Proceedings e report

94

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EVA 2013 Florence

15 – 16 May 2013

edited by
Vito Cappellini

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PROGRAM

Electronic Imaging & the Visual Arts

'The Foremost European Electronic Imaging Events in the Visual Arts'

Forum for Users, Suppliers & Researchers

The key aim of this Event is to provide a forum for the user, supplier and scientific research communities to meet and exchange experiences, ideas and plans in the wide area of Culture & Technology. Participants receive up to date news on new EC and international arts computing & telecommunications initiatives as well as on Projects in the visual arts field, in archaeology and history. Working Groups and new Projects are promoted. Scientific and technical demonstrations are presented.

Main Topics

- ♦ 2D – 3D Digital Image Acquisition
- ♦ Leading Edge Applications: Galleries, Libraries, Education, Archaeological Sites, Museums & Historical Tours
- ♦ Mediterranean Initiatives in Technology for Cultural Heritage: Synergy with European & International Programmes
- ♦ Integrated Digital Archives for Cultural Heritage and Contemporary Art
- ♦ Management of Museums by using ICT Technology: Access, Guides, Documentation & Other Services
- ♦ The Impact of New Mobile Communications on Cultural Heritage and Modern Arts Area
- ♦ Semantic Webs
- ♦ Human - Computer Interaction for Cultural Heritage Applications
- ♦ Copyright Protection (Watermarking & Electronic Commerce)
- ♦ Culture and *e-government*
- ♦ Activities and Programmes for *e-learning*
- ♦ Application of Digital Terrestrial Television
- ♦ 3D Developments and Applications in the Cultural Heritage Area
- ♦ Digital Theater
- ♦ Cultural Tourism & Travel Applications
- ♦ Art and Medicine

WHO SHOULD ATTEND

THE CULTURAL SECTOR: The Visual Arts Community including Museums, Libraries, Archaeological Sites, Educational Institutions, Commercial Galleries and Dealers, Auction Houses, Artists & Collectors

THE HI-TECH INDUSTRY SECTOR: Multimedia Systems, Image Acquisition & Analysis, Data-bases, Display & Printing, ICT Industry, Telematics & Systems Manufacturing, On-line Information Services

MEDIA & RELATED SECTORS: Publishing, Press, Film, Television, Photography, Printing, Advertising, Graphics Design, Consumer Media

IMAGING SYSTEMS RESEARCHERS: Imaging Systems, 3-D Acquisition, Reconstruction & Representation, Information Sciences

TOURISM & TRAVEL SECTOR: Tourism Agencies & Operators, Travel Agencies

THE GOVERNMENT SECTOR: Ministries of Culture and other Institutions involved in Cultural Heritage, Ministries of Industry, Education, Research and Science, Regional Governments

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PROGRAM

1 - CONFERENCE

Wednesday, 15 May: 14,15 – 18,45
Thursday, 16 May: 9,00 – 19,05

2 - WORKSHOPS

Wednesday, 15 May: 9,00 – 13,30
Thursday, 16 May: 14,30 – 18,00

3 - SPECIAL EVENTS

Wednesday, 15 May: 19,30 – 22,30

4 - TECHNICAL EXHIBITION

Wednesday, 15 May: 15,00 – 18,30
Thursday, 16 May: 10,00 – 13,00

1 - CONFERENCE

Wednesday, 15 May

ROOM A

Chairmen: *Vito Cappellini, Florence University*
James Hemsley, EVA Conferences International

14,15 *Welcome:* *Representatives of Sponsors and Supporters*

Opening: *Cristina Scaletti,*
Assessore alla Cultura, Commercio e Turismo,
Regione Toscana, Italy
Pierluigi Rossi Ferrini,
Vice-Presidente Ente Cassa di Risparmio di Firenze, Italy

15,15 Coffee Break

15,30 **SESSION 1 – STRATEGIC ISSUES**
Chairman: *Paolo Blasi, Università di Firenze, Italy*

"Excellence Digital Archive Project for Polo Museale Fiorentino: Developed Activities"

Cristina Acidini[1], Vito Cappellini[2], Takayuki Morioka[3], Marco Cappellini[4]
[1]Polo Museale Fiorentino, Italy
[2]MICC - Università di Firenze, Italy
[3]DIS Project, Hitachi Ltd., Yokohama, Japan
[4]Centrica Srl, Firenze, Italy

"VisLab OSAKA and Knowledge Capital Project"

Shinji Shimojo[1], Masaki Chikama[2], Kaori Fukunaga[2], Rieko Kadobayashi[3] , Tsuneo Jozen[3]
[1]Cybermedia Center, Osaka University, Ibaraki, Japan
[2]National Institute for Information and CommunicationsTechnology, Keihanna/Koganei, Japan
[3]Osaka Electro-Communication University, Shijonawate, Japan

""3D Technologies at the Museums": A Perspective of the Staatliche Museen zu Berlin (National Museums in Berlin)"

Andreas Bienert
Staatliche Museen zu Berlin - Stiftung Preußischer Kulturbesitz, Dept. ICT, Berlin, Germany

ROOM A

16,45 **SESSION 2 – EC PROJECTS AND RELATED NETWORKS & INITIATIVES**
Chairman: Franco Niccolucci, PIN, Prato, Italy

"Europeanaphotography: early Photography Accessible in Europeana"	Antonella Fresa[1], Valentina Bachi[1], Andrea De Polo[2], Marzia Piccininno[3], Frederik Truyen[4], Sofie Taes[4] [1]Promoter SRL, Italy [2]Fratelli Alinari, Fondazione per la Storia della Fotografia, Firenze, Italy [3]Istituto Centrale per il Catalogo Unico delle Biblioteche italiane, Roma, Italy [4]KU Leuven, Belgium
"Reengineering and Construction of a Relief for an Organ Loft Based on Drafts by Friedrich Press"	Christine Schoene Faculty of Mechanical Science and Engineering, Technische Universität, Dresden, Germany
"3D in Archaeology: 15 Years of Research. The Role of EU Projects"	F. Niccolucci[1], S. Hermon[2] [1]PIN, Prato, Italy [2]STARC – The Cyprus Institute, Nicosia, Cyprus
"Context Sensitive Services and Information Systems in the Pergamonmuseum and the Jewish Museum in Berlin"	Jürgen Sieck University of Applied Sciences Berlin, Berlin, Germany
"CENDARI: a Collaborative EuropeaN Digital ARchive Infrastructure for Medieval studies"	Emiliano Degl'Innocenti Fondazione Ezio Franceschini ONLUS (Florence) Società Internazionale per lo Studio del Medioevo Latino, Florence, Italy
"The Marcopolo Project: Agile Development of Mobile Cross-Platform Tourism Applications on the Cloud"	L. Garulli[1], J. Gutierrez[2], F. Spadoni[3], R. Rossi[3], [1]Asset Data S.r.l., Roma, Italy [2]Paradigma Tecnologico S.A., Madrid, Spain [3]Rigel Engineering S.r.l., Livorno, Italy

Thursday, 16 May

ROOM A

9,00 **INTERNATIONAL FORUM ON "CULTURE & TECHNOLOGY"**
Chairman: Vito Cappellini, Università di Firenze, Italy

The structure of the FORUM is presented.
Actual developments and perspectives are outlined:

- Cooperation Groups

- Proposed Projects
- Funding Opportunities.

Speakers Include:

- Antonia Ida Fontana, Centro UNESCO di Firenze, Italy
- Takayuki Morioka, DIS Laboratory – HITACHI Ltd., Yokohama, Japan
- Marco Aluigi, Fondazione Meeting per l'amicizia fra i popoli, Rimini, Italy
- Edoardo Calia, Istituto Superiore Mario Boella, Torino Wireless, Italy
- Elizabeth Markevitch and Cinzia Garzoni, ikono TV, Berlin, Germany

11,00 Coffee Break

11.15 **SESSION 3 – 2D - 3D TECHNOLOGIES & APPLICATIONS**
Chairman: Bernd Breuckmann, Breuckmann GmbH, Germany

"Advanced Super-Resolution Techniques for Digital Image Quality Enhancement"	Fabrizio Argenti[1], Alessandro Lapini[1], Giovanni Giusti[1], Luca Bencini[2] [1] Department of Information Engineering, University of Florence, Italy [2]TT Tecnosistemi S.p.A., Prato, Italy
"Image Registration Using 3D Models"	F. Uccheddu[1], A. Pelagotti[2], P. Ferrara[2] [1]Dept. of Information Engineering – DINFO, University of Florence, Italy [2]INO (National Institute of Optics), Firenze, Italy
"Challenging 3D Scanning Applications in Arts and Cultural Heritage"	Bernd Breuckmann Breuckmann GmbH, Meersburg, Germany Breuckmann 3D-Engineering, Meersburg, Germany
"3D Surface Reconstruction Using Multiple Kinects"	J.K. Aggarwal, Lu Xia Department of Electrical and Computer Engineering, The University of Texas at Austin, Austin, Texas, U.S.A.
"Integrating Real 3D Data and Historical Sources for the Digital Reconstruction of Five HinduTemples"	G. Guidi[1], M. Russo[2], D. Angheleddu[1] [1]Dept. of Mechanics, Politecnico di Milano, Milan, Italy [2]Dept. of Design, Politecnico di Milano, Milan, Italy
"An Introduction to Gait Recognition"	Haiping Lu[1], Anastasios N. Venetsanopoulos[2], [1]Institute for Infocomm Research, Singapore [2]Ryerson University & University of Toronto, Toronto, ON, Canada

13,15 Lunch Break

ROOM A

14,30 **SESSION 4 – VIRTUAL GALLERIES – MUSEUMS AND RELATED INITIATIVES**

Chairman: Andreas Bienert, Staatliche Museen zu Berlin, Berlin, Germany

"Museums Outside Museums: Districts of Knowledge"	Luca Toschi, Lorenza Orlandini, Marco Sbardella, Gianluca Simonetta Communication Strategies Lab., University of Florence, Italy
"Bringing back the "Fontana di Sala Grande" to its Original Setup according to Bartolomeo Ammannati's Project"	Giorgio Verdiani, Giacomo Pirazzoli Dipartimento di Architettura, Università degli Studi di Firenze, Italy
"The creation of a multimedia information resource <the Church of the Savior on Ilyina street in Novgorod the Great>"	T. Laska, S.Golubkov Institute of Arts, The Faculty of Arts, St. Petersburg State University, St. Petersburg, Russia
"ROME MVR"	A. Furlan ALTAIR4 MULTIMEDIA, Rome, Italy
"Integrating museum archive and town. An app for a fortified town"	Johan Richard Møhlenfeldt Jensen Archive and Museum, Museerne i Fredericia, Fredericia, Denmark
"HTML Responsive Design and Apps for Museums: Needs and Options at Museo Galileo"	Marco Berni, Fabrizio Butini, Elena Fani Museo Galileo - Institute and Museum of the History of Science, Florence, Italy

16,30 Coffee Break

ROOM B

16,45 **SESSION 5 – ACCESS TO THE CULTURE INFORMATION**

Chairmen: James Hemsley, EVA Conferences International, UK and

"CNR Retrieval of Images from Hyper-Spectral Data through Interactive Network Access (CRISTINA)"	Filippo Micheletti, Lorenzo Stefani, Costanza Cucci, Marcello Picollo Institute of Applied Physics "Nello Carrara" - Italian National Research Council (IFAC-CNR), Sesto Fiorentino, Firenze, Italy

"PENCO SYSTEM"	Sara Penco "Discovering the work of art", European University of Rome, Rome, Italy
"Introducing a Virtual Reality EEG-BCI and Priming-Based Tool to Make Art Interactive: a Technological and Linguistic Challenge"	Miriam Bait[1], Annalisa Banzi[2], Raffaella Folgieri[1], Sabrina Minetti[3] [1]Dipartimento di Economia, Management e Metodi quantitativi, Università degli Studi di Milano, Milan, Italy [2] Istituto di Comunicazione, Comportamento e Consumi "Giampaolo Fabris", Università IULM, Milan, Italy [3]C.A.P.A.C., Politecnico del Commercio, Milan, Italy
"Virtual Museum *Ancient Fortresses of the Northwest of Russia*: Koporye Fortress – Virtual Reconstruction"	Nikolay Borisov[1], Vera Slobodyanuk[1], Artyom Smolin[1], Iren Haustova[2] [1]Department Informational Systems in Arts and Humanities, Saint-Petersburg State University Centre of Design and Multimedia, Saint-Petersburg National Research University of Information Technologies, Mechanics and Optics, Saint-Petersburg, Russia [2]Architect and restorer, superior category, Russia
"DOCART900: A Web Application for Cultural Heritage"	A. Del Bimbo, A. Ferracani, L. Landucci, G. Serra MICC – Media Integration and Communication Center, University of Florence, Firenze, Italy
"Travel Industry ICT Vertical Solutions"	Giovanni Gasbarrone Business – Sales Top Clients and Public Sector, Industry Marketing, Telecom Italia, Roma, Italy
"VIVIT: A Semantic Web System for the Promotion of Italian Linguistic and Cultural Heritage"	M. Bertini, A. Del Bimbo, A. Ferracani, N. Hosseini, D. Pezzatini Media Integration and Communication Center, Università degli Studi di Firenze, Firenze, Italy

2 - WORKSHOPS

Wednesday, 15 May

ROOM B

WORKSHOP 1 **INTERNATIONAL COOPERATION**
9,00 – 13,00 *Chairman: James Hemsley, EVA Conferences International*

The general aspects of international cooperation in Cultural Heritage are presented. The impact of new technologies in the field is considered, outlining the more suitable ones for cooperative plans.

The importance of Virtual Heritage for better cooperation among the Nations in the World is considered.

Projects currently developed in different parts of the World are presented.

The importance of coordination and promotion by International Organization (as by UNESCO) is outlined.

European Commission programmes and initiatives are presented. Collaborative activities in Europe are in particular described.

Speakers include:
- *Maria Luisa Stringa, Centro UNESCO di Firenze, Italy*
- *Dirk Petrat and Dirk Börnsen, Free and Hanseatic City of Hamburg Ministry of Culture, Hamburg, Germany*
- *Jens Bley, Living Labs Germany GmbH, Germany*
- *Antonio Scuderi, Capitale Cultura*
- *Paolo Del Bianco, Fondazione Romualdo Del Bianco – Life Beyond Tourism, Firenze, Italy*
- *Carlo Francini, Ufficio UNESCO del Comune di Firenze, Italy*
- *Carlo Quinterio, Film Producer, Firenze, Italy*
- *Detelin Luchev and Desislava Paneva-Marinova, Institute of Mathematics and Informatics – Bulgarian Academy of Sciences, Sofia, Bulgaria*

ROOM A

WORKSHOP 2 **INNOVATION AND ENTERPRISE – INNOVAZIONE E IMPRESA**

(Italian Language)
9,00 – 13,00

Chairman: *Francesco Chirichigno, Consigliere dell'Organo di Vigilanza per la Parità di Accesso alla Rete TELECOM TALIA*

Technological requirements in the Cultural Heritage field are outlined and opportunities for Italian SME's working in the field, using new technologies, are presented.

Regional and national applied research Programs in Italy are described.

Activities by National Organizations and Firms working in the area of Telecommunications, Informatics, Optoelectronics, Environment and Infomobility are presented.

Funding by European Commission is considered, with particular reference to multimedia and telematics for Cultural Heritage, Environment and Education (*e-learning*). Initiatives regarding the "know-how" transfer from Research Organizations to the Industrial Sector are described.

Organizations and Companies present their activities and experiences.

Opening:	*Alberto Tesi,*	*Rettore, Università degli Studi di Firenze*
Invited Speakers:	*Marco Bellandi,*	*Pro-Rettore al Trasferimento Tecnologico, Università degli Studi di Firenze*
	Marco Masi,	*Regione Toscana*
	Enrico Bocci,	*Responsabile Commissione Regionale Servizi Innovativi e Tecnologici, Confindustria Toscana*

Speakers include:
- *Claudio Tasselli, Sezione Servizi Innovativi e Tecnologici, Confindustria Firenze*
- *Paola Castellacci and Silvano Baldassare, VarGroup*
- *Luca Bencini, T.T. Tecnosistemi, Prato*
- *Andrea del Re, Studio Legale Del Re – Sandrucci, Firenze*
- *Franco Guidi, NEUMUS, Firenze*
- *Simonetta Bracciali and Sofia D'Alessandro, Studio di Architettura e Restauro, Firenze*

Thursday, 16 May

ROOM B

WORKSHOP 3 CREATIVE INDUSTRIES AND CULTURAL TOURISM

14,30-18,00 *Chairman: Franco Niccolucci, PIN, Prato, Italy*

In the framework of the EU Project CREATIVE CH, PIN organizes a Workshop titled "Internationalization and localization".
At the Workshop, international experts will present their experiences concerning the use of technology to promote development using applications to cultural tourism.

Speakers:
- Franco Niccolucci (PIN, Prato – Coordinatore progetto CREATIVE) *Chair*
- Mike Spearman (CMC Associates, Edinburgo) *Virtual exhibitions and 3D models*
- Susan Hazan (Israel Museum, Gerusalemme) *Museum heritage and multimedia*
- Maria Teresa Natale (MIBAC e Ass. Culturale Appasseggio, Roma) *Slow tourism and smartphones*
- Daniel Pletinckx (Visual Dimension, Oudenarde) *Cultural Heritage and multimedia*.

At the Workshop PIN will present the apps. developed within the CREATIVE Project on cultural and natural itineraries at Carmignano and in Maremma.

3 - SPECIAL EVENTS

Wednesday, 15 May 19,30 – 22,30

RECEPTION at Grand Hotel Minerva
"Multimedia Presentation of Art and Science"

4 - TECHNICAL EXHIBITION

Wednesday, 15 May: 15,00 – 18,30
Thursday, 16 May: 10,00 – 13,00

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PROCEEDINGS

STRATEGIC ISSUES

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EXCELLENCE DIGITAL ARHIVE PROJECT FOR POLO MUSEALE FIORENTINO: DEVELOPED ACTIVITIES

Cristina Acidini, Superintendent Polo Museale Fiorentino, Florence, Italy
Vito Cappellini, President MICC, University of Florence, Italy
Takayuki Morioka, Director DIS Project, Hitachi, Ltd., Yokohama, Japan
Marco Cappellini, CEO Centrica S.r.l., Florence, Italy

1. INTRODUCTION

The Project on "Excellence Digital Archive for Polo Museale Fiorentino", developed by MICC – University of Florence, Hitachi Ltd. and Centrica S.r.l., with supervision by Superintendent Cristina Acidini, is continuing its activities along the planned lines. Many important art-works of Polo Museale Fiorentino have been digitized at very high resolution:

1. Leonardo da Vinci, Annunciazione, Uffizi
2. Leonardo da Vinci, Adorazione dei Magi, Uffizi
3. Leonardo da Vinci, Battesimo di Cristo, Uffizi
4. Michelangelo, Tondo Doni, Uffizi
5. Tiziano, Venere d'Urbino, Uffizi
6. Caravaggio, Bacco, Uffizi
7. Caravaggio, Medusa, Uffizi
8. Piero della Francesca, Dittico di Urbino, Uffizi
9. Bronzino, Ritratto di Eleonora di Toledo, Uffizi
10. Botticelli, Madonna del Magnificat, Uffizi
11. Botticelli, Primavera, Uffizi
12. Botticelli, Nascita di Venere, Uffizi
13. Giotto, Madonna di Ognissanti, Uffizi
14. Raffaello, Madonna del Cardellino, Uffizi
15. Raffaello, Madonna della seggiola, Palatina
16. Lega, Il Canto dello Stornello, Museo d'Arte Moderna
17. Fattori, Libecciata, Pitti
18. Correggio, Adorazione del Bambino, Uffizi

Several technological improvements have been added since the starting of the Project.
Some developed activities in last year are described in the following.

2. DEMONSTRATIONS AND EXHIBITIONS IN ITALY AND CHINA

2.1 DC-NET International Final Conference

On 7 March 2012 the DC-NET International Final Conference has taken place in Rome, organized by Ministero per i Beni e le Attività Culturali - Istituto Centrale per il Catalogo Unico delle Biblioteche Italiane.

At the conference Cristina Acidini, Superintendent of Polo Museale Fiorentino, in her speech entitled "Seen near and almost inside: painting masterpieces and high definition", has explained the possibility to explore on line high-resolution images of the major masterpieces. Botticelli's Madonna del Magnificat and Birth of Venus, Michelangelo's Tondo Doni, Leonardo's Annunciazione, have been shown through a "beta version" of a Web site presented by Marco Cappellini, Centrica CEO. The Web site, developed by Centrica and powered by XLimage® technology, enables the interactive visualization of any detail of images of several GigaPixel through XLimage®. In the following a screenshot of the web site:

2.2 "Rinascimento a Firenze. Capolavori e Protagonisti" Exhibition

"**Renaissance in Florence - Masterpieces and Protagonists**" exhibition has opened on 6 July 2012 in Beijing till April 30th, 2013. The exhibition, which has inaugurated a permanent museum area, "**Space Italy**", at the National Museum of China in Tiananmen Square, the largest and most visited museum in the world, has brought the Italian masters of painting and sculpturing of the Florentine Renaissance in the Chinese capital city. Once crossed the entrance hall, visitors approach the **Narrative Room**, a didactic area where the main themes of the exhibit are illustrated in depth through innovative technologies and emotional contents: the Renaissance, Florence, the cultural and social context, the history, places and characters. Centrica has produced the multimedia videos that, in a semicircular itinerary, present the historical context, the artists and their artworks and the architectures.

