of Florence, Tbilisi State Academy of Art, National Archaeological Museum of Georgia.


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