At the center of the Narrative Room is set the first interactive installation with images of **Florence from 1480 to the present day**. With the installation, visitors can navigate through space and time in various maps of Florence, with the opportunity to know better and get closer to the most important monuments, highlighted in the maps. A selection of works of art from Excellence Archive of Polo Museale Fiorentino have been used inside the interactive installation, based on Uffizi Touch® architecture and technologies.

3. EXHIBITION “UFFIZI VIRTUAL MUSEUM” IN JAPAN

3.1. Outline

Following the success of "Uffizi Virtual Museum (UVM)" from November to December 2011 at the Italian Cultural Institute in Tokyo, the Italian Embassy in Japan, the Italian Cultural Institute in Tokyo and DIS Project of Hitachi, Ltd. have been promoting this exhibition for broader audience. Paired with the innovative mindset of Tokyo Fuji Art Museum and the Kyoto University Museum, two UVM exhibitions opened to the public at both museums. In addition, the Hitachi DIS showroom was established in Yokohama to present the main concept of UVM. By inviting students and general public for free of charge to this showroom, Hitachi has been conveying the importance of the digitization for Cultural Heritages while introducing Italian culture to Japanese people. In this chapter, the UVM exhibitions in the two museums and the DIS showroom are reported.

3.2. UVM in Tokyo Fuji Art Museum (29 June - 23 September 2012)

(All the content, including text and images, are published under the permission of Mr. Akira Gokita, Director of Tokyo Fuji Art Museum.)

3.2.1. About the Museum (http://www.fujibi.or.jp)

Tokyo Fuji Art Museum is located in the Hachioji City, Tokyo with a collection of approximately 30,000 Japanese, Eastern and Western artworks, including paintings, photographs, etching and woodcut prints, photographs, sculptures, ceramics, lacquer ware, swords and armors. Its collection of oil paintings from Renaissance, Baroque, Rococo, Neoclassicism,

Tokyo Fuji Art Museum

Romanticism, Impressionism to Modern Art provides comprehensive overview of 500-year history of European Art.

3.2.2. Contents of Exhibition

Main components in the UVM exhibition in Tokyo Fuji Art Museum, listed below, remain the same as in the Italian Cultural Institute in 2011. Each component was documented in the paper written for EVA 2012 FLORENCE.

(1) Life-Size Replica: 10 pieces
(2) Large-Size Display to highlight the official interpretation: 10 sets
(3) Digital Theater: 1 set
(4) Masterpiece Navigation: 3 sets
(5) Feel Uffizi: 1 set.

Flyer of UVM

3.2.3. Overview of Exhibition

The UVM exhibition was divided into three rooms for Replicas, Digital Theater and Masterpiece Navigation on the same floor as the museum's own collection. It was the first attempt to mix virtual exhibition with the real artworks in one venue. The large room was prepared to exhibit life-size replicas, providing the visitors calm spacious environment for art viewing appreciation. The touch-sensitive displays for interactive Masterpiece Navigation were adjusted at lower position for smaller children. As a special exhibition for summer holidays, it drew many families and students.

Entrance


Replica Room


Digital Theater


Masterpiece Navigation

3.3. UVM in the Kyoto University Museum (16 January – 24 March 2013)

(All the content, including text and images, are published under the permission of Dr. Terufumi Ohno, Director of the Kyoto University Museum.)

3.3.1. About the Museum (http://www.museum.kyoto-u.ac.jp/)

The Kyoto University Museum, located in Kyoto city, has more than 2.5 million objects in the fields of natural, cultural and technological history, including Japanese national treasures and internationally acclaimed type specimens. The museum's mission is to preserve and archive those historical objects, to offer scholars from both inside and outside of University the opportunity for advanced research and education, and to share the academic findings to other scholars.

3.3.2. Contents of Exhibition

Main components in the UVM exhibition in the Kyoto University Museum remain the same as in the Italian Cultural Institute in 2011. Each component was documented in the paper written for EVA 2012 FLORENCE.

The Kyoto University Museum

3.3.3. Overview of Exhibition

Because the Kyoto University Museum is specialized in both cultural and technological history, the concept of virtual exhibition utilizing the modern technology for the benefit of historical art was considered relevant. The exhibition was held also as a pre-event to commemorate the 50th anniversary of the sister-city partnership between Florence and Kyoto. Dedicated rooms for Replica and Digital Theater were built in the permanent exhibition space.

Flyer of UVM

Entrance

Replica

Digital Theater

Masterpiece Navigation

3.4. Hitachi DIS Showroom

3.4.1. About DIS Showroom

DIS Project of Hitachi, Ltd. opened a new showroom in Yokohama in October 2012. Main components from UVM exhibition are being presented to general public for free of charge. Its purposes are to introduce Italian Culture through our technology and to collect visitors' opinion and needs to improve our approach for better digital museum.

3.4.2. Contents of Showroom

Showroom Entrance

Replica
(Lectures to students)

Digital Theater

4. CONCLUSIONS

During the Excellence Digital Archive for Polo Museale Fiorentino Project, we have been researching and developing both the digital acquisition technology and the effective use of high quality image data. The exhibitions described in the paper had received critical acclaim for high degree of perfection on both individual component and the exhibition as a whole. In order to extend its popularity in various venues around the world, the flexible structure of the exhibition with appropriate components appears very attractive to meet the need of each Organizer in different condition.

UVM can be considered one of the successful applications for high quality image data. By improving components and systems through visitors' feedbacks, we aim for better digital museum that is accessible to everyone.

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VisLab OSAKA and Knowledge Capital Project

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Abstract – In this paper, we describe the unique "science park in the city project", *Knowledge Capital project (KC)* and one of its leading group, *VisLab OSAKA*. Knowledge Capital project is a unique urban development project which heavily relies on the human, information and technology as a capital in the city. By utilizing this capital, the city can disseminate a new creativity for future human life. VisLab OSAKA is interdisciplinary group of people from Academia and industry following KC concept. We describe the current status of KC and VisLab Osaka.

INTRODUCTION

In Spring 2013, in the north of JR Osaka railway station, among a 24-ha redevelopment zone (called "Umekita"), an area of 7 ha on the east side of the zone is developed and named GRAND FRONT OSAKA(Fig. 1). The lower floors of the central area (Block B) is called Knowledge Capital (KC) which has a unique concept. Its concept is described as follows:

"Knowledge Capital, by bringing together companies, researchers and creators with "human creativity" and "technology" from countries throughout the world, will result in a multi-complex to create new intellectual values through interaction and collaboration. As well as office workers, many visitors will come to this place for shopping and leisure. New products and services exhibited at Knowledge Capital will evolve to the higher level through evaluation of visitors with higher sensitivity." [1]

To promote its concept and bridging it reality, we are gathering interdisciplinary people from academia and industry. This group is called VisLab OSAKA[2]. In this paper, we describe the current concept of KC and VisLab OSAKA.

A brief history of Knowledge Capital

Concept of KC was born in 2004. When a JR large marshaling yard had decided to move some other area, town development promotion committee of north Umeda Station proposed a plan for development of this area in [3]. In [3], they propose a plan of KC where this area should develop as a base camp of creation and dissemination of information for future life where new knowledge is created and spread out to the world by using human, information, knowledge and technology as a capital. Based on the plan, the owner of the land, UR (Urban Renaissance Agency), offers a public subscription with condition to follow the proposed plan. After this public subscription, one joint venture lead by Orix real estate cooperation was decided as a developer of the area. From them, they are working hard to realize the idea of KC. Recently, two organizations, General incorporated association "Knowledge Capital" and "Knowledge Capital Inc." were built 2012 for continuous promotion and development of the concept.

Fig. 1 Grand Front Osaka and Knowledge Capital

Knowledge Capital Project

Knowledge Capital is considered as *a science park in the city*. It consists of multi-complex of Knowledge salon, Knowledge Theater, Collabo Office, Knowledge Office, Conference rooms, Future Like Showroom, Knowledge Capital Congres Convention Center and the showcase area, which is called *the Lab* (Fig. 2). In the Knowledge Capital, Academia, Industry and Government will come together to develop products which use advanced technology and are tried in the showroom. The concept of this advanced showroom is called the Lab.

The concept of the Lab. is a laboratory where new values converging on the Knowledge Capital are showcased. Researchers from Academia, Industry and Government show their research prototype at the Lab and get feedback from wide variety of visitors on KC. This feedback is expected to become a source of next inspiration.

This concept has been tried in the pilot exhibitions from Trial 2009, 2010, 2011 and final trial event, Knowledge Capital awards 2012. In these event, various groups from industry and academia who are candidates of tenants of KC join to show their latest technologies or prototypes. More than ten thousands people came to each event and enjoyed exhibits. Exhibitors also enjoyed feedback from audiences. In Trial 2011, also concept of Knowledge Salon is tested and show its feasibility.

The lab

A unique facility in the KC is its exhibition area called the lab. This 4 floors museum shows latest research results or prototype of products from companies. Important concept of this museum is audience's participation. When an audience enters this area, he/she is expected to become a subject of a research or a trial use of a prototype product. A researcher can get direct feedback of impact of his research from the general public. A company can get the feedback whether its prototype is liked to the ordinary people or not. Therefore, in this facility an audience is considered as a member of their research and development but still he can enjoy the exhibit.

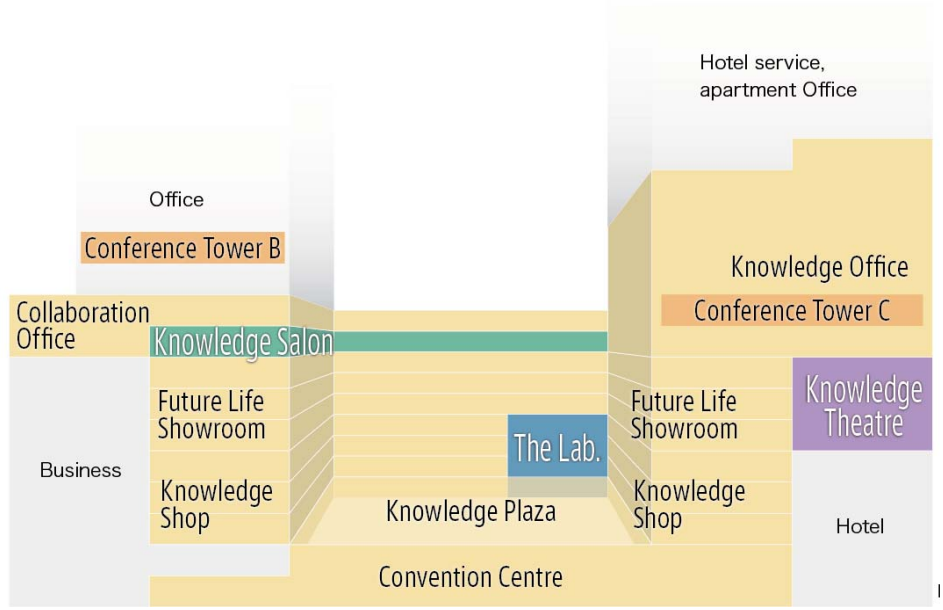

Fig. 2 Layout of Knowledge Capital

Concept of VisLab OSAKA

A number of researchers from universities, national institutes, and industry have agreed on the concept of KC and formed an interdisciplinary group of people called VisLab OSAKA. VisLab will have lent an office at 9th floor of KC and have a booth on 3rd floor of the Lab to show our collaboration results. Currently, the member of VisLab consists of Osaka University, Kansai University, Kwansei gakuin university, Osaka Electro-Communication University, NPO biogrid Kansai and Cyber Kansai Project. On the same 9th floor, there are also an office of CK-AMEI (Consortium Kansai Advanced Medical Engineering and Information) and NICT (National Institute of Information and Communications Technology).

For creation of new value and services, we think "visualization" is mostly important. Especially, one of the member of VisLab OSAKA in Cybermedia Center, Osaka University, thinks visualization of simulated result in a Supercomputer or other types of computer systems help many researchers and citizens to understand science and technology as a service and outreach. However, we extend this notion of "visualization" to include more wide variety of applications of visualization such as a new computer human interaction, information visualization and digital museum, etc. To pursue this wide range of applications, we need interdisciplinary teams of engineers, artists and designers. In the higher education field such as university, such interdisciplinary team worker is highly required. Many universities try to foster this type of new talent such as MIT media lab, D-school at Stanford or e-dream institute at University of Illinois(http://edream.illinois.edu/). VisLab is a group taking the same path as those institutes in inter university way. Each organization in VisLab has some special area. Cybermedia Center, Osaka University provides supercomputing and networking service within university and out of university. Therefore, visualization of the result of supercomputing is a part of user service. Osaka Electro-Communication University has Faculty of Information Science and Arts and lot of inter-art and culture students who has interest in gaming, design and art, etc. Kwansei Gakuin University has a strong CHI research. Kansai University is very strong at Computer Graphics. CyberKansai Project is a team of network researchers and engineers consists of industry and academia. NPO agency biogrid Kansai promotes in-silico drug discovery who liaise with industries. We will have several activities jointly in KC.

Among this interdisciplinary group, we produce several works with the collaboration of museums such as Giotto's "Polittico di Badia" and Takamatsuzuka Tumulus in interactive Tiled Display, myGallary Interactive.

As the help of CyberKansai project, we extend two national research backbone networks, SINET4 and JGN-X in many area such as Knowledge office, the lab, and Knowledge Theater, etc. in the KC. SIENT4 is a national academic network backbone which connects almost all university in Japan and provides international connection to other Research and Education network. JGN-X is a network testbed for research and development and academia and industry can use it free of charge. Those network infrastructure in KC provides experimental network in the KC which expected to be used in the new R&D such as Future Internet.

In the 2nd floor of the lab, there is a big space suitable for about 50 people to have a workshop or an event, called Active studio. In the Active studio, we set up a 8-tiled display wall and connect it to the experimental network. Using this environment, we can perform a remote conference as we did in Trial 2009. This 8-tiled display becomes one of cybercommons site[4].

NICT (National Institute of Information and Communications technology) and VisLab has an agreement to share its office spaces at 9th floor and the 8-tiled display wall in the active studio. NICT performs research on the ultra high definition 3TV with SDN (Software Defined Network) and applications of future internet technology. NICT provides Multiview 3D display on 3rd floor of the lab and a 10-tiled 3D wall and 24 tiled wall on the 9th floor.

Conclusion

In this paper, we describe about a unique science park project, called Knowledge Capital in Osaka and one of leading group of KC, VisLab OSAKA. We are now preparing for opening of KC on 26th April, 2013.

ACKNOWLEDGMENTS

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"3D TECHNOLOGIES AT THE MUSEUMS" A PERSPECTIVE OF THE STAATLICHE MUSEEN ZU BERLIN (NATIONAL MUSEUMS IN BERLIN)

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A THE 2D PERSPECTIVE

Providing access to the rich, often highly fragile and endangered Cultural Heritage is an objective of primary importance. Digital representation and electronic documentation of entire collections can be regarded as a commitment to the future and a contribution to preservation and development. It is both beneficial to scientific research, and comfortable for the public. In close co-operation throughout the libraries, archives and museums under the auspices of the Prussian Cultural Heritage Foundation the National Museums in Berlin have envisaged this as a mission.

However, the disposability of the treasures of our past in textual and visual reproductions, though seemingly a modern challenge of the information age, is not a recent concept. The dissemination of graphical images and copied replicas of a collection's holdings can be traced right back to the origin of the Museums themselves. Increasing demands of contemporary audiences and prestigious distinction of courtly collectors established a market for high-quality and most authentic reproductions already in times of early copperplate printing. Improved techniques like lithography and, finally, photography fostered this market and allowed for reproductions of the greatest possible likeness.

Actually, digital imaging carries the day and has replaced photography as a prevailing media. High-resolution images are widely accepted for most purposes of documentation, preservation and a world-wide distribution via electronic channels. These offer ubiquitous access to the collections at affordable prices and with high availability. And they meet, in short, the expectations of either industry or the generic audience.

The rapid success of 2D-digital imaging at Museums and Archives is worth to be noticed. It is obviously based on long traditions mentioned here above. This has to be kept in mind when comparing it to the modest deployment of 3D-modelling techniques in the CH-sector. While 2D-imaging has reached the mass-market in less than 20 years time, 3D modelling still plays a rather marginal role. Although most of the artefacts of our collections are of 3dimensional size, the use of adequate 3D-technologies for representing objects in a virtual environment seem to be reserved quite exclusively for archaeological research and single preservation efforts. Public resonance and outreach of the museums are mainly based on the 2dimensional perspective.

B THE 3D PERSPECTIVE

A change of attitude arises with significant delay. It is only for the last few years, that 3D-TV and interactive applications, multimodal interfaces and augmented reality applications have

shaped the consumer's expectations. Relevant technologies, like HTML5 and Web-GL, which are fundamental for entering the mass-market, have only recently been standardized.
Nonetheless, the potential of 3D modelling is now on the horizon for any of the museum's objectives. A focus should be set on the following options:

- Easy integration of digital 3D-replicas in different media and contexts,
- implementation of 3D-models to support the museum's workflows, facility-management, and documentation,
- virtual representation of the collection and attractive outreach,
- physical replicas on the bases of a digital 3D-model,
- re-use of authentic 3D-models in supported industries, edutainment and interdisciplinary research.

At the Staatliche Museen zu Berlin this potential has been recognized. 3D-scanning and the use of 3D-models form a circuit of our strategy towards the digitization of the collections.

C PILOT PROJECTS

Several projects have been initiated over the last years to gain experience with 3D-capturing in different areas of application. A selection of five projects shows a varying bias and equipment.

1. Documentation of mesopotamian cylindric seals at the Museum of the Ancient Near East.

A co-operation of the excellence-cluster TOPOI (cf. www.topoi.org) and the Museum of the Ancient Near East led us to scan in 3D about 1.400 babylonian and mesopotamian rolled seals from the Museum's collection. A structured light 3D-multi-sensorsystem with variable resolution has been provided by the Fraunhofer Institute for Applied Optics and Precision Engineering. The "kolibri MULTI" scanner (http://www.iof.fraunhofer.de/de/produktblaetter-k-o/kolibri-multi.html) allows for geometric models of high resolution. Small objects with an average size of 10 cm hight can be scanned with measurement uncertainty from 1µm to 5 µm. One of the objectives of the project has been the rendering of images of the seals. The geometric models of the cylindric seals were virtually rolled out to show coherent and calibrated 2dimensional views of the depicted narratives.

2. Research in the Egyptian Museum using RTI

Reflectance Transformation Imaging (RTI) is a low-cost and user-friendly method that captures a subject’s surface shape and colour with a set of interactive lighting of the subject from any direction. At the Egyptian Museum RTI has been introduced as means for the documentation of finds during archaeological excavation. (cf. http://culturalheritageimaging.org/Technologies/RTI) The RTI does not create geometric models but allows for analytic studies of 3D-objects from any possible angle and lightning direction.

3. Simulation and reconstruction of original showplaces: Santa Croce in Florence

A sounded reconstruction of the altarpiece of Ugolino de Nerio in Santa Croce (about 1325) has been the objective of a complex and elaborate 3D-animation of the choir chapel. The interactive animation shows an integrated composition of the altarpiece on the bases of the surviving fragments. The reconstruction of the original architectural setting of the church allows for greater insight into the complex interaction of architecture, windows, light and perspective. (cf. Weppelmann, Stefan / Winkler, Stephan: Digitale Kunstgeschichte? Eine

Fallstudie an Ugolinos Altarwerk aus Santa Croce, in: Geschichten auf Gold - Bilderzählungen in der Frühen Italienischen Malerei, Berlin, 2005.)

4. Physical reproduction of the collection's objects at the Replica Workshop in Berlin

The Replica Workshop of the National Museums in Berlin owns a unique collection of 7000 replicas of works of art of the collections. More than any other material, plaster is ideally suited to recreate faithfully the intricate details of historical original objects. But many of the old moulds incur wearouts and damages over the years. Cloning of new moulds from the original is not recommended by preservation reasons. 3D-scanning has therefore been considered as an appropriate and easy going approach. With the busts of Nefertiti and Teje from the Egyptian Museum a pilot application has already been explored. A co-operation project of the Replica Workshop, the Egyptian Museum and the Technische Universität Berlin is focused on the development of a hybrid manufacturing workflow of moulds from a digital 3D-model.

5. CultLab3D

The joint project CultLab3D covers the issue to speed up the expensive and time-consuming procedures with which cultural assets can be digitally recorded in 3D. The new approach brings out three main aspects:

- an innovative mobile digitisation laboratory, called "CultLab3D",
- use of semantic technologies to integrate and spatially link 3D-models to multimedia information already present in museums and to its metadata,
- new business models for 3D-objects of the Cultural Heritage.

CultLab3D takes into account mainly selected classes of objects such as vases, coins, weapons and busts. The National Museums in Berlin – Prussian Cultural Heritage Foundation support and participate in the project. The consortium is composed of technical partners: Fraunhofer Institute for Computer Graphics Research (FhG-IGD, co-ordinator), Polymetric GmbH, , Architectura Virtualis GmbH and the Forschungszentrum Informatik (FZI).

D FORUM KULTUR IN 3D

The survey of 3D pilot-projects reveals a bunch of pragmatic and useful results. But one quite fundamental experience should not be overlooked. Still today, 3D projects require not only an ample and expensive technical infrastructure but also skilled engineers and well-versed operators. Reliable guidelines and best practice rules are still a desiderate as well as the integration of complex data-assets into the ordinary data-management, access strategies and effective longterm-storage mechanisms of the museums. Suggested demands, therefore, concern a further simplification of handling and service, the reduction of costs, the development of workflows and institutional knowledge transfers.
A caucus for discussion and exchange of expertise in this sense is the newly founded "Forum Kultur in 3D". It is an ambitious platform to pool and consolidate relevant activities in the 3D-digitalisation and to allow for impartial technical advice. Based on the results of the former CEC-project "3D Coform" (cf. http://www.3d-coform.eu) it is led by the Fraunhofer IGD (https://www.igd.fraunhofer.de/Kulturerbe) and open to any member from the cultural heritage sector.

EC PROJECTS AND RELATED NETWORKS & INITIATIVES

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EUROPEANAPHOTOGRAPHY: EARLY PHOTOGRAPHY ACCESSIBLE IN EUROPEANA

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Abstract – EuropeanaPhotography is an EU-funded digitization project that will provide Europeana with over 430.000 of the finest examples of early photography, for an impressive increase in the number of photos available in the Europeana. These photographs provide a unique insight into the evolution of European society and of the art of photography between the 19th and 20th century, which is a valuable source for research in many fields (history, economics, sociology…). EuropeanaPhotography will also enrich Europeana with materials from countries with a currently limited display, for a wider overview of European history.

INTRODUCTION

EuropeanaPhotography is a CIP ICT PSP pilot B project with the principal objective to select, enrich and digitize masterpieces of early photography, and to contribute the relative metadata and thumbnails to Europeana, the European digital library (www.europeana.eu). The consortium includes both public and private bodies with very different backgrounds, thus providing a variety and richness of content. Moreover, several partners come for the first time in a Europeana-feeder project, also belonging to those European countries - such as Bulgaria, Slovakia, Lithuania and Denmark - that are still under-represented in Europeana. They will contribute original content for the first time ever, thus enlarging and enriching the pan-European approach of Europeana. The General Coordinator of EuropeanaPhotography is the Institute for Cultural Studies of the Katholieke Universiteit Leuven; Promoter S.r.l. provides the Technical Coordination.

Project objectives

EuropeanaPhotography will digitize, enrich and then contribute to Europeana over 430.000 early photographs. Content selection and digitization form the basis of the project. Further steps are: the multilingual enrichment (through the EuropeanaPhotography vocabulary, especially designed for the needs and specifics of the EuropeanaPhotography consortium), and the aggregation of metadata via the MINT system[1], which allows the metadata mapping and the final ingestion of the digital content into the Europeana system. To support the consortium and to develop a safe and valuable environment for both public and private bodies, the project foresees very strong functions related to IPR issues and sustainability. Within the project, moreover, the commercial benefits of working with Europeana will be highlighted and clarified, in order to attract new content providers from the private sector in the future.

Work done so far

The project has just successfully closed its first year of activities, achieving very good results. A dedicated work-package was focused on the content of this project's contribution to Europeana: digitized photographic images, tracing the evolution of European society and the

art of photography, from 1839 (first images by Niepce in France) to 1939 (start of the WWII). The tasks constituting this work package were directed to the selection of images to be delivered to Europeana's database. The process was coordinated by KU Leuven, but the actual selection was carried out by each of the content providers. They were guided by the following criteria: Masterpiece quality and impact; General interest and appeal; Complementarity with existing material in Europeana; Synergy with content from other providers. As a result of this process, a deeper understanding of the richness and true value of the EuropeanaPhotography collections has come up. Since the partners had the opportunity to explore their collections, hidden treasures have been – and will keep on being - discovered throughout the project period.

As EuropeanaPhotography is a digitization project, another of the main objectives for year one consisted in establishing and preparing standards for digitization and image quality, so as to align the content providers to the most recent technologies and procedures for preparation of early photos and digitization techniques. A particularly important achievement so far is the development of a multilingual vocabulary for early photography, which currently consists of over 500 concepts in three facets – photographic technique, photographic practice and keywords – structured hierarchically. This vocabulary is completed in 12 languages and it will be used in the annotation, translation and semantic enrichment of the metadata. Discussions with other projects, in particular Linked Heritage[2], are on-going, to improve the EuropeanaPhotography Vocabulary as a starting point for other useful multilingual tools to enrich digitization activities (both for photography and for other types of cultural heritage). The technology at the base of the mapping and ingestion process is the MINT platform, a web-based software for the aggregation of metadata that is currently used by Europeana and other projects of the Europeana ecosystem. The tool, customized according to EuropeanaPhotography requirements and including the already mentioned photography-specific multilingual vocabulary, is ready and fully working and helped in preparing the initial slot of about 12.000 images, ready to be published in Europeana.

A dedicated work-package in the project is devoted to the analysis of IPR issues and sustainability solutions. An IPR Committee is reflecting upon the requirements and needs of all partners - both private companies and public bodies - in order to define the priorities and a valid strategy to comply with the Europeana standards. On the side of sustainability, the project will reflect upon the benefits for private and public partners from the presence of their photos in Europeana, in order to establish a viable ongoing service with commercial potential or another workable funding model.

The EuropeanaPhotography collection

Within the project consortium 16 partners can be designated as content providers. Some are public institutions or institutions with a public mission, such as museums, archives and universities (KU Leuven, ICCU/SGI, Polfoto, CRDI Ajuntament de Girona, GenCat Cultura, Nalis, MHF, Arbejdermuseet, Divadelny Ustav, ICIMSS, Lithuanian Museums), others are privately funded photo agencies (TopFoto, Imagno, Parisienne de Photographie, United Archives, Alinari). This unique blend has not only given rise to spirited discussions on the shared responsibility towards the preservation of European heritage - a valuable contribution towards Europeana - but also to a better understanding of early photography. At a seminar in Leuven, Belgium (12-13 April 2012), where content providers showcased their collections, a wide array of images was unveiled: a combination of treasures of early photography never before disclosed to the public. Also at the seminar, the consortium agreed upon a definition of "photographic masterpiece", that has served as a guideline throughout the establishment of what might be called "the EuropeanaPhotography Collection".

This collection, which will eventually be fully available through Europeana, counts no less than 430.000 images and spans the period 1839-1939, capturing city and family life, sports, portraits, landscapes, politics, colonial and war history, and thus reviving the history of

Europe through prosperous as well as difficult times. Besides top images from valuable collections and renowned photographers, it boasts the photographic heritage of Europe's newest member states, offering a fascinating view on a chapter in the canonical common European historical narrative that hasn't even fully been written yet. Each of the project partners has managed to bring a distinctive and superior selection to the EuropeanaPhotography Collection. KU Leuven's choice from its university library archives sheds light on 19th and 20th century educational usage of images. Alinari draws from the archives of Alinari24Ore and Fondazione Alinari, offering a "Grand Tour" across Italy. The image selection of Central News, Alfieri, Planet News and John Topham collections (TopFoto) and the Agentur Schostaland Christian Brandstätter collections (Imagno) each contain exceptional and high-quality images. At Parisienne de Photographie, images from the Maurice Louis Branger archive, portraits by Boris Lipnitzki and Parisian scenes by Gaston Paris are the undisputed highlights. United-Archives will add a.o. the Carl Simon archive, the KPA collection, the Andres and IFTN archives and a film still collection. ICCU offers a selection from the Historical Fund of the Photographical Archive of the Italian Geographical Society (SGI), containing ca. 30.000 photographs acquired from 1867 until the 1930's. Polfoto contributes images by press photographers Holger Damgaard and Tage Christensen. Provided by CRDI are images related to the Rif War and portraits of cinema stars, utilizing a great variety of early photographic print processes. Gencat Cultura and Catalan Cultural Institutions have selected images of great aesthetic value and historical importance, as well as photographs documenting changes in society, culture, economy, etc. Krakow's Museum of History of Photography chose images that offer a panoramic view on its entire collection and include almost every type of early photography practice. The Arbejdermuseet collections document the formation of modern society focusing on everyday life, while Theatre Institute Bratislava's pick discloses a visually attractive story of the Central European theatre and theatricality. Two project partners are breaking ground in exploring unknown treasures of their photographic holdings. ICIMSS collections will present material that has remained hidden up till now and will enrich the documentation of Polish history. The contribution of NALIS explicitly aims at the exploration of unknown collections as well: as a knowledge broker, NALIS will build bridges between the content owners, the consortium and Europeana, at the same time granting local museums and archives access to the professional knowledge of the EuropeanaPhotography consortium. This dynamic "treasure hunt" will undoubtedly prove to be a fruitful venture and has a clear added value for the project as a whole.

The digitization activity

During year 1, the consortium organized specific workshops for the content providers, to deeply discuss and agree upon methodologies for digitization and metadata usage. First, in Leuven (April 2012), the consortium agreed on the digitization standards (resolution, image format, colour depth, etc.). At the same occasion, there was a review of the metadata schemes used by each content provider, an analysis of requirements for any extra metadata fields on a provider-by-provider basis, and an assessment of the need for support to generate metadata in XML format, again for each provider.

The content providers then met in Girona in May, for a 14-hours workshop intended to provide an overview of the available systems for original photographic materials digitization as well as the procedures, in order to obtain the best results in terms of image quality and fidelity to the original. The teachers for this workshop were professors from the Polytechnics University in Catalonia (UPC). The workshop provided content providers with several recommendations and hints for a good practice, resulting in a digitization workflow that can be briefly summarized as follows:

1. Digitization should be done by camera better than by scanner. The use of camera avoids physical contact with the original and has virtually no limits in terms of original properties and sizes.

2. Lighting for digitization with camera should be provided by electronic flash strobes. It allows for very short exposure times that prevent the camera from shaking at large magnifications and provide better sensor response.

3. The camera lens must be as good as free of distortion (best options below 1%); this is not possible with zoom lenses.

4. The camera lens resolution must be tested in order to find a useful aperture range, thereby avoiding aberrations when fully opening, and diffraction effects when closing the diaphragm.

5. Depending on the resolution needed for a given application, the more pixels on the sensor, the lower the diffraction limit will be at smaller apertures. A possible solution is to increase the physical sensor size.

6. Sensors without anti-aliasing filter (optical low pass filter or OLPF) can produce image artifacts taking pictures from textures with small details periodically structured

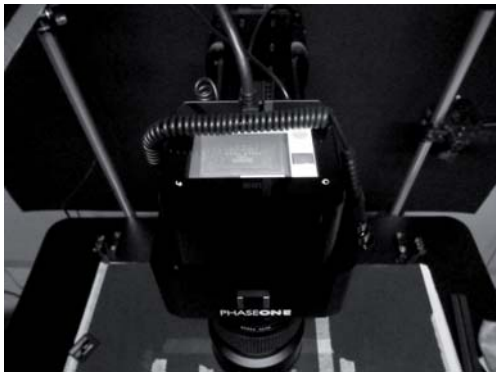
7. Screens must be calibrated in order to visualize image colors accurately and to process images correctly. It is important to know the color space of the screen and avoid the visualization of images with wider color spaces; working with ProPhotoRGB is not recommendable to visualize images.

8. When applying a new ICC profile (or standard color space) it is important to know the difference between Assigning and Converting, as the result is different.

9. Working with RGB color spaces is the recommended option to process and archive images, because it has a higher bit depth than grey scale images and wider color ranges than CMYK color spaces.

Example of storage room and long term preservation area

The photographic identification process using a 30x microscope



Example of a digital camera back device (PhaseOne/Leaf Aptus-II 80 megapixels CCD)

Cambo repro stand

Expected Outcomes For Year 2

From February 1st, 2013, the project has entered into its second year of activity, in which the objective of 250.000 digitized images (100.000 published in Europeana), has to be achieved. Digitization, metadata mapping and enrichment will be main activities for the content providers. As a consequence, a great effort will be necessary from the digitization supervisors deployed in each content provider to follow the project recommendations produced so far, in order to assure a proper, timely and qualitative content delivery. Furthermore, several dissemination and exploitation activities are planned, and big results are expected within the domains of IPR and Sustainability. With these efforts, EuropeanaPhotography will continue to establish itself as a role-model for any public-private partnership in the field of cultural heritage, and of photography in particular.

DISSEMINATION

The EuropeanaPhotography project adopted an integrated approach for the dissemination activities using different communication platforms and channels and enjoying the cooperation of the whole consortium. The publics that are targeted reflect the diversified composition of the project consortium, that includes stakeholders both from the public and private sectors.

The EuropeanaPhotography website [3] has an institutional communication approach because it is intended as a window of the project's main outcomes; it collects institutional information related to the project partners, life, events and news about both digital cultural heritage and photography; Europeana, that will benefit from the partner's contributions, has a dedicated section with the main relevant information and a direct access to its database thanks to the integration of a Europeana API. The publics that the project website mainly intends to reach are those working in the Europeana environment: the Europeana Foundation itself, the group of Europeana feeding projects, the experts from cultural institutions working in the field of digital cultural heritage and the European Commission.

On the other hand, EuropeanaPhotography enjoys a dedicate showcase on digitalmeetsculture.net [3]: an interactive magazine managed by Promoter srl, where culture and digital technology collide. Articles about the EuropeanaPhotography activities, events, and milestones, as well as a dedicated newsletter are published in this showcase; moreover, the partners have the chance to give visibility to their role in the project thanks to interviews and dedicated editorials. This showcase can reach both a specialized public made out of digital cultural heritage experts and photography professionals, as well as a wider public of people interested in these topics thanks to its magazine nature. Digitalmeetsculture.net also hosts the project's internal repository.

Project website (www.europeana-photography.eu)

EuropeanaPhotography showcase on Digitalmeetsculture.net (http://www.digitalmeetsculture.net/heritage-showcases/europeana-photography/)

Recently, the project opened a Facebook page [3] with a twofold scope: reaching a wider public of people interested in photography (and redirect them to the website) and allow the EuropeanaPhotography partners to have a fast and easy-to-use platform for disseminating the images they are digitizing for the European portal, telling the wonderful stories that those pictures illustrate.

EuropeanaPhotography is present at several national and international events; next main appointment will be from 9 to 11 September in Vilnius, within the framework of the Lithuanian presidency of the European Union, when, besides the project plenary meeting, an early photo exhibition as well as cultural and educational open events will take place.

ACKNOWLEDGMENTS

This research is partially funded by the Competitiveness and Innovation Framework Programme (CIP) (http://ec.europa.eu/cip/)

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[1] The MINT mapping tool system is a web based platform, developed by NTUA (the National Technical University of Athens), that was designed and developed to facilitate aggregation initiatives for cultural heritage content and metadata in Europe. http://mint.image.ece.ntua.gr/redmine/projects/mint/wiki/Introduction

[2] Linked Heritage is a best practice network with the main objective to facilitate and deliver large-scale, long-term enhancement of Europeana's content and services. http://www.linkedheritage.org/

[3] EuropeanaPhotography main dissemination internet channels: Website: http://www.europeana-photography.eu/, Facebook page: http://www.facebook.com/pages/EuropeanaPhotography/389351434475298 Showcase on Digitalmeetsculture.net: http://www.digitalmeetsculture.net/heritage-showcases/europeana-photography/;

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REENGINEERING AND CONSTRUCTION OF A RELIEF FOR AN ORGAN LOFT BASED ON DRAFTS BY FRIEDRICH PRESS

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Abstract

Beginning in 1970, Press redesigned the interior of the St. Joseph's church (Josephskirche) in the Dresden district of Pieschen. Friedrich Press was responsible for the appearance of more than 40 churches both in the GDR and in Western Germany. At first glance, the church interiors created by Friedrich Press are confusing. They are in strong contrast to the bombastically designed baroque buildings of Dresden. Unfortunately, he did not have enough time to implement a draft of a relief alongside the organ loft for the St. Joseph's church in Dresden. At present, the congregation has available a physical 3D scale model (approximately 1:20) illustrating Christ's ordeal. In addition to this model, there are also drawings showing the contours of the full-scale figurines.

INTRODUCTION

Having completed his education as a wood- and stone sculptor in Münster from 1924 to 1926, Friedrich Press (7.9. 1904 – 5.2.1990) attended the College of Applied Arts in Dortmund. Afterwards, he studied in Berlin and in Dresden. Until 1935, he lived and worked as a freelance artist in the vicinity of his native town. In this period, he created his famous "Christ head", which attracted significant attention at exhibitions in Münster and Berlin in 1932. His work soon met with resistance from the National Socialists, his Art was labeled "degenerate". In 1946 he returned after being a prisoner of war to a destroyed Dresden and concentrated in his work on sacred art and church interior design. Beginning in 1970, Press redesigned the interior of the St. Joseph's church (Josephskirche) in the Dresden district of Pieschen. Friedrich Press was responsible for the appearance of more than 40 churches both in the GDR and in Western Germany. At first glance, the church interiors created by Friedrich Press are confusing. They are in strong contrast to the bombastically designed baroque buildings of Dresden. The Pietà in the Hofkirche (court church)/ cathedral in Dresden, the biggest sculpture ever made of Meissen porcelain, is one of his most famous works.

Unfortunately, he did not have enough time to implement a draft of a relief alongside the organ loft for the St. Joseph's church in Dresden. At present, the congregation has available a physical 3D scale model (approximately 1:12) illustrating Christ's ordeal. In addition to this model, there are also drawings showing the contours of the full-scale figurines.

Plans have been announced to use the 3D design to create a real relief as Friedrich Press intended, but was unable, to do. The implementation will be computer-assisted (3D scanning, surface calculation, CNC milling, artistic modification and moulding, 3D scanning again, Virtual Reality,…) and will involve extensive cooperation among members of the congregation, researchers and students from the Dresden Academy of Fine Arts, and art historians and engineers from the University of Technology Dresden.

1. INITIAL SITUATION: THE NAVE

In the sanctuary (view from the organ loft, see Figure 2), the scene ”The new Jerusalem“ is shown. The figures on scene are depicted in a very abstract and angular form.

Figure 1: Nave interior, view from sanctuary to the wainscoted organ loft

Overall, the design of the nave is modern and bright. At present, the back of the organ loft is covered in wood, but the intension is to adorn it with the “Passion, death and resurrection of Jesus Christ” by Friedrich Press in the future.

Figure 2: Sanctuary and nave flooded by light; view from the organ loft

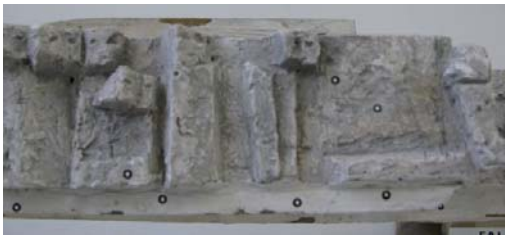
In the sanctuary (view from the organ loft, see Figure 2), the scene ”The new Jerusalem“ is shown. The figures on scene are depicted in a very abstract and angular form.

2. THE CLAY MODEL AND THE SKETCHES

Figure 3: Draft of the “Passion, death and resurrection of Jesus Christ” as clay model (scale 1:20)

The clay model depicts the passion, death and resurrection of Jesus Christ from left to right. This model is available on a scale of 1:20. Selected motifs are listed and shown in Table 1 below.

Table 1: Motifs and group of figures in the passion

Nativity scene (crib in stable)	Behold your Lord, Immediately the cock crowed
	
The risen Jesus in front of the cross	Our sorrow for things Jesus has not given (miracle of the loaves, transformation of water into wine, incarnation of prosperity as, for instance, a car or weekend house; peace)
	
The empty tomb, Sleeping watchman	Ascension
	

Additionally, we have available several pells showing the passion, death and resurrection on a scale of 1:1. In Figure 4, a detail of the group of figures called “Ascension and sleeping watchman“ is illustrated. The Roman numerals 0, I to IV indicate the layer, where 0 is the back of the organ loft. The task was to determine the difference in height between the layers. To do this, the clay model was subjected to 3D digitising and surveying. The distance between the layers was found to be 120 mm.

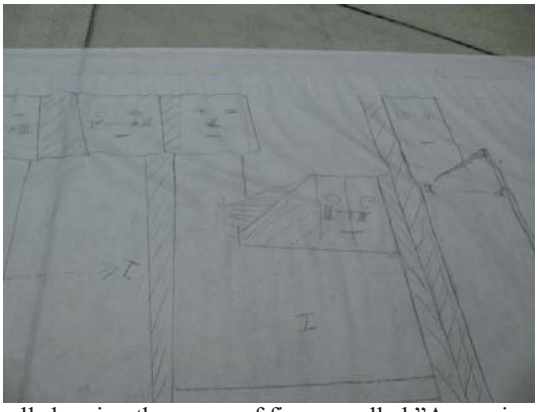


Figure 4: Detail of a pell showing the group of figures called ”Ascension and sleeping watchman“

3. IMPLEMENTATION

3.1 Digitising

The available clay model was scanned with a 3D scanner. We used a structured light scanner, which is in wide use in the mould- and diemaking business, of the type GOM-ATOS Triple Scan [1]. For scanning, the mean range of view (250mm x 250mm) was applied, which provides a 20 µm resolution. After meshing by means of the GOM software, we obtained a triangulated surface (Figure 5) that can be made available in exchange format STL for further processing.

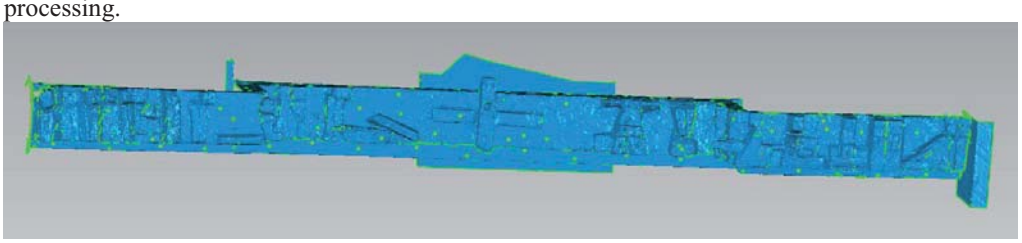


Figure 5: Digitised clay draft of the passion, death and resurrection of Jesus Christ by Friedrich Press

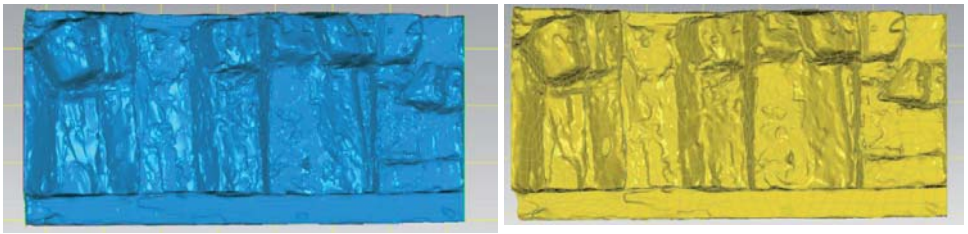


Figure 6: Detail of a fragment group “Ascension and sleeping watchman“, as STL-model (left) and as a surface model

3.2 Data conditioning

For scan data conditioning, the following sequence of operations had to be performed:

1. Elimination of unnecessary areas
2. Alignment in co-ordinate system

3. Closing of gaps
4. Magnification by a factor (x 5)
5. Segmentation into partial areas; 8 were generated altogether
6. Reverse Engineering to obtain Spline surfaces

These operations are performed by means of GEOMAGIC Studio [2]. Creating the parts' representations was time-consuming, requiring approximately one hour per partial area. Reverse engineering is required in order to enable follow-up CNC programming.

3.3 Creating the model on a larger scale

In the next step, the individual parts (model material) are CNC milled to scale. A detail is shown in Figure 7.

Figure 7: Detail of the passion, death and resurrection of Jesus Christ, CNC milled in model material

3.4 Ongoing implementation

Scaling of pattern models on a magnified scale entails a risk that unevennesses and inaccuracies may also be magnified. This is also the case in the existing draft. For this reason, it is impossible to use this method. In fact, we rely on "redesign" of the sculpture groups by means of 2D sketches. We use the design software SolidWorks [3].

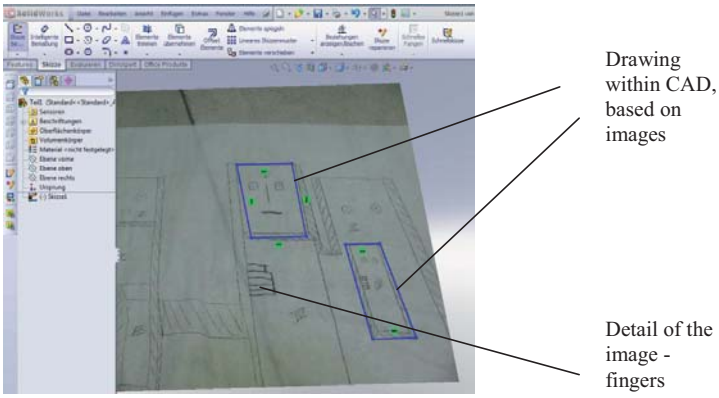


Figure 8: Sketches in SolidWorks

It is first necessary to take photos of the pells, to deskew the photos and scale them to the correct size. The deskewed photos scaled to the correct size will then be imported into SolidWorks as sketches, the contours will be retraced, and the figures will subsequently be reproduced in a linear manner.

Afterwards, the 3D model of the passion, death and resurrection of Jesus Christ and the church interior will be created as a virtual scene and evaluated in a CAVE as well as on a power wall.

In the next step, the shapes have to be CNC milled. Structuring of the surface is a process that cannot be done in an automated manner and/ or by means of machines. The structure will be created by hand.

4 SUMMARY

For the organ loft, a 3D pattern model on a scale of 1:20 and drawings on parchment on a scale of 1:1 are available as a representation and for modelling of the passion, death and resurrection of Jesus Christ. The artist's idea can be brought to life through a combination of computer-assisted work and artistic handicraft.

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The project is sponsored by the EU

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3D IN ARCHAEOLOGY: 15 YEARS OF RESEARCH. THE ROLE OF EU PROJECTS

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Abstract – The paper describes the contribution of EU-funded research to the advancement of the use of 3D technologies in archaeological applications. Starting from the most recent – and perhaps most important – EU project ARIADNE, it critically examines the role of 3D computer visualization, tracing back the evolution of such applications since the end of the 20th century.

Introduction

The number and size of archaeological digital repositories is becoming a challenge. As discussed in [1], archaeological investigations produce and require increasingly larger datasets, where for example the results of scientific analyses on materials or large models of sites and monuments are stored. It happens often that past cultures correspond to territories now split among different modern countries, so records are organized in different ways and compiled in different languages. These problems motivated the need of setting up a project integrating the diverse research infrastructures hosting archaeological data. This project is named ARIADNE (www.ariadne-infrastructure.eu) and is funded by the European Commission under the FP7 research Infrastructures programme. ARIADNE stands for Advanced Research Infrastructure for Archaeological Datasets Networking in Europe, but also recalls the thread that the mythical Ariadne provided to escape from the Labyrinth.
ARIADNE has a duration of four years starting from 1st February 2013. Its goal is the integration of archaeological repositories into a Europe-wide research infrastructure made of interoperable datasets, with a harmonized interface and a unique approach to data storage. Of course, integration will proceed by clustering datasets that are homogenous as far as content is concerned. The integration process will rely on a common metadata schema based on and compliant with CIDOC-CRM (cidoc-crm.org), the ISO 21127 standard for the documentation of cultural heritage, which will be extended to incorporate the needs of different subdomains such as archaeological 'grey literature', i.e. unpublished excavation records; and dendrochronology, the well-known dating system based on tree rings. The project will develop innovative services based on an in-depth analysis of the needs of the research community. Another activity will concern the exploration of new avenues in archaeological research opened by the availability of integrated datasets: for example, advanced 3D visualization methods enabling the use of digital replicas, instead of originals, for research.
The ARIADNE partnership includes 24 partners from 16 EU member states, and is coordinated by PIN, the educational and research centre based in Prato, Italy.
In this perspective, the present paper synthetically analyses 15 years of progress in the use of 3D visualization in archaeology. We take as start date the 1998 CAA Conference in Barcelona where a special symposium addressed the applications of virtual reality in Archaeology.
We will show that EU-funded projects have played a paramount role in advancing research and improving good practices in this domain.

1. 3D and archaeology: the dawn

The above-mentioned 1998 symposium marked a turning point in what until then had been an occasional use of virtual reality techniques to re-create the past appearance of archaeological monuments. Usually, the 1990 paper by Paul Reilly [2] is acknowledged as being the very first (or at least one of the first) application of virtual reality technology to cultural heritage. The first use of the term 'Virtual Archaeology' must be ascribed to this paper. After the publication of a popularizing volume by Forte and Siliotti [3], the 1998 CAA Conference attempted to systematize this topic, publishing the results in a separate proceedings volume [4]. It is clear that apart from a few insulated attempts of using visualization techniques for research, e.g. to reconstruct the appearance of a deceased person from his facial bones, the 'core business' of virtual archaeology in those times was communication and dissemination. 3D visualization was seen as an effective storytelling tool, informing the public at large of what could have been the past appearance of buildings and sites, nowadays reduced to heaps of stones, and visually communicating the imaginative interpretation of archaeologists. The scholars' reactions to this approach waved between the enthusiasm of a small but combative group of innovators, and a large majority of traditionalists who confined these techniques to mass dissemination use, when not directly in the realm of games.
The VAST conference, taking place for the first time in the year 2000, and its proceedings [5] published shortly afterwards, complemented the CAA1998 volume [4] by presenting the outcomes of another important research thread, expression of the 3D visualization community and supported by EU funding. It also collected the reaction of a number of researchers which favoured the introduction of state-of-art technology in archaeology but started expressing serious concern about the misuse of 'pretty pictures'. This was clearly expressed in [6], indicating solutions to give sound cultural bases to technological solutions.

2. Early EU projects on 3D visualization

Within the FP5 'Information Society and Technology' programme, an objective addressed the use of advanced visualization techniques for communicating cultural heritage. The related calls were managed by the Digicult Unit then directed by Bernard Smith. A substantial number of projects were funded, many of which consisted in small projects circumscribed to a limited scope and application in special cases only. Among the projects with a wider perspective, CHARISMATIC (Cultural Heritage Attractions Featuring Real-time Interactive Scenes and Multi-functional Avatars as Theatrical Intelligent Agents), ARCHAEOGUIDE (Augmented Reality-based Cultural Heritage Onsite Guide) and 3D-MURALE (3D Measurement & Virtual Reconstruction of Ancient Lost Worlds of Europe) are worth mentioning. ARCHAEOGUIDE eventually produced a complex but uncomfortable wearable equipment to create augmented reality applications (i.e. virtual reality superimposed on images of the current appearance) on the archaeological site of Olympia. The helmet for immersive visualization and the knapsack containing the computer which the visitor had to wear to experience the reconstruction were not exactly the best solution for a summer visit of this Greek site, but they demonstrated that the concept was feasible and interesting. 3D-MURALE went for a stationary device, a telescope achieving the same augmented reality result, with a loss of mobility but a decisive improvement on comfort for the visits of the Sagalassos Hellenistic site in Turkey. All these projects extended form 1999-2000 to 2003.
If the technological results were brilliant, the effects of such projects on the organization and communication of archaeological sites were minimal, if any. The technology was still experimental and expensive, and, above all, the ownership by the archaeological community of these results was nil. These projects were totally technology-led, and cultural heritage was just a nice application domain. Nevertheless, their long-term impact was substantial. It is

difficult to conceive the current day augmented reality apps on smartphones without these pioneers who paved the way. Credit must be given to such a foresight initiative of the EU and of the Unit mentioned above, for promoting and sustaining this mixture of technology and cultural heritage. In those times, national funding policies were totally uninterested to these topics in most countries, with possibly the exception of UK and a few others [7].
FP6 continued in this path funding more projects on the applications of computer visualization to cultural heritage. Furthermore, the programme supported the creation of a dedicated Network of Excellence, EPOCH (2004-2008).
EPOCH was founded on completely different premises. It programmatically mixed together archaeologists and technologists, stating that the lead belonged to the former. It understood that it was necessary to involve a large community, reaching the incredible number of 100 partners, what caused more than a headache to the coordinator, the University of Brighton. EPOCH had a shaping effect on the research community and left a quantity of concrete achievements and a huge number of publications, notably its State of the Union reports [7] and its Research Agenda [8]. The former surveyed and reported about the current state of affairs in the EU member states, the latter described the research perspectives in the domain. In sum, the project set the foundations for further developments and put new, precise research questions.

3. The new century: a critical approach to 3D visualization

A paper published in the VAST2000 Proceedings [6] had already posed the question of a philological approach to the visual representation of the interpretation of the past. It criticized the cases of arbitrary – or at least, undocumented – reconstructions, which conveyed in the public the false impression that being 'snapshots' of the past, they had to be true. Virtual reconstructions in no way carried the uncertainty of interpretation and the possible existence of alternate solutions. The work within EPOCH confirmed the need of clear criteria for the reliability of virtual reconstructions and supported the birth of a movement among scholars, advocating the creation of guidelines for a correct approach to visualization in archaeology, which culminated in the statement of the London Charter (2005).
The London Charter for the Computer-Based Visualization of Cultural Heritage (www.londoncharter.org) is a Charter establishing internationally-recognized principles for the use of computer-based visualization by researchers, educators and cultural heritage organizations. Besides the detailed explanation of the Charter on the web site, [9] and [10] provide an in-depth description of the Charter.
The main principle of the Charter is that 3D visualization must rely on documentation that records not only information on the involved real cultural objects, but also the so-called paradata, i.e information about the circumstances in which the record was produced. It has been proved that such circumstances may affect the reliability of the digital data and the usability of the digital replica. More details on paradata and their importance are presented in [11].
The Charter dictates general principles, which need guidelines for good practices according to different applications, some of which are presented in [11].
Nowadays the London Charter is widely accepted and compliance to it is stated as a requirement in the most important current projects on 3D replicas.
The publication of the London Charter on one side replied to the issues of credibility and reliability of 3D visualization mentioned above; on the other, it opened a new research thread, because the principle stated in the Charter programmatically apply to communication and research alike. The Charter thus registered that there was a scientific interest in using 3D visualization as an archaeological research tool, acknowledging the existence of a 'virtual archaeology' – or, better, 'digital archaeology' – domain within the disciplinary methods.

4. 3D visualization as a research tool

In recent years, a number of experimental applications have used 3D technology to improve the documentation of archaeological sites and artefacts [12, 13, 14]. Such applications have shown that 3D visualization is not only useful, but also has a potential to change the way research is made in archaeology. Good 3D replicas might in fact be used to study objects and sites instead of the originals. This approach motivates the need for guaranteeing the reliability and credibility of the 3D models [15]. Furthermore, ways for storing, retrieving and browsing such huge digital objects are required, as well as tools to manipulate them.

Another EU project has addressed these issues. The recently concluded FP7 3D-COFORM project (www.3d-coform.eu) has produced a set of tools to create and manage virtual 3D collections of cultural objects. 3D-COFORM has also proposed a CIDOC-CRM extension documenting the 'provenance' of the 3D objects, i.e. the technical information about the creation and the processing of the digital replicas. Such data may be assimilated to the paradata advocated by the London Charter. This methodology contributes to giving sound scientific bases to Digital Archaeology, and opens new research avenues such as those taken into account, among others, by ARIADNE, and mentioned in the introduction.

5. Conclusions and future work

After 15 years of research, virtual archaeology appears today as a mature scientific domain, and the resistance in the archaeological community no longer exists, or is confined only to a small patrol of elderly conservatives. Virtual reality and augmented reality are used in mobile applications that visitors are supposed to use when visiting archaeological sites. Such apps are still unpolished, but it is just a matter of time to see much better tools assisting the explanation and communication of archaeological remains. Stationary devices for visualization are commonplace in museums. FP7 has funded the V-MUST.NET project (www.v-must.net) on digital storytelling in museums availing of 3D visualization techniques. 3D technology has started becoming a tool for research as well.

European research programmes have played a fundamental role in structuring research. For example the survival of the VAST Conference as an international forum for this domain has been indirectly guaranteed by the funding of researchers presenting their results at the Conference. The EU has provided the necessary resources for a thread that was usually underappreciated by national funding agencies enabling the creation of advanced technological tools. Above all, it has concretely fostered the cross-fertilization between technology and culture.

It is hoped that the EU confirms a primary role for cultural heritage also in its future programmes, and continues the farsighted strategy of fostering the collaboration of technology and culture to exploit the richness of its heritage assets.

3D models of monuments have started showing also in Europeana, the European digital library. For example, the 3D ICONS project (www.3dicons-project.eu) is collecting high-quality 3D models of iconic monuments throughout Europe, to offer to the public the opportunity of visualizing such masterpieces via Europeana. 3D ICONS takes into account the debate on the reliability of digital replicas and is adopting a metadata schema compliant with the London Charter requirements of 3D visualization. It is anticipated that 3D ICONS models will be useful also for research.

However, as it often happens, answering to an issue, e.g. providing tools for better visualization or methods to support the reliability of 3D replicas, opens new research questions. This time they concern the ontological foundations of digital archaeology. Basic concepts as space, time, actors and things require renewed attention to enable machine

reasoning based on the integrated repositories ARIADNE will set up, beyond the naïve use that so far gave them for granted and universally understood.
Maybe, another European project will address also these questions, continuing a tradition that has given so many benefits to scientific research in the cultural domain.

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CONTEXT SENSITIVE SERVICES AND INFORMATION SYSTEMS IN THE PERGAMONMUSEUM AND THE JEWISH MUSEUM BERLIN

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Abstract—The development of information and communication technology during the past 30 years is characterised through the continued technical evolution. These technical developments raise the possibility of new applications and application areas. It is important for the acceptance of new technologies, that new applications create additional value, use the advantages of basic technologies and are adapted to the needs of the user.
This article describes several technical aspects of mobile devices, sensor networks, web technologies, multimedia applications, context sensitive services in information systems for museums developed at the author's university. It examines key features of the technologies and the systems, shows multiple methods of using information systems, sensor networks and multimedia as well as future research potentials.

Keywords—Museum Information Systems; Context Sensitive Services; RFID; Mobile Multimedia

I. INTRODUCTION

The development of computer technology, mobile devices and sensor technology during the past 30 years has continually affected the creation of new applications based on emergent technologies. Whilst newly developed device types with different technical specifications have surrounded us in our everyday life and private environment, new base technologies have also been established step-by-step.

By combining the advantages of established technologies with these new approaches and furthermore adapting those criteria to the different user needs and application scenarios, including the location of users, we are able to extend existing applications with new mobile components and services.

II. RFID SENSOR NETWORKS AND CONTEXT-SENSITIVE SERVICES ON THE BASIS OF THE OPEN BEACON TECHNOLOGY

We decided to use the OpenBeacon[2] technology as the basic technology for sensor networks and context-sensitive services being actively developed by Bitmanufaktur[7]. OpenBeacon is an open source solution in hardware and software for active RFID. It operates in the 2.4 GHz ISM band and each device contains a unique ID. OpenBeacon is designed to transmit and receive radio waves. The advantages of an active RFID system are:

- high range,
- ability to transfer more than just one unique ID,
- cryptographic security,
- full processor on the tag and base station side,
- tags can control peripheral devices.

The OpenBeacon technology consists of two main components – the tags and the base stations. OpenBeacon base stations are tiny network devices to receive and process the signals sent by OpenBeacon tags. The OpenBeacon tags are tiny battery-powered devices and consist of RF24L01 2.4 GHz transceiver and are controlled via a microcontroller (Microchip PIC16F684). The device is powered with one CR2032 coin cell and is expected to run for up to several months without battery change. The 8-Bit RISC CPU with special low-power features provides the opportunity to implement a very sleek and power-saving transmitting routine at minimal costs.

Since 2010 the open source project offers a new generation of RFID tags, so called proximity tags, broadcasting additional information about the tags in their surrounding. This is realised by setting up the RFID tags in a transceiver mode. The transponders scan their neighbourhood by alternating transmitting and reception cycles. They use a specific radio channel to firstly send low-power packets, they then switch into receive mode and listen on the same channel for packets sent by nearby devices [6]. These responses serve as indicator for proximity evaluations. These special tags can be considered as a type of RFID reader. As these transponders are much smaller and also cheaper than an ordinary RFID reader, the option of using the proximity tags to realise the runway use case was chosen. Every tag transmits six to eight times per second. The tags transmit with four power levels, periodically. The following illustration describes the transmitted protocol:

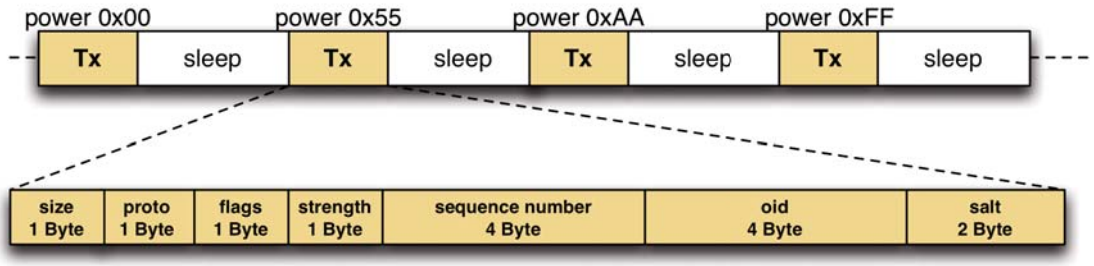

Figure 1. OpenBeacon Protocol

The OpenBeacon tag sends not only the unique ID, but it could send a multitude of other information. The unique ID, the specific information of an OpenBeacon tag and the packet loss per period can be used for distance and position estimation and for the development of location and context-based services [1].

Location and context-based services as well as mobile information systems and multimedia applications require the same computer, sensor and network components. Not only the hardware components of the different OpenBeacon applications are the same but also their software components. We built a standardised modular toolbox for the different OpenBeacon applications which comprise software modules and hardware components. We employ this toolbox for information systems in different museums like the Jewish Museum Berlin or the Pergamonmuseum Berlin.

III. Context Sensitiv Services Based on a RFID Sensor Network for an Information Systems for the Museum of Islamic Art in the Pergamonmuseum

The main focus of project 'Poseidon' is to design mobile multimedia indoor information systems and context-sensitive services based on a RFID sensor network in museums and passive RFID tags. In order to cover a wide range of applications we developed a standard system architecture. The main components of the system are RFID transponders (active and passive) and RFID readers, data collection and management system, a web server, and wireless and cable based network systems (WiFi, UMTS and Internet). The system architecture is illustrated in Fig. 2.

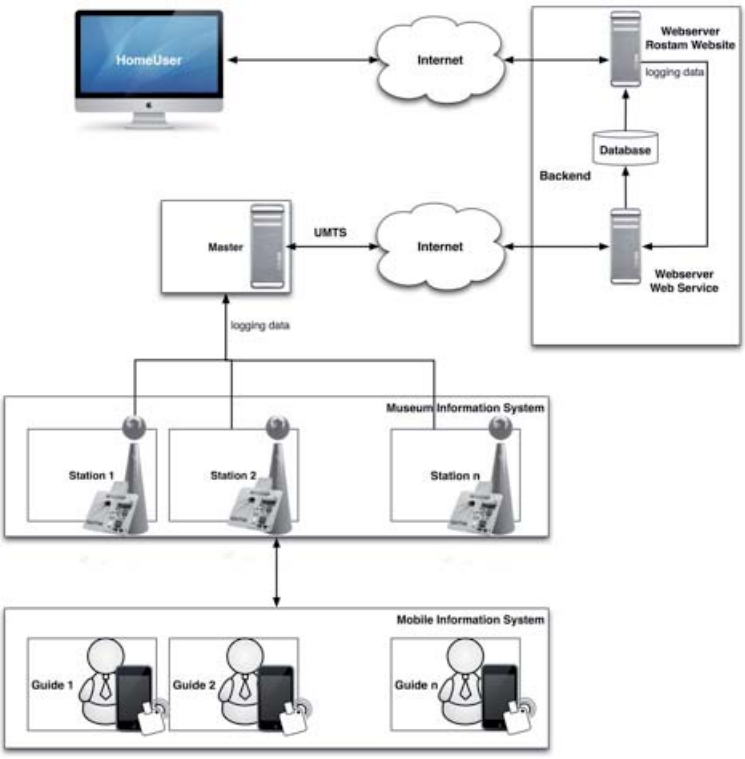

Figure 2. System Architecture

All RFID components, a controlling computer, feedback components (audio and light) and antennas are installed in a shell. Only the shell varies for different applications, e.g. a digital storyteller for the Schahname exhibition the Museum of Islamic Art in the Pergamonmuseum Berlin, see Fig. 3. The visitor to the museum can collect information (stories) with a bookmark, see Fig. 4.

Figure 3. Storyteller of the Schahname Exhibition (left)

Figure 4. Schahname Bookmark with RFID Tag (right)

The museum creates a private website for each visitor to the museum. The visitor has to register on this website with the code printed on their bookmark (in the example "AQ9BDD"). After registration the visitor has access to all collected stories, see Fig. 5.

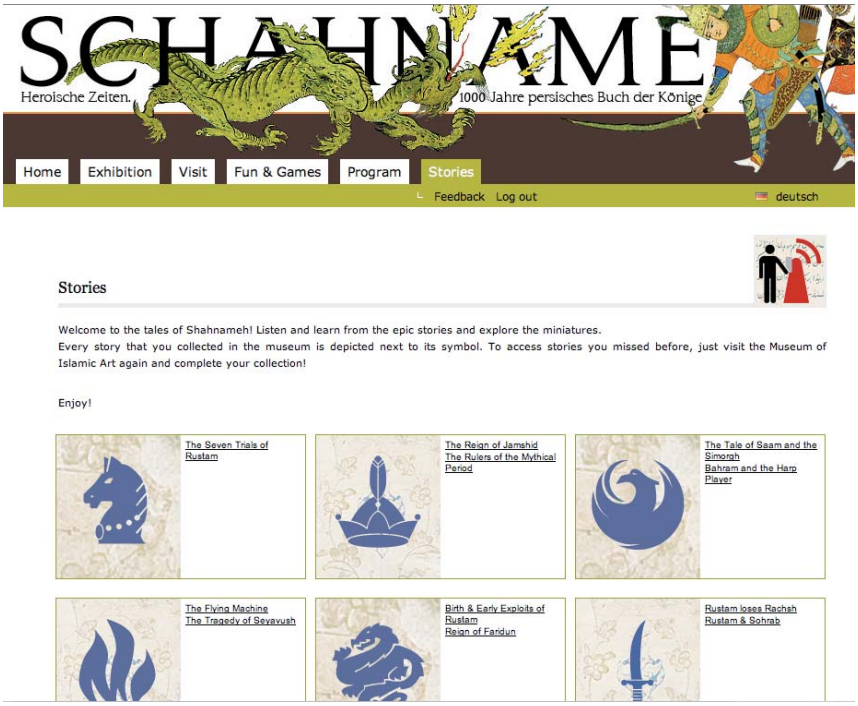

Figure 5. Website with the Stories

IV. "A La Carte"– Personalise Information Systems for the Jewish Museum

The same system, technology, toolbox and system architecture was used for the exhibition "Kosher & Co" at the Jewish Museum Berlin. The storyteller was replaced be a plate and the bookmark by a spoon. The visitors to the exhibition "Kosher & Co" collected cooking recipes.

The main idea of the RFID based "A La CARTE" installation is data collection without a typical computer interface. The visitor to the museum received a spoon with an attached passive RFID tag as an entrance ticket and a short description of how to use the spoon for data collection. Additionally, a unique spoon (RFID-) ID and the URL of the "Koscher & Co" website are printed on the spoon. The user can find one media station in each of the ten rooms of the temporary exhibition. The media station consists of a plate, a hidden RFID reader and a miniature computer. The user will see only the plate, and only the spoon and the plate can interact.

Figure 6. Passive RFID Tag, Reader and Feedback Light

If a visitor wants to have more information regarding the objects in the room and the attached recipes they have to place the spoon on the plate. The RFID reader under the plate receives the ID from the spoon and sends the ID with a time stamp to the server. If the transfer of the ID was successful the media station generates an optical and acoustic feedback. Now the visitor knows that they have collected the recipes on their spoon. There are three recipes of three different categories in each room. The three categories are "5 ingredients", "5 senses" and "5 minutes". The "Koscher & Co" context-sensitive software determines which recipes best fit the visitor. The selection of recipes and relevant category for the specific visitor is dependent on their visit. Criteria are for example the visited media station, the sequence and the duration of the visit.

Following the visit to the museum visitors can enter the website. Firstly, they have to log in (by typing the ID found on the spoon). Following that they will see the category and the collected recipes.

Figure 7. Personalised Webpage of "Koscher & Co" (login)

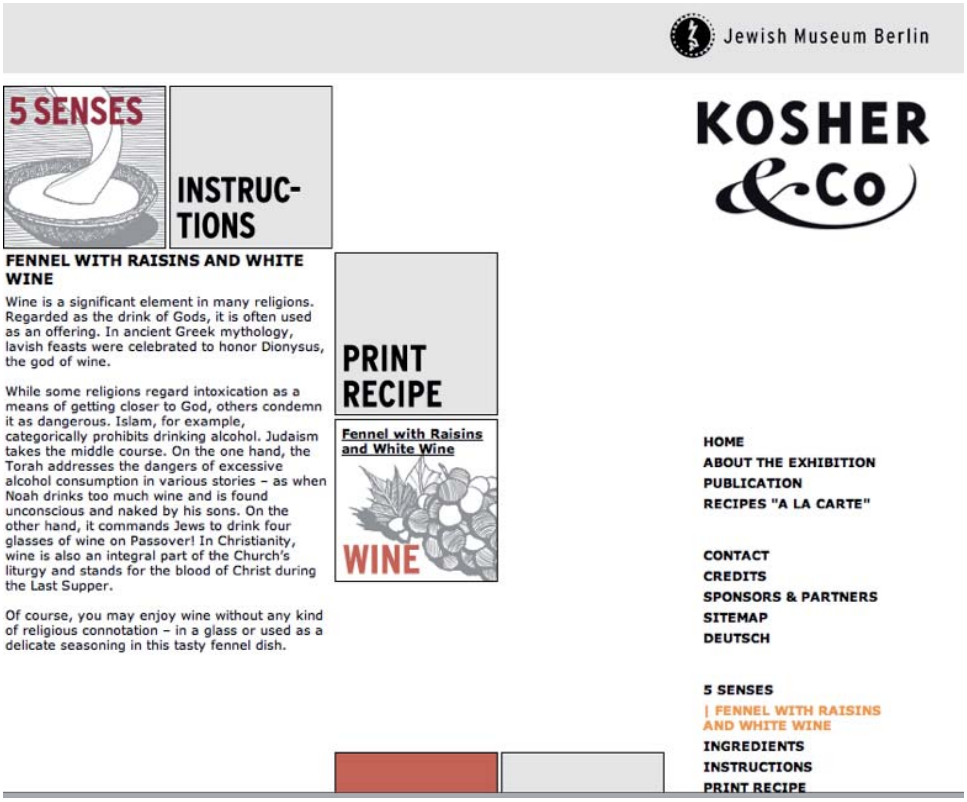

Figure 8. Personalised Webpage of "Koscher & Co" (recipe)

Further applications are possible. The visitor research department can analyse the data collected and provide the visitor with more detailed information about the visited artefacts or additional information about other artefacts in the exhibition. The museum can also recommend additional tours through the museum. Staff members can use the data and sensor networks for the management of the museum and the Acknowledgment

This paper described the work undertaken in the context of the project POSEIDON and SIGNAL hosted by the research group "Information and Communication Systems" INKA [2] in cooperation with the Humboldt University Berlin, the Jewish Museum Berlin, the Pergamonmuseum and the two companies Bitmanufaktur and Acoustiguide, and gratefully funded by the European Regional Development Fund (ERDF).

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CENDARI: a Collaborative EuropeaN Digital ARchive Infrastructure for Medieval studies

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Abstract - CENDARI (Collaborative EuropeaN Digital ARchive Infrastructure) is a project funded by European Commission under the 7th Framework Programme. The project is built upon a consortium of 14 partners from 7 countries, with 3 italian members (Fondazione Ezio Franceschini and Società Internazionale per lo Studio del Medioevo Latino in Florence and Università degli studi di Cassino) and is focused on creating a research infrastructure for scholars that is easy to use and essential to research goals within two different Pilot Areas: World War I and Medieval European Culture. Among the goals for the CENDARI project is the creation of an innovative enquiry environment, bringing together disparate sources and various formats through the establishment of a broad network of collaborations between different communities (historians, archivists, librarians, computer scientists, research infrastructures) and the use of groundbreaking methodologies and technical processes to overcome national and institutional data silos and describe relevant assets in lesser-known memory organisations. The project will run from 2012 to 2016, and the end results will be integrated into the DARIAH Research Infrastructure. This paper will briefly describe the medieval part of the CENDARI project.

Medieval Culture within the CENDARI Research Environment:

Contemporary cutting edge trends of research in the domain of medieval culture are by design transnational, translingual and interdisciplinary: the CENDARI[1] infrastructure aims at becoming one of the leading reasearch tools for doing research in this field, so it should be able to address a number of scientific needs coming from different disciplinary traditions. This paper is meant to describe the role and meaning of medieval cultural heritage within the CENDARI environment. During the first year of activity of the project we learned a lot from the collaboration with historians coming from the WW1 field of research[2]: this close collaboration helped us to focus on similarities and differences present at many levels: contents, standards, current research infrastructures and practices, as well as scientific community expectations. From this experience we reshaped our idea of the possible aims and priorities for the medieval side of the CENDARI project and found a number of bottlenecks along with possible workarounds, based on domain specific considerations. It means that to be effective - though if we are aware of plenty of overlappings between the research fields of WW1 and Medieval Culture - we decided to focus on the ground-level reality of our scientific community.

CENDARI, links with other similar projetcs and actions:

Since we need to address a vast number of scientific needs coming from the scholarly community we established connections with other important projects and actions running on the same aspects, namely the IS1005 COST action - *Medieval Cultures and Technological Resources*[3] and the *Text and Manuscript Transmission of the Middle Ages in Europe - TRAME*[4] project. The context provided by the IS1005 COST action is relevant because it groups together major research

[1] cfr. the project website: http://www.cendari.eu.
[2] in particular: Friedrich Meinecke Institute - Freie Universität Berlin (Germany) and University Of Birmingham (UK)
[3] cfr. the IS1005 action website: http://www.medioevoeuropeo.eu.
[4] cfr. the TRAME webiste: http://trame.fefonlus.it. Cfr. also E. Degl'Innocenti *TRAME: Building a Meta-Search Tool for the Study of Medieval Western Literary Traditions* in EVA 2011 Florence Proceedings, Pitagora Editrice, Vito Cappellini Ed., pp. 94-9, 2011.

institutes from 23 different european countries, providing feedback over a number of actual scientific questions and needs that we included in our overview, developing a more articulated idea on the role of medieval culture in the digital domain. The TRAME project is also relevant as it is a reaction to the needs expressed by the scientific community of medievalists coming from the same ground (reasearch insitutions) - able to address some of the issues raised by the scholars but not sufficent to fullfil all of them - in other terms is one of the possible starting points for the research environment to be designed.

Doing research in the field of medieval culture involves a large number of different sources and tools and although the basic needs are related to the discoverability of metadata on relevant material sources as charters, manuscripts, ancient books etc., scholars are also looking for other tools to gather information about authors and works, anonymous texts, etc., as well as related bibliography, possibly with a high level of integration and with effective reserach (not merely *search*) tools.

During the starting phase of the CENDARI project we had a closer look at other similar initiatives running in the same field, looking for their strengths and weaknesses. Here a list of the most relevant findings:

- to limit the investigation only to archives is not enough. Furthermore the division between libraries and archives on the long run could represent a limit for the user, concerning resources discoverability;
- a well designed research environment for medievalists should also provide information on libraries, their holdings and *items* (i.e.: mss, documents etc.). Information granularity is essential for the quality of the system;
- EAG/EAD schemas - that fits most of the needs of the archival community - are not enough to map the complexity of the medieval domain. Mapping the actual situation and building convenient crosswalks among different schemas is a priority;
- finding a convenient solution to deal with the number of different standards and data formats used by libraries and research institutes, without imposing another standard, is a complex challenge. Trying to exploit a blackboard architecture[5] to manage the CENDARI *data-soup* could improve the overall system quality;
- to clearly define the CENDARI data model we pointed out a core of valuable scholarly resources and standars to be integrated in the CENDARI workspace;
- we need to assure the possibility that the CENDARI environment would be useful for scholars and researchers even after the end of its lifecycle (2016); it could be done relying not only on a central repository which will become difficult to maintain after it but also on tools and services deeply involved in the scholarly research community processes, able to provide live, updated information (TRAME, etc.)

State of the art and work plan

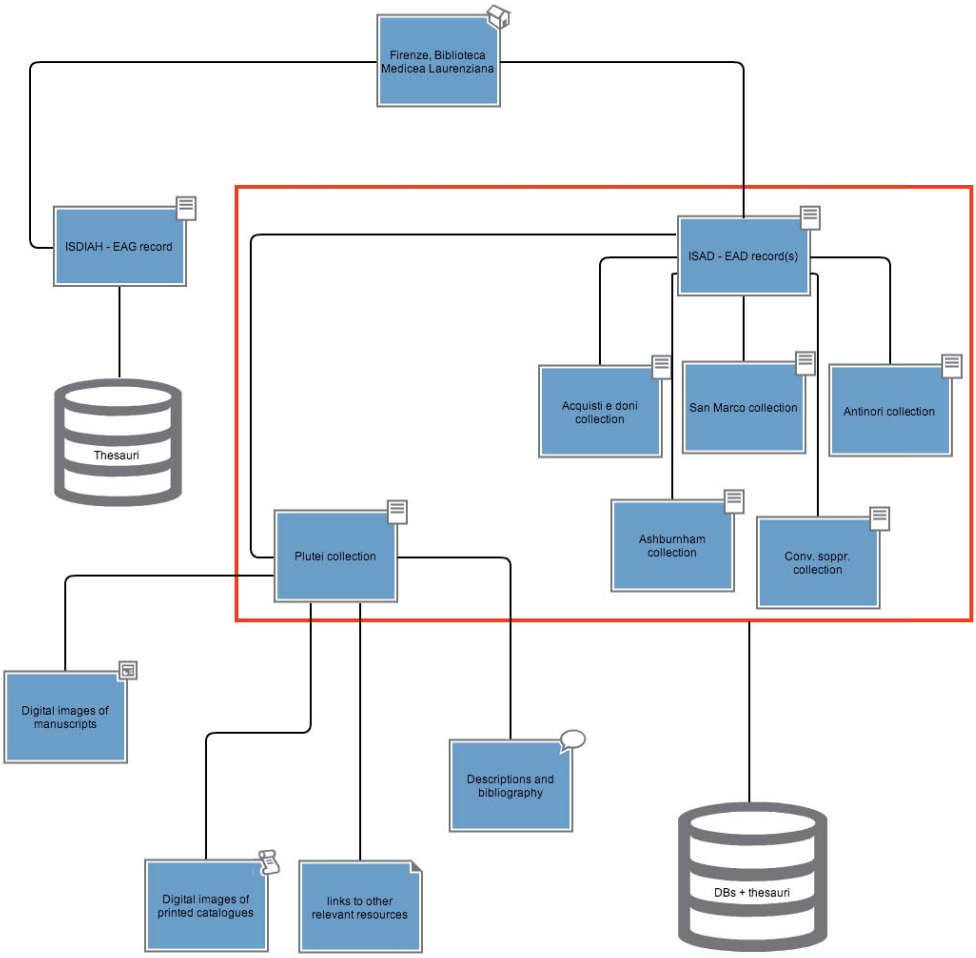
The starting point of the CENDARI activities was the Archive Directory: in it scholars will find all the most important institutions (with holdings) that are found to be relevant for the medieval culture field of research; both archives, libraries and other private collections should be present in the final directory. The Archive Directory was meant to be the gateway to discover interesting sources for doing research, but is not in itself a research tool; scholars in medieval culture are interested in institutions and collections but for the most part the research work is focused on the level of the *item* (individual ms. or document). Since an extensive *ex-novo* cataloguing work was not possible within the CENDARI framework we tried to find a way to get this important piece of information at disposal of the CENDARI user with a limited human data-entry and focusing on data enrichment (with various external ingestion tools), providing a consistent and comprehensive

[5] cfr. http://en.wikipedia.org/wiki/Blackboard_system

directory of institutions/collections as a entrypoint to make the whole infrastructure work. The actual workflow was structured as follows:

- institution and/or collection record creation (first level; human data-entry)
- collection/holding level records enrichment via external data integration (or manual entry)
- collection/holding link to *items* (mss., etc) via external data integration

To be sustainable and effective this activity should be focused on the integration of already avalaible data, coming from different sources, linked to the collection/holding level, providing users information with a higher level of granularity without relying only on human data-entry.



1. Example of data enrichment and interlinking

To address actual resarch needs, as said, in addition to the level of the collection CENDARI should be able to give scholars information at a *item* level: in particular we found that - among others things - scholars doing research on manuscripts are interested in having information on and access to:

manuscritps shelfmarks	parts of single manuscripts: fragment leaves (*fragmenta membranea*)
languages and scripts in the manuscripts	reconstructed manuscripts
writing supports and materials (parchment, papyrus, paper etc.)	textual traditions
presence of decorations in manuscripts	topics
information on institutions: not only concerning current but also former owners, scriptoria, etc.	timespans
bibliographical information	digital images and full-text documents

The CENDARI research environment design should also help to overcome the data silos architecture and foster interoperability, allowing a high level of integration for already existing data related to the collections and holdings in the Archive Directory, but also giving a deeper level of detail (reaching the *item/document* level). It should allow a high level of integration for different types of digital resources focused on various aspects of the medieval culture, such as - for example - manuscripts, places, authors and works. The medieval section of the CENDARI research environment should not try to address every possible research interest and need, but rather to focus on the most representative scenarios, based on everyday research practice (i.e.: scholars working on medieval authors and texts; scholars working on manuscripts and textual tradition; scholars working on textual corpora and reading tools, etc.).

Interlinking and federated access to resources:

One of the main goals for the CENDARI project is about discoverability of metadata pertaining to medieval resources: currently a number of international research institutes, memory institutions and other partners are willing to put their metadata on the web to the benefit of the research community. One of the most challenging issues for the CENDARI research environment was to find a way of linking resources to other (related) metadata in the best possible manner to open up the possibility for federated search, faceted search (searching not 'just' on free text basis, but on particular properties of the metadata exposed) and letting local updates of metadata percolating immediately to the whole federated ecosystem of metadata (see 2. *priorities for data integration*)

Semantic framework and domain ontologies:

To design a coherent and effective knowledge management infrastructure, based on deeply interlinked resources needs to clearly point out which piece of information will be used as linking points/categories: persons, places, events, objects, works, lemmas, subjects, etc. That is a stepping stone towards trying to establish a common ontology for the disciplines involved in medieval research. Furthermore, depending on the technical approach used by the project, we could rely on a number of already available scholarly databases (including authority lists etc.) to be integrated within the CENDARI research environment (see 1. type of information to be included and 3. contolled vocabularies to be included). All the selected resources could be subsequently adapted to match with the technical specs of the research infrastructure (through RDF triplification of existing DBs, data extraction and mapping, etc.), the same could be said for the TRAME search engine that could become the hub for the medieval section.

Research Guides:

To become an effective research environment, CENDARI should not only offer a variety of high quality, ready-to-use, research guides (in the broad sense of the term: both in the form of traditional essays or innovative e-research products): the research guide itself has to be considered as a product that the scholar, researcher etc. could obtain using the tools and contents provided by CENDARI, the final goal for the medieval focused part of the project is not limited to the

production of a fixed number of guides, but rather to design an effective pipeline to build research guides (and paths), similar to the ones already published whithin the CENDARI portal.

Working prototypes:

A first version of the working prototype of the CENDARI research environment, representing the features of the final portal will be developed in the second year of the project (2013-2014) and released through the official project website.

<table>
<tr><td>topics/subjects</td><td colspan="4">→</td><td rowspan="4">- reference repertoires
- printed and digital editions
- selected Studies
- general Bibliography</td></tr>
<tr><td rowspan="2">sources (mss. / documents)</td><td>→ person names</td><td>→</td><td>→ roles
→ religious order</td><td>→</td></tr>
<tr><td>→ works
→ anonymous texts</td><td>→</td><td>→ literary genres
→ literary forms
→ documents type</td><td>→</td></tr>
<tr><td>places</td><td>→ institutions</td><td>→</td><td>→ religious orders</td><td>→</td></tr>
</table>

1. type of information to be included

linked data integration	advanced data integration tools
permanent identifiers management	advanced data visualization techniques
permalinks (for citation etc.)	advanced H/M interaction
sharing and integration of external authorithy lists and thesauri (TGN, VIAF etc.), e.g.: - http://www.getty.edu/research/tools/vocabularies/tgn - http://viaf.org/	advanced tools for data export and reuse
semantic and annotation tools	

2. priorities for data intergration

Content	**Type**	**Example**	**Notes**
topics/subjects	authority list, multilingual	Storia delle città medievali, History of medieval cities	*related to*: shelfmarks, person names, works titles and anonymous texts
shelfmarks	authority list, multilingual, complex syntax	Firenze, Biblioteca Medicea Laurenziana, Plut. 01.17 Florence, BML, Plut., 01.17	*related to*: person names works titles anonymous texts, place names, institutions, literary forms and genres
person names	authority list, multilingual, complex syntax	Alcuinus de York Alboinus Flaccus	*related to*: roles, works titles, religious orders, place names, shelfmarks, institutions

		Pius II papa Aeneas Piccolomini Aeneas Silvius Aeneas Silvius Piccolomini Aeneas Silvius Piccolomini Senensis	
personal roles	authority list, multilingual, simple syntax	abbas, papa, advocatus, professor ...	*related to*: person names
religious orders	authority list, multilingual, simple syntax	OFM, OESA, OP	*related to*: intitutions, person names
works titles	authority list, multilingual, complex syntax	Lectura super Iohannem [Reportatio]	*related to*: person names, shelfmarks
anonymous texts titles	authority list, multilingual, complex syntax	Anonymus Valesianus De sepultura eorum qui falso excommunicati dicuntur non turbanda	*related to*: shelfmarks
place names	authority list, multilingual, simple syntax	Teschen → Cieszyn	*related to*: institutions
institutions	authority list, multilingual, simple syntax	Italia, Toscana, Firenze, Santa Maria Novella, Convento OP	*related to*: place names
literary genres	authority list, multilingual, simple syntax	Chronographia et computus, Drama comicum	*related to*: person names, shelfmarks, works titles, anonymous works
literary forms	authority list, multilingual, simple syntax	Accessus, Anthologia, Carmina, Commentum, Dialogus	*related to*: person names, shelfmarks, works titles, anonymous works
document/source type	authority list, multilingual, simple syntax	Atto di acquisto, Atto di cessione, Atto di confisca, Atto di consegna, Atto di costituzione di società, Atto di divisione dei beni, Atto di donazione	*related to*: shelfmarks, works titles, anonymous works

3. contolled vocabularies to be included

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THE MARCOPOLO PROJECT: AGILE DEVELOPMENT OF MOBILE CROSS-PLATFORM TOURISM APPLICATIONS ON THE CLOUD

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Abstract – This paper presents the preliminary results of the MarcoPolo project, co-funded by the European Commission and the Italian Ministry of education, University and scientific Research (MIUR) under EUROSTARS, an innovation program addressed to European research intesive SMEs.

MarcoPolo aims at developing a mobile cross-platform metaframework based on the Open Source Roma Metaframework and Model Driven Architecture (MDA) techniques, for speeding up development for smartphones and tablets based on Android and iPhone. This is complemented by an innovative cloud-based Integrated Development Environment (IDE).

INTRODUCTION

The mobile application market, and in particular the market addressing mobile application is booming. Until three years ago smartphones were sold to business-men or companies that needed advanced features. Today this technology is cheaper and easier to use, specially thanks to the "touch" technology, high resolution displays and more intuitive Operative Systems.

The cost reduction of reliable software development is very important nowadays, when companies are not able to make huge investments in competitive developments. Also, the competition in the field of mobile applications is huge. For instance, 775.000 applications are available at the Apple AppStore and the portal counted 40 billions downloads [1] and 12.3 billions downlods for rhe more than 630.000 apps on the Android Market [2].

Apps are creating highly streamlined, personalized user experience, which is driving a new software development and changing consumer behaviour. Practically all smartphones users utilise mobile apps, mostly for private aims, but the next wave of new apps will be market niches specialising on business apps. This is why today, in western countries, the target of mobile applications are not only companies or business-men, but mainly common people with no special skills in technology. This mass phenomenon has created a huge demand of mobile applications not only business-to-business but, most of all, for consumers. Consumers are end-users in any range of ages that download and use mobile applications to play, search and share knowledge while accessing or visiting cultural venues.

Currently, mobile applications are being developed using two main approaches: native applications and web-based applications. Both approaches have two main problems: each application has to be developed for each target device and the mobile frameworks are in continuous evolution, decreasing the productivity in the design and the development of mobile applications.

The project aims at innovating in several aspects. Our approach is oriented to intensive data-oriented applications (such as tourism guides, visiting support, interactive and social applications) and will

allow end users even to create databases in a transparent way. We propose the definition of a *meta-device* or device model for collection the different facilities (sensors and actuators) provided by smartphones and tablets. This device model could be the starting point for object of public specifications to standardize these interfaces.

At the end of the research activities, the results will be released as an Open Source and will be available to the Roma community which could contribute to the validation and evolution of the products. Thanks to the open source business-friendly license (Apache2) MarcoPolo could be used to develop and deploy busines-to-business mobile applications. MarcoPolo is targeted at the integrators market, following an open source business model for exploiting the results of the project. In addition, the cloud-based IDE could be exploited with the support of an advertisement commercial strategy.

In the next section, we give an overview of the general methodology developed in MarcoPolo for the dynamic development of mobile applications in a scenario of cultural fruition. Then we describe the modeling of user experience in tourism fruition when using mobile devices. In the main section, we will present in detail how the general methodology developed in MarcoPolo has been implemented in a metaframework dedicated to non-expert developer, for the creation of mobile apps to support tourists during the fruition of cultural experiences. Finally we propose some indications for further work.

THE MARCOPOLO METHODOLOGY

The project MarcoPolo aims at defining and developing a mobile metaframework which allows to focus on the application domain, and then generate automatically the packaged application depending on the targeted device. The project will extend the open source Roma Metaframework in order to provide a MDA approach to the generation of native web applications based on existing multi-platform web frameworks such as Cordova/PhoneGap, Backbone, Bootstrap.

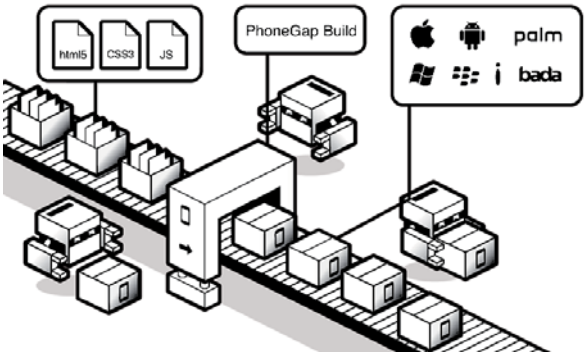

Figure 1. PhoneGap model.

The usage of a mobile metaframework will provide a consistent and neutral environment for future devices. The project takes advantage of the services already offered by the emerging mobile cloud, which enable mobile applications to scale far beyond the capabilities of any smartphone, without limitations on data storage and processing power. Furthermore, the combination of Roma and

MarcoPolo facilitates the generation of web portals and client mobile applications based on the same domain model.

In addition, MarcoPolo aims at providing a cloud-based IDE for developing mobile cross-platform applications targeted at rich phones and tablets based on Android and iPhone/iPad platforms. This drag & drop based IDE will enable end-users to create, without any programming skills, their own applications for their devices by connecting existing components from a pre-configured library.

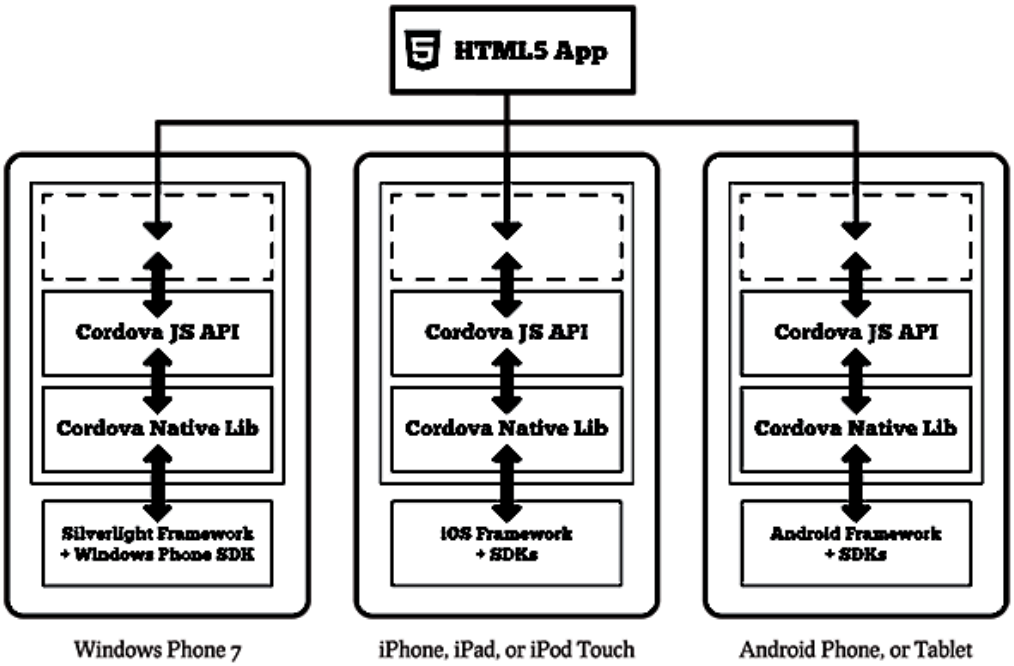

Figure 2. Cordova architecture

The development of mobile applications follows two general approaches: development of native applications, using the development frameworks provided by mobile OS, mainly iPhone (Apple) or Android (Google), or a development approach based on web technologies using mobile frameworks such as PhoneGap or Titanium based on JavaScript. These frameworks provide a uniform approach to the development of multidevice applications.

The main advantage of following a native approach is the efficiency and the time to market for including new updates of the operating systems. The main disadvantage of this approach is that the development should be done for each platform using different technologies (Java, C, Objective C), and even worse, it is required to maintain the app in all these environments. Since this can be unviable (economical, time restrictions, skills required), the common approach is limiting the targeted devices usually to one), which reduces the potential customers and the overall exploitation.

The web-based approach tries to solve the previous identified problems and take advantage of the great availability of engineers mastering web technologies. The main advantage of mobile web

frameworks is that the core application can be shared between disparate devices, and the specific functionalities of a device can be integrated as an application branch. The main disadvantage of this approach is that, since this field is yet immature, there is no leading or standard technology. New frameworks are appearing and the existing ones are evolving. In this way, engineers have to learn all the frameworks and their evolution, in order to provide support to their customers. In addition, applications need to be migrated when a framework evolves or its development does not evolve as expected. This lower productivity will impact significantly in the competitiveness of the integrator, reducing its margin.

Our approach is based on providing a metaframework which reduces the technological risk of selecting one of these frameworks with unknown evolution but preserving the big advantage of developing cross-platform applications for reaching more potential customers. In addition, Roma Metaframework already provides many other facilities (mashups, semantics, workflow, ...) which are not present in these frameworks. Thus, the combination of the facilities already provided with Roma, with the new ones provided by MarcoPolo, can offer a competitive environment for developing complex server-side business logic with mobile applications clients, specifically targeted at mobile business applications. The main disadvantage of this approach can be the required agility for the development of adaptors to these modules when they evolve.

USER EXPERIENCE IN MOBILE TOURISM APPS

Currently there are no sufficiently complete studies and analysis related to the needs and behavioral patterns of he new types of tourists during the fruition of touristic and cultural experiences. In addition, the state-of-the-art of new services is characterized by a strong focus on technology and the possibilities that it offers, while little attention is still paid to the content. This poses serious limitations in understanding how the opportunities offered by new technologies can be fully deployed to produce content and services that can meet the real expectations of users.

A further consequence of this lack of attention to the user needs and the potential impact in the field of content engineering is the limited productivity of the obsolete techniques used today to develop tourism applications for different mobile platforms.

In addition, a growing interest exists for less obvious and minor touristic targets, constituting the long tail [8] of the tourism and culture markets (e.g. the more than one hundred minor cities characterizing the Italian landscape beyond the obvious destinations such as Florence, Rome, Naples, and Venice).

In this scenario, and in a global landscape where communication and networking equipment (smartphones, PDAs, navigators, tablets) are becoming widely available commodities, it emerges clearly the need for a quick and cost-effective development of mobile applicatios for different platforms (iOS, Android, Bada).

We started with an analysis phase focused on user experience and behavioral patterns for tourism fruition, trying to devise use cases and modelling interactions between users and explanatory/additional content as well as interactions between users and portable information devices used to access the content, and to complete and enhance the tourist experience. We started by examining users behavior during fruition of tourist and cultural places, in order to model the behavior of different categories of users in the cultural spaces, both indoor (museums and other cultural containers) and, especially, open-air (cities, art and cultural districts).

The preliminary work was based on examination and study of the literature on visitor studies, to identify any behavioral patterns of use in cultural places. We compared the results of the analysis conducted with the results of visitor studies available in literature, in order to model the behavior of visitors in cultural places.

Next, we analysed the digital content to be delivered through mobile devices and the relationships established between such cultural content and mobile device users during the cultural experience in both museums and city environments. allowing us to draw a clear enough picture of the dynamics of interaction between the user and the content flow to the cultural contexts examined.

During the research, we analyzed in particular expectations, fruition logic, and user satisfaction during digital content fruition by mobile devices as support to a cultural visit. We also took into account the dynamics developed by fruition processes where the tour guides drive additional content (interactive insights, information, logistics and business, etc.).

THE MARCOPOLO METAFRAMEWORK

MarcoPolo proposes an innovative approach to build mobile cross-platform applications based on agile and MDA techniques and the notion of a metaframework. The project aims at innovating in several different components of the mobile applications development value chain.

Mobile Metaframework

The metaframework notion was born in response to the disparity of web frameworks available in Java, which require developers to master and migrate between these frameworks. The metaframework provides a common interface to all these frameworks and use MDA techniques for generating automatically the code for a specific framework. Roma Metaframework is an open source project started in 2006 and extended within the FP7 ICT Romulus project. Our goal in this project is to define a mobile metaframework for the incoming mobile cross-platform frameworks, such as PhoneGap/ Cordova and Titanium, providing a layer on top of them. PhoneGap is an open source framework that allows you to create mobile apps using standardized web APIs for many mobile platforms [5], while Titanium Currently, Roma has innovated in the Java landscape, and the advantages of the metaframework notion have been publicly recognized by competing solutions such as OpenXava.

Cloud IDE

In addition, during the FP7 Romulus project, an initial web IDE was developed for tuning applications. Based on this expertise, our aim in this project is to build a web IDE which provides a simple web interface for healing data intensive mobile applications to end users. Recently, Android has proposed a similar approach based on the MIT Scratch project. Our approach is oriented to intensive data-oriented applications (such as time report, expenses, scheduling, ...) and will allow end users even to create databases in a transparent way. The IDE simplifies the development of new applications by end-users and programmers through a Web interface in the cloud. This drag & drop based IDE will enable end-users to create, without any programming skills, their own tourism applications for their devices by connecting existing components from a pre-configured library.

Device Model

One of the most innovative aspect of the project is the definition of a 'meta-device' or device model for collection the different facilities (sensors and actuators) provided by smartphones and tablets. This device model could be the starting point for standardization efforts for the specification of these interfaces.

CONCLUSIONS AND FURTHER WORK

The project MarcoPolo is addressing agile development processes for mobile applications for tourism and cultural fruition, taking advantage of industrial practice, research progress and emerging mobile technologies. The involvement of real users, i.e. communities of developers of mobile applications, in the development of the methodology and tools is essential for its acceptance in the target markets.

The first part of the reseach was dedicated to accurately and concretely modeling of user needs and behavior during fruition of cultural tourism events, and to the analysis and development of an innovative methodology for information retrieval and indexing of a large unstructured knowledge base.

Next steps in the project are to finalize a system architecture integrating the different system components (mobile metaframework, cloud IDE, device aspects) and to design and implement the IDE for rapid development of mobile tourist application. Finally, the IDE tool will be evaluated with apps developers, specifically for the tourism scenarios.

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2D - 3D TECHNOLOGIES AND APPLICATIONS

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ADVANCED SUPER-RESOLUTION TECHNIQUES FOR DIGITAL IMAGE QUALITY ENHANCEMENT

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ABSTRACT

The problem of resolution enhancement has been recently attracted the image processing community both for its theoretical and applications relevance. Achieving an higher and higher resolution capability is the objective of imaging sensor technology, which is often paid in terms of high equipment costs. On the other hand, the advances in signal processing theory and equipment make appealing solutions for resolution enhancement based on post-processing of low-resolutions acquisitions.

In this paper, we review the most advanced techniques available for the super-resolution of images, with specific reference to those tools proposed for the processing of single images. Some experimental results are given in order to demonstrate the capability and the possible applications of the different methods.

1. INTRODUCTION

Super-resolution (SR) techniques aim to overcome the limit of spatial resolution in low-cost acquisition devices by means of signal processing. Hence, their objective is producing images at a high spatial resolution starting from low-resolution (LR) images. Several application of SR can be found in different fields, such as surveillance, medical imaging, remote sensing [1].

At a first glance, SR methods may resemble simple interpolation techniques. This latter class of methods, e.g., bilinear or bicubic spline interpolation, introduces no increment of the information content of the SR image with respect to the and usually produces blurred SR; with SR techniques, instead, we try to increase the information content - ideally, to restore the original analog image content lost in the process of acquisition - starting by an appropriate model of the image itself.

The techniques of SR can be classified as multi-frame, if a single SR image is created from multiple LR images, or single-frame, if the SR image is based on a single LR image. The multi-frame technique is based on the combination of the information contained in successive images of a same scene and is indicated when a sequences is acquired by low-resolution cameras or other sensors, such as ultrasound probes [2]. In this work, we will concentrate our attention only on single-frame SR techniques.

Numerous techniques have been proposed in the literature for the problem of the SR by single image; [1] contains a survey on the topic. A first class of algorithms may be classified as adaptive interpolations. They attempt to reproduce in the SR image a regularity of the structures present in the LR image [3][4][5], such as edges, or to maintain the local covariance structure [6]. Recently, techniques based on the concept of sparsity, at the basis of the compressed sensing concept, have been proposed with success also in the field of SR [7][8][9][10].

In this work, some of the most advanced techniques proposed for SR are reviewed and compared in order to identify the potentiality of such processing methods for the res enhancement of low-resolution images.

2. THE SUPER-RESOLUTION PROBLEM

The problem of super-resolution of images is depicted in Figure 1. The low-resolution image $\mathbf{Y}$ is the observed image. It is considered as a blurred (operator H) and subsampled (operator S) version of an original (unknown) high-resolution image $\mathbf{X}$, that is

$$\mathbf{Y} = SH\mathbf{X} = L\mathbf{X} \tag{1}$$

where $L = SH$ is a linear operator that model the acquisition process.

The objective of SR algorithms is estimating $\mathbf{X}$ from $\mathbf{Y}$. This is an ill-posed problem, since in the acquisition process some information of $\mathbf{X}$ is lost; it can be partly recovered only by using some *prior* knowledge about the model of the high resolution image. The prior knowledge may include also the operator H.

3. ADVANCED SR ALGORITHMS

In this section, some recently proposed algorithms for SR are reviewed. In the following sub-section, the basic concepts of compressed sensing SR methods are given, whereas in the

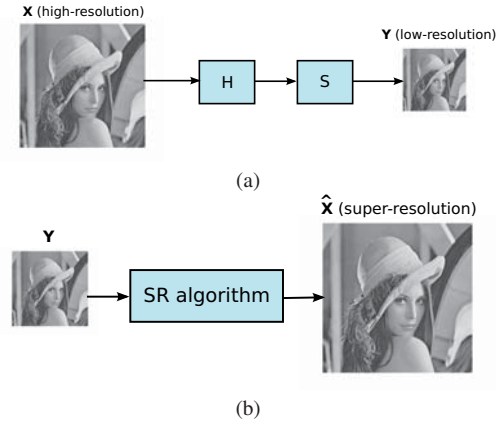


Fig. 1. SR methods: (a) acquisition model (H and S denote the blurring and subsampling operators, respectively); (b) the SR image $\hat{\mathbf{X}}$ is estimated from $\mathbf{Y}$.

successive one an efficient adaptive interpolation method is described.

3.1. Sparsity based SR

These methods model the patches of the original high resolution image as sparse signals [7]. A signal is defined as sparse if it can be expressed as a linear combination of few elements of a given known set of *atoms*, called *dictionary*. If $\mathbf{x}$ denotes a patch of the high-resolution image and $\mathbf{D}_h$ the dictionary, then we have

$$\mathbf{x} = \mathbf{D}_h \mathbf{q} \tag{2}$$

where $\mathbf{x} \in \mathbb{R}^n$, $\mathbf{D}_h \in \mathbb{R}^{n \times K}$, $\mathbf{q} \in \mathbb{R}^K$. The vector $\mathbf{q}$ is *sparse*, i.e., it has only few components different from zero, that is $\|q\|_0 \ll K$.

The model can be generalized to take into account model mismatches and acquisition noise by introducing an additive noise component, that is

$$\mathbf{x} = \mathbf{D}_h \mathbf{q} + \mathbf{v} \tag{3}$$

Thanks to the linear acquisition model, the low-resolution patches can be expressed as

$$\mathbf{y} = L\mathbf{x} = L(\mathbf{D}_h \mathbf{q} + \mathbf{v}) = \mathbf{D}_l \mathbf{q} + \mathbf{v}_1 \tag{4}$$

From this equation, we can infer that also the low-resolution patches satisfy a sparse model according to a low-resolution dictionary $\mathbf{D}_l$, but sharing with the original high-resolution patches the same sparse vector $\mathbf{q}$.

If we assume that the dictionaries $\mathbf{D}_h$ and $\mathbf{D}_l$ are known, then the SR problem is solved in two steps

Step 1 Find the sparse vector solving the problem

$$\mathbf{q}^* = \arg\min_{\mathbf{q}} \|\mathbf{q}\|_0 \text{ so that } \|F\mathbf{y} - F\mathbf{D}_l\mathbf{q}\|_2 < \epsilon \tag{5}$$

where ϵ is a given constant that accounts for the noise; the linear operator F is introduced to extract perceptually significant features of the image (F is usually a high-pass filter).

Due to the presence of the norm $\|\cdot\|_0$, the above problem is NP-hard and can be relaxed in more tractable ones. It can be shown [11], that an efficient ways to achieve the sparse vector are given by solving the problem

$$\mathbf{q}^* = \arg\min_{\mathbf{q}} \|\mathbf{q}\|_1 \text{ so that } \|F\mathbf{y} - F\mathbf{D}_l\mathbf{q}\|_2 < \epsilon \tag{6}$$

or the problem

$$\mathbf{q}^* = \arg\min_{\mathbf{q}} \|F\mathbf{y} - F\mathbf{D}_l\mathbf{q}\|_2 + \lambda\|\mathbf{q}\|_1 \tag{7}$$

where the parameter λ balances the "fidelity" and the "sparsity" terms in the composition of the overall target error function (this latter approach is also known as *Lasso* [12]).

Step 2 Generate the SR patch as

$$\mathbf{x} = \mathbf{D}_h \mathbf{q}^* \tag{8}$$

The main problem related to SR compressed sensing approaches is the computation of a good pair of low- and high-resolution dictionaries (*dictionary learning*). If we assume that the high-resolution image $\mathbf{X}$ is known, then the problem can be approached in different ways.

A first method solves two separate minimization problems. The first problem tries to estimate the low-resolution dictionary $\mathbf{D}_l$ and the sparse vector $\mathbf{q}$ by solving (we omit the operator F for the sake of simplicity)

$$\{\mathbf{D}_l^*, \mathbf{Q}^*\} = \arg\min_{\{\mathbf{D}_l, \mathbf{Q}\}} \|\mathbf{Y} - \mathbf{D}_l\mathbf{Q}\|_F^2 \text{ so that } \|\mathbf{Q}_i\|_0 < T \tag{9}$$

where we now consider all the patches of the low-resolution image and the relative sparse vectors collected in the matrices $\mathbf{Y}$ and $\mathbf{Q}$, respectively (the column $\mathbf{Q}_i$ is the sparse vector of the ith patch); $\|\cdot\|_F$ is the Frobenius norm of a matrix; T denotes the (imposed) vector sparsity. The K-SVD [9] algorithm can efficiently solve this problem. The second approximation problem estimates the high-resolution dictionary $\mathbf{D}_h$ by solving

$$\mathbf{D}_h^= \arg\min_{\mathbf{D}_h} \|\mathbf{X} - \mathbf{D}_h\mathbf{Q}^*\|_F^2 \tag{10}$$

which is a quadratic problem if the output $\mathbf{Q}^*$ of the first minimization is used.

Other methods have been proposed for a joint estimation of the dictionaries and of the sparse vectors. In [7], the following minimization problem is solved:

$$\{\mathbf{D}_h^*, \mathbf{D}_l^*, \mathbf{Q}^*\} = \arg \min_{\{\mathbf{D}_h, \mathbf{D}_l, \mathbf{Q}\}} \left[\|\mathbf{X} - \mathbf{D}_h\mathbf{Q}\|_F^2 + \lambda_1\|\mathbf{Y} - \mathbf{D}_l\mathbf{Q}\|_F^2 + \lambda_2\|Q\|_1\right] \tag{11}$$

where the constants λ_1 and λ_2 are introduced to balance the different components of the apporoximation errors and of the sparsity constraint (that has been relaxed from $\|\cdot\|_0$ to $\|\cdot\|_1$ for mathematical convenience).

Dictionary learning embeds the prior knowledge of how a high-resolution image $\mathbf{X}$ is transformed into a low-resolution image $\mathbf{Y}$ by the acquisition process. Often, a large dataset of images, both high- and low-resolution, is used for dictionary learning. The performance of a SR algorithm depends on how the training dataset is representative for a specific class of image to which SR is applied. As an alternative, both the dictionaries can be constructed from the observed image $\mathbf{Y}$ to which the SR must be applied by using a *bootstrap* approach. In this case, $\mathbf{Y}$ is first considered the high-resolution image and the operator L is applied to it, obtaining a further low-resolution image $\mathbf{Z}$. Dictionary learning is then applied to the couple $\{\mathbf{Y}, \mathbf{Z}\}$ and then the SR is obtained from $\mathbf{Y}$.

For further details related to the implementation of compressed sensing SR, such as the treatment of overlapping patches, the reader can refer to [7][8].

3.2. Adaptive interpolation SR

Adaptive interpolation SR methods assume that local statistical properties of an image are maintained during the acquisition process. Hence, they try to extrapolate local covariance information, estimated from the observed low-resolution image, in order to reconstruct the high-resolution image.

In the following, we review one of the most promising methods belonging to this class, presented in [6]. The method is based on 2-D autoregressive (AR) modeling of images with soft-decision estimation of the SR image.

The algorithm works in two steps. In the first step, half of the pixels (shown as grey circles in Figure 2) are estimated from the original low-resolution pixels (shown as black circles), whereas in the second step the remaining pixels are estimated (shown as white circles).

Let us analyse the first step. According to a 2-D autoregressive model, the pixels of the observed low-resolution image x satisfy (see Figure 3 for the definitions of the neighboring pixels)

$$x_i = \sum_{1 \le j \le 4} b_j \bar{x}_{i,j} + v_i \tag{12}$$

where v_i represents a model mismatch term. In an analogous way, other expressions relating the unknown SR image pixels, denoted as y, and their neighbours (belonging to either SR or LR image) can be written as

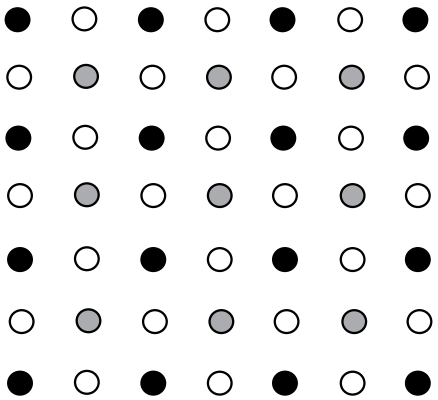


Fig. 2. SR by adaptive interpolation with soft-decision estimation [6]: original pixels (black circles); pixel positions estimated in the first step (grey circles); pixel positions estimated in the second step (white circles).

$$y_i = \sum_{1 \le j \le 4} a_j \tilde{x}_{i,j} + v_i \tag{13}$$

$$x_i = \sum_{1 \le j \le 4} a_j \tilde{y}_{i,j} + v_i \tag{14}$$

Furthermore, the unknown SR pixels should satisfy the constraint

$$y_i = \sum_{1 \le j \le 4} b_j \bar{y}_{i,j} + v_i \tag{15}$$

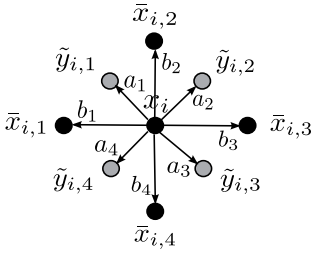
Let $\mathcal{A}$ be a local area in which we want to estimate the SR image. If the AR parameters are known, the SR pixels can be estimated by minimizing the energy of the modeling error with the constraint in (15), that is

$$J(\lambda) = \sum_{i \in \mathcal{A}} \|y_i - \sum_{1 \le j \le 4} a_j \tilde{x}_{i,j}| + \sum_{i \in \mathcal{A}} \|x_i - \sum_{1 \le j \le 4} a_j \tilde{y}_{i,j}\| + \lambda \sum_{i \in \mathcal{A}} \|y_i - \sum_{1 \le j \le 4} b_j \bar{y}_{i,j}\| \tag{16}$$

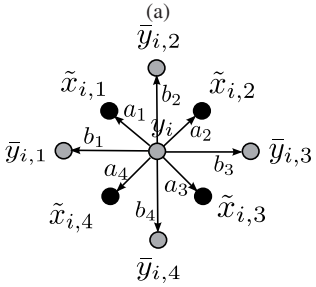
Iterative adjustment may be used for the choice of λ, even though a constant choice ($\lambda \approx 0.5$) works as well.

The AR parameters b_j are estimated from the LR image by minimizing the modeling error in (12), whereas a_j are estimated by using a similar equation relating x_i and its 45-degrees neighbors $\tilde{x}_{i,j}$.

The second step of the algorithm is similar to the first one, with the difference that, in this case, SR pixels - denoted with white circles in Figure 2 - can now be estimated by using also the results of the first step. For further implementation details, the reader may refer to [6].



(a)



(b)

Fig. 3. Autoregressive parameters and definitions of pixel positions used for the algorithm in [6].

Fig. 4. Test images used to assess SR algorithms performance.

4. EXPERIMENTAL RESULTS

In this section, some examples of the application of the methods described in the previous sections are shown. We have considered the algorithm in [8] (the software has been downloaded from [13]) and the algorithm in [6]. The test images shown in Figure 4 have been used.

As to the compressed sensing SR algorithm, 3×3 patches and a dictionary of 1000 atoms have been used. In the adaptive interpolation method, the window used for local parameters estimation was 5×5. The interpolation results (only details are shown) are given in Figure 5. The results show that a certain amount of sharpening can be achieved by using the SR techniques, especially in those areas that contain strong edges that classical interpolation methods tend to blur. Some considerations however are necessary. Single-image compressed sensing SR methods are sensitive to the prior knowledge about the acquisition system. The results we presented were obtained by using the bootstrap approach, in which a lower resolution image was obtained from the observed one by using a simple decimation filter, that not necessarily models the actual acquisition system. Furthermore, in applications where the class of images is well-defined (e.g., biomedical images obtained from a specific sensor), the construction of the dictionaries may benefit from the use of a large training set instead of the use of the single observed image. Using pre-calculated dictionaries is also convenient from a computational cost point of view. On the other hand, SR methods based on adaptive interpolation are less sensitive to a lack of prior knowledge and may be considered as more suitable when the class of images to which SR is applied is heterogeneous.

5. CONCLUSIONS

Super-resolution is an emergent area in signal processing that tries to overcome the resolution limitations of acquisition systems by post-processing. Several approaches have been proposed in the literature to achieve SR. In this work, some advanced methods for SR of images have been reviewed and some experimental tests have been set up to compare them.

6. ACKNOWLEDGEMENTS

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Fig. 5. Some results of the application of the SR algorithms: bilinear interpolation (leftmost column), method in [8] (central column), method in [6] (rightmost column).

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Image registration using 3D models

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Abstract – Multimodal data are a very informative source of information for cultural heritage diagnostics and documentation. Whether we want to map the state of conservation or to analyze the materials and methods used, generally saying, it is not possible to gather all necessary information by using a single technique. Therefore a more complete diagnostics campaign generally includes a number of different records acquired with various methods, and at different time instances. Data attained not always spatially overlap completely, moreover in case, e.g. of multimodal images, they may be taken from different viewpoints. In this work we introduce a new method to register two or more multimodal images acquired even from very distant points of views, by making use of the 3-D model of the artwork.

INTRODUCTION

Multimodal data are a very informative source of information for cultural heritage diagnostics and documentation. Whether we want to map the state of conservation or to analyze the materials and methods used, generally saying, it is not possible to gather all necessary information by using a single technique. Therefore a more complete diagnostics campaign generally includes a number of different records acquired with various methods, and at different time instances. Data attained not always spatially overlap completely, moreover in case, e.g. of multimodal images, they may be taken from different viewpoints. In this paper we proposed a new strategy to match pixels from independent images sharing the same subject, by using 3D information of the represented object. Finding reliable correspondences in two images of a object taken from arbitrary viewpoints, possibly recorded with different cameras and with diverse methods is a difficult and critical step. However, in order for data to be meaningfully integrated, they need to be spatially registered, so that at each special location corresponding information in different datasets could be inferred and the information correctly integrated.

THE PROBLEM STATEMENT

Registration of two images is the process of finding a geometrical transformation that aligns points in one image, representing a view of an object, with corresponding points in another image (view) of that object.

Thus, if we define an image, as the "template" (A), with coordinates r_A, and another the "target" image (B), with coordinates r_B, the aim of image registration is to estimate a geometric transform T:

$$T: r_A \rightarrow r_B$$

such that

$$T(r_A) = r_B.$$

Where the transformation T describes a spatial mapping from r_A to r_B.

The most general transformation between sets of points is elastic, which means that a straight line is mapped onto a curve [1]. If the transformation preserves the distance between any two points, it is called a rigid-body transformation.

Image registration or image alignment algorithms can be moreover classified into intensity-based and feature-based.

Intensity-based methods compare intensity patterns in images via correlation metrics, while feature-based methods find correspondence between image features such as points, lines, and contours.

As far as intensity methods are concerned, when a rigid body transformation is supposed, generally speaking an affine transformation is employed, i.e. a combination of translation, rotation, scaling and/or shearing (i.e. non-uniform scaling in some directions) operations. Its parameters are then selected so that the proposed similarity measure is optimized. A plethora of methods has been developed, which are relate to the kind of similarity measure used. Cross-correlation and Mutual Information are among the most commonly error measures employed. The main limitation are linked to the performance of the similarity measure, especially for multimodal registration purposes, even when a 3D curve transformation is employed.

Feature based methods, despite the efforts o extend this technique to non-planar objects, are even more prone to fail when two multimodal views are to be registered. Multimodal images, in fact, can have very few features in common.

Finding reliable correspondences in two images taken over a large baseline, so to determine the geometrical transformation among them, is an even more challenging task.

In the wide-baseline case, local image deformations cannot be realistically approximated by an affine transformation, Although many matching techniques in short baseline have been developed, as described above, the wide baseline correspondence problem with large scale, rotation, illumination and affine transformations is still intensely researched [2-5].

To the best of our knowledge, all these methods make no assumptions about the knowledge of the 3D model of the object. However nowadays, the 3D model of an artwork can be quite easily achieved, and is often one of the data available after the diagnostic campaign.

In this work we introduce a new method to register two or more multimodal images acquired even from very distant points of views, by making use of the 3-D model of the artwork.

FROM 2D TO 3D AND BACK

The key idea of our approach is to find, without making any assumption about the camera poses, the exact correspondences between the pixel of two different images sharing partially the same content by exploiting their mane common feature: the 3D object they represent.

Given two images I_1 and I_2 (fig. 1) and the 3D model of the represented scene (or of a specific object) (fig. 2), our method intends to find the right matching between the overlapped pixel in I_1 and I_2.

The overall approach is described in fig. 3: the 3D model is mapped with the pixels color of I_1 thus obtaining a partially colored 3D model, then it is moved according to a given position. Similarly I_2 is mapped and another partially textured model is obtained and moved to the given position.

The pixel information on the image are mapped in the 3D space (2D→3D) , once the 3D model is mapped and moved to the given position, a 2D projection of its vertex color is performed in order to obtain a new image for each of the two partially colored 3D model (3D→2D). Such images are inherently aligned and registered each other.

Fig. 1. Two images sharing partially the same content

Fig. 2. The 3D model of the represented object (Costanza Bonarelli from Museo del Bargello in Florence)

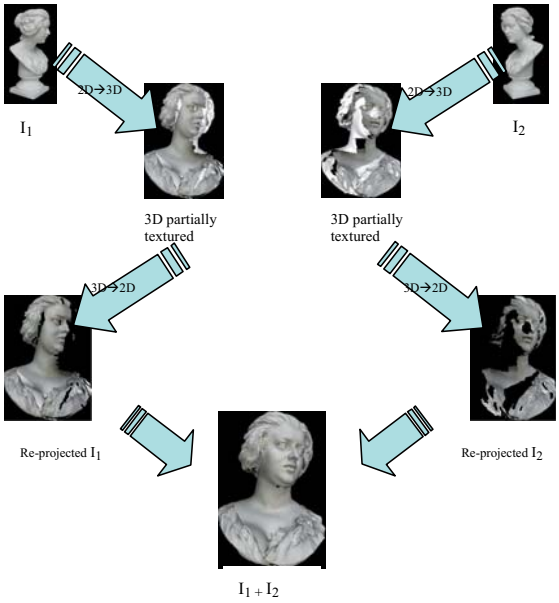

Fig. 3. The images (I_1 and I_2) are mapped on the 3D vertices of the model then the obtained 3D models are moved to a particular viewpoint and reprojected as two images. The resulting images are already aligned.

RESULTS

In order to evaluate the different performances of the proposed image registration system, some tests were executed using the some subject. The first is a XVI century wooden crucifix. We first scanned the object in order to get the 3D measures as shown in figure 4. Then we got a X-ray image of it and a fluorescence image (figure 5). On figure 6 the resulting registered images.

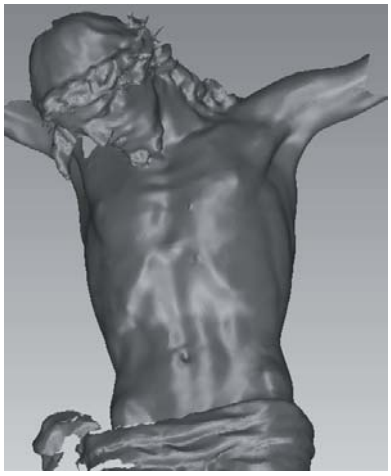

Fig. 4. 3D Scanning of the XVI century wooden crucifix

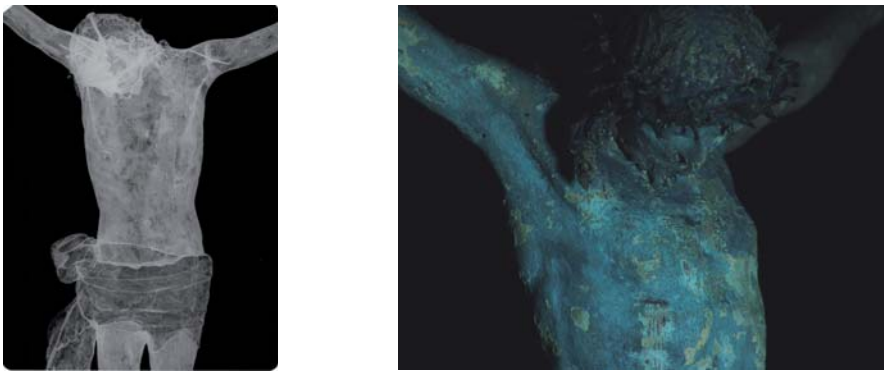

Fig. 5. On the left X-ray image, on the right the Fluorescence image of the XVI century wooden crucifix

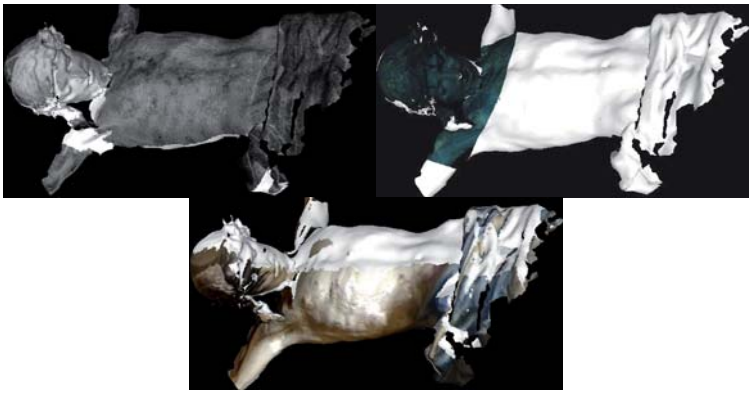

Fig. 6. Results of the X-ray, fluo and visible images alignment

An other test has been performed Costanza Bonarelli from Museo del Bargello in Florence. With the proposed solution we were able to align two images from the web (on Google images).

Fig. 7. Two images of Berninis' Costanza Bonarelli

Fig. 8. Results of the alignment

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CHALLENGING 3D SCANNING APPLICATIONS IN ARTS AND CULTURAL HERITAGE

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Abstract

The paper presents the state of art of high definition 3D scanning technologies and a selection of challenging applications, demonstrating that high definition 3D scanners can be operated not only in special labs with controlled conditions, but may be used in remote areas and under difficult environmental conditions. It focuses on projects with a wide range of objects – from very small structures to huge immobile buildings – in different locations, from Europe to Asia and America and even Antarctica – documented three-dimensionally under challenging conditions.

INTRODUCTION

We are now looking back on about 30 years of experiences with modern 3D scanning technologies. Nevertheless, it shall be pointed out, that the basic principle of triangulation and the knowledge, how to use it in metrology is much older. Already the ancient Babylonians and Egyptians started to use triangulation techniques in the field of geodesy and astronomy, although this was on a quite basic level, without having tools for measuring angles.

Later on, ancient Greek mathematicians such as Euklid and Archimedes have studied the mathematical fundamentals of trigonometry. One of the fathers of modern trigonometry, based on optical triangulation, was Snell von Rojen in the beginning of the 17th century.

The invention of the laser and the availability of reliable HeNe lasers resulted in significant progress in the realization of optical devices for measuring distances and surface maps, such as Laser triangulation sensors, light section and Moiré techniques [1], [2].

However, only the progress in some other key technologies, especially image processing and digital cameras in the mid of the 80th, allowed the development of reliable commercial 3D scanning devices for arbitrary surfaces. One of the first important attempts of using these techniques in cultural heritage was the scanning of the David within the Digital Michelangelo project [3]. With the remarkable progress in 3D scanning technology of the recent 10 - 15 years, also the 3D documentation and archiving of archaeological and cultural objects became more and more important, with an increasing number of archaeologists who are familiar with these techniques.

STATE OF THE ART OF HIGH DEFINITION 3D SCANNERS

Within the first ten years, i.e. until about 1995, only a very few 3D scanners based on fringe projection technique were commercially available, most of them developed by German companies. In the meantime, there is a large number of manufacturers offering topometrical scanners.

Nowadays many of these scanners are equipped with DLP projectors available on the comsumer market. However, high-end systems are still based on special projection units, designed for the integration in topometrical scanners, especially with respect to system stability and data performance. Table 1 shows typical specifications of existing topometrical scanners; they may greatly vary in important parameters, such as available FOVs, triangulation angle, accuracy and resolution. Additionally, there are special scanners with parameters optimized for dedicated applications.

	Typical Specifications	**smart*SCAN*^{3D} 5C**
Camera type	digital CCD or CMOS chip	2 CCD colour cameras
Camera resolution	VGA up to 16 MPixel	5 MPixel, each
FOV	few mm to about 2 m	30 to 1500 mm
Operating distance	several 10 cm to a few m	250 to 1500 mm
Triangulation angle	10 to 40 degrees	3 triangulation angles (30°/20°/10°) within one setup
Acquisition time	100 msec to 1 min	ca.1 sec (fastmode)
Sensor weight	1 to 20 kg	ca. 4 kg
X/Y resolution	10 µm to several mm	10 to 500 µm
Z resolution	few µm to mm	2 to 50 µm

Table 1: Typical specifications of topometrical 3D scanners

For many applications, especially in the field of bodymetry and life science as well for the documentation of cultural objects, e.g. paintings (see fig. 1), it is necessary to record the colour together with the 3d shape both with high resolution.

A straight forward way to realize a suitable scanner is to equip the 3D scanning device with colour camera(s). Such a setup automatically guarantees a one-to-one correspondence between the recorded colour and 3d information. The only additional equipment needed for this approach are suitable light sources to illuminate the object for the colour acquisition. This illumination should be as homogenous and diffuse as possible, as it should allow the colour recording from all the scanning positions without any distortions such as reflections or other effects caused by the illumination. As a special demand, the illumination must be stable for the whole scanning session, a requirement which is difficult to fulfil outside of special labs and for complex objects, where the scanning might take lots of hours or even days.

In those cases, it might be advantageous to record a sequence of 2D images with an additional external camera and to map those images onto the 3D model. This approach especially allows to record the colour with higher resolution than the 3D model.

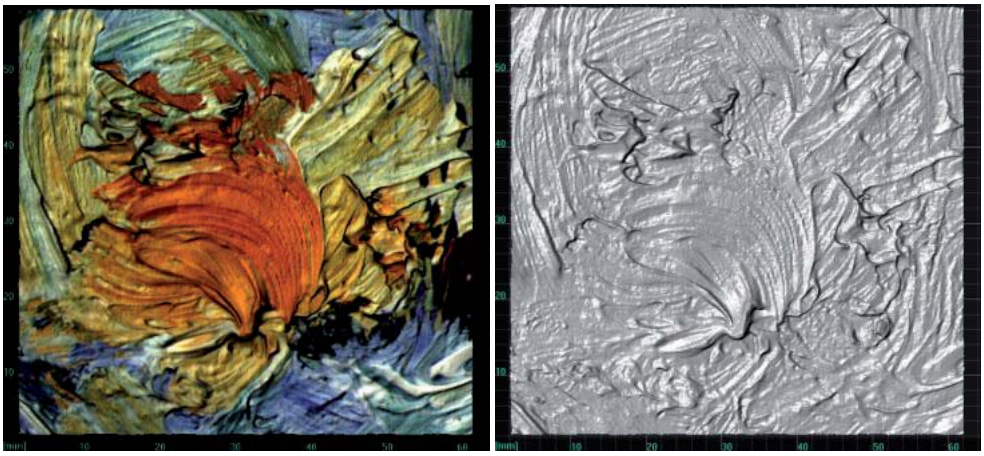

Figure 1: Different visualizations of a small area (about 6 x 6 cm) of a painting (Water Lilies, Monet, 1916, Kunstmuseum Winterthur), with/without texture

To overcome the limited dynamic range of digital CCD or CMOS chips, modern photographic cameras offer a High Dynamic Range (HDR) mode by combining images recorded with different shutter times.. This technique has been adapted to the 3D data acquisition allowing to record 3D data on shiny surfaces or for objects with strong differences in reflectivity. Figure 2 shows an example of the digitization of a black Obsidian.

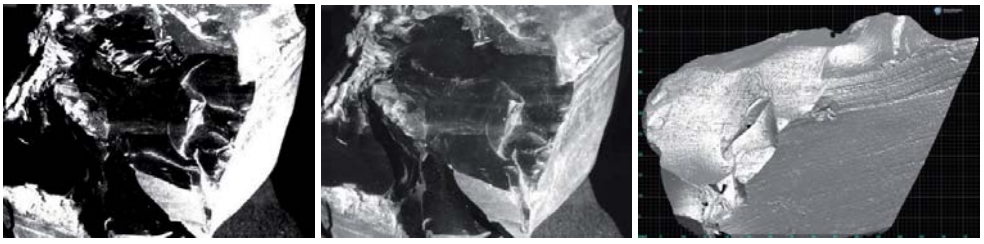

Figure 2: Digitization of an Obsidian with a modified High Dynamic Range Technique
left : conventional 2D-image, mid : 2D-image recorded with HDR, right : 3D-data

SELECTED APPLICATIONS

This paper will present a selection of challenging applications, demonstrating that high definition 3D scanners, based on fringe projection technology can be operated not only in special labs with controlled conditions, but may be used in remote areas and under difficult environmental conditions.

It focuses on projects with a wide range of objects – from very small structures to huge immobile buildings – in different locations, from Europe to Asia and America and even Antarctica – documented three-dimensionally under challenging conditions, resulting from difficult objects (size, material, complexity), measurement requirements (resolution, accuracy, amount of data) or environmental conditions (changing weather, burning sun-shine, freezing

cold, high humidity, sand and thunder storms as well as dangerous animals). Examples are shown in figures 3 to 7.

Figure 3: Combining 3D data of ancient coins **(**Denar of Gaius Iulius Caesar) with data of Electron Probe Micro Analysis (EPMA)
(in cooperation with University Erlangen-Nürnberg, Germany [4])

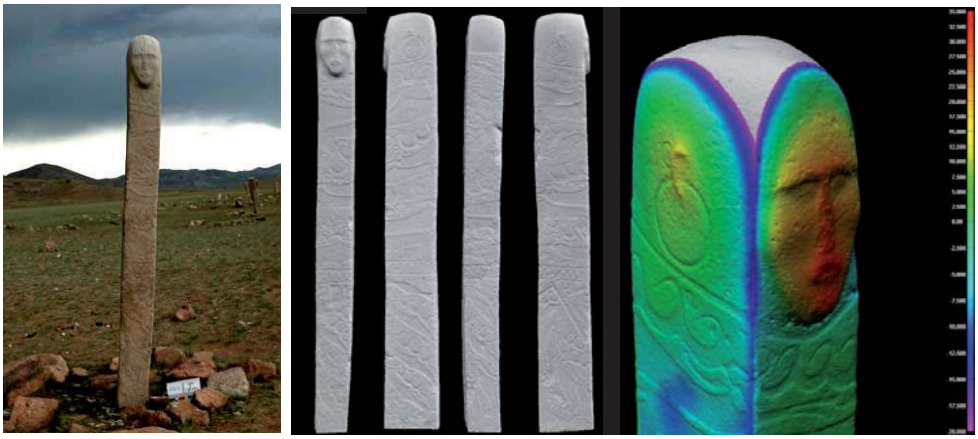

Figure 4: 3D scanning in truly remote areas: ancient monuments "deerstones" in Mongolia
(in cooperation with Smithsonian Institute, Washington [5])

Figure 5: The Peabody Museum's Corpus of Maya Hieroglyphic Inscriptions
(Harvard University [6], [7])

Figure 6: High-Definition 3D Acquisition of Angkor Style Reliefs (by IWR, Heidelberg [8])

Figure 7: 3D scanning at Terra Nova Hut in Antarctica (by Geometria, New Zealand [9])

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3D SURFACE RECONSTRUCTION USING MULTIPLE KINECTS

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Abstract – Devices that capture three dimensional (3D) surface characteristics have been around for over thirty years. These devices known as range scanners are expensive and output a two-dimensional array of distances corresponding to each point in the imaged scene. The recent introduction of the KINECT by Microsoft has revolutionized the use of range scanners. The KINECT uses a different technology and is significantly cheaper. This paper presents the results of 3D surface reconstruction using both depth and RGB images captured by multiple KINECTS. The surface description generated will be useful in rendering description of objects and other artifacts.

INTRODUCTION

The evolution of computer vision, the use of a camera and a computer to recognize objects, began in the early 1960s. It has matured fairly quickly and contributes to the solutions of some of the most serious societal problems. Until now, most of the vision algorithms have been built on 2D intensity images, but we are living in a 3D world. The estimation of 3D geometric structure is necessary for most computer vision applications such as navigation and object search. However, earlier range sensors were either too expensive, difficult to use in human environments, slow at acquiring data, or provided poor estimation of distance. Our group's research on range data dates back to the 1980s, when we used laser range sensors. Among the earlier attempts, we did experiments combining intensity and range edge maps [1], describing 3D structures of objects [2, 5]. To overcome the defect of the slow speed of the laser range sensor, we explored an intensity guided range sensing recognition of 3D objects [3]. Later, we studied image reconstruction using multiple sensing modalities [4].

While depth cameras are not conceptually new, the recent release of the Kinect has made such sensors accessible to all and received a great deal of attention from the public for its broad applications. The Kinect provides both an RGB image and a depth image. It generates real-time depth maps containing discrete range measurements of the physical scene. This data can be re-projected as a set of discrete 3D points. The quality of the depth sensing, given the low-cost and real-time nature of the device, is compelling, especially when compared with the previous commercial range sensors. There is a significant number of research studies using the Kinect in the last three years. Projects and applications can be found on human detection [6], pose estimation [7], tracking [8] and activity recognition [9].

The construction of 3D description of a scene or an object is an important issue. In this paper, we aim at constructing the description of objects from multiple views. From a single depth image, we can recover the 3D structural information on a portion of the object. If we capture data from multiple views, we can reconstruct the full 3D surface of the object. Particular, we construct the 3D point clouds of the objects in view from pairs of depth images and RGB images. We first calibrate the depth and RGB images, back project the pixels from image coordinates to the real-world coordinates, and calibrate the data from all views and combine them to construct full 3D point clouds. Figure 1 gives the overview of the main steps.

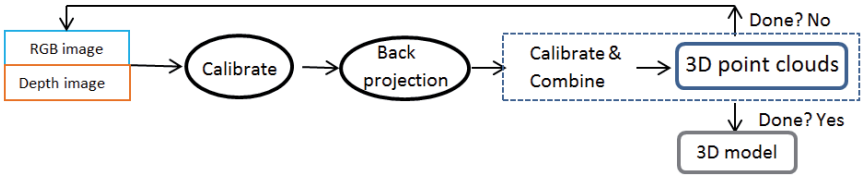


Figure 1. Overview of the algorithm

CALIBRATION OF DEPTH AND RGB IMAGE

The Kinect device has a color and a depth camera pair rigidly attached to the Kinect sensor. Because the infrared and RGB cameras are separated by a small baseline, the two views from the two cameras are not exactly the same. In order to reconstruct a 3D scene from the camera pair measurements, the system must be calibrated to match the (r, g, b) values to the depth value. This includes internal calibration of each camera as well as relative pose calibration between the cameras. The calibration procedures and parameters can be found in literatures [10, 11]. And this procedure has been combined into many of the tools or libraries, such as MSR SDK, OpenNI, Matlab, and OpenCV.

BACK PROJECTION

In the depth image, every pixel corresponds to the distance between that real-world point to the sensor in millimeters; The X and Y coordinates in the Euclidean space can be calculated from its image coordinates and the depth value:

$$X_k = -\frac{Z_k}{f}(x_k - x_0 + \delta_x)$$
$$Y_k = -\frac{Z_k}{f}(y_k - y_0 + \delta_y) \quad (1)$$

where x_k and y_k are the image coordinates of the point, x_o and y_o are the coordinates of the principal point, and δ_x and δ_y are corrections for lens distortion, for which different models with different coefficients exist, and we take it as zero.

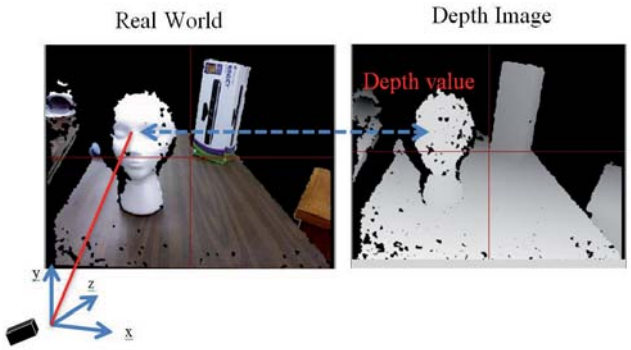


Figure 2. The illustration of the depth image

CALIBRATION BETWEEN DIFFERENT VIEWS

We assume the Kinects are stationary. First, we place the object or sculpture in the scene. Then we capture the images from different views by either using multiple Kinects or moving one Kinect to different locations. We calibrate the images from all the views by calibrating one pair at a time. First, we get correspondent points from the pair of depth images. We can calculate key points [12] from the two views and estimate correspondences when there is a great deal of overlap between the two views, or we can find the correspondent points

manually when there is not enough overlap to compute correspondence automatically. After we get the correspondences, we compute the transformation between the two views and calibrate. Supposing the key points from view 1 are denoted by $p_k \in R^3, k = 1,...,n$, where the three components of $p_k = [x_k, y_k, z_k]^T$ represent its horizontal, vertical, and depth coordinate respectively. We compute its coordinates in Euclidean space using equation (1), denoted by $\hat{p}_k = [X_k, Y_k, z_k]^T$. The corresponding key points in view 2 are denoted by $q_k \in R^3, k = 1,...,n$. We transform them into Euclidean space as $\hat{q}_k, k = 1,...,8$. Note the key points are selected such that the matrix $P = [\hat{p}_2 - \hat{p}_1, \ ..., \ \hat{p}_n - \hat{p}_1] \in R^{3\times(n-1)}$ has rank 3. Then, we compute the estimated rotation matrix R and translation vector T as follows:

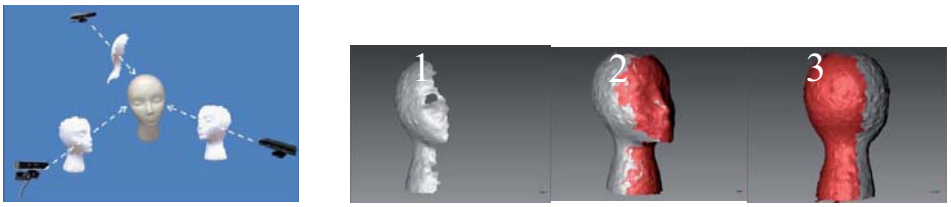
$$R = Q\overline{P},$$
$$T = \frac{1}{n}(\tilde{Q} - R\tilde{P})\vec{1}, \qquad (2)$$

Where, $Q = [\hat{q}_2 - \hat{q}_1, \ ..., \ \hat{q}_n - \hat{q}_1] \in R^{3\times(n-1)}$, $\tilde{P} = [\hat{p}_1, \ ..., \ \hat{p}_n] \in R^{3\times n}$, $\tilde{Q} = [\hat{q}_1, \ ..., \ \hat{q}_n] \in R^{3\times n}$, $\vec{1} = [1,...,1]^T \in R^n$, and $\overline{P} \in R^{(n-1)\times 3}$ is the pseudo-inverse of P such that $P\overline{P}P = P$, $\overline{P}P\overline{P} = \overline{P}$ and both $P\overline{P}$ and $\overline{P}P$ are Hermitian.

With the computed R and T, the transition between a point $p \in R^3$ in the first depth image and its corresponding point $q \in R^3$ in the second image is $q = Rp + T$.

CONSTRUCT 3D MODEL

With equation 4, by calibrating one pair of views at a time, we can transform all the data to one reference frame. This will give us the full 3D point clouds of the object in view. To clean the point clouds, we can do background subtraction in the 3D point clouds. Unlike in RGB images, it is comparatively easy to do background subtraction in 3D. In most cases, we just filter by its 3D location, and we can get clean point clouds. We can further build 3D mesh from the point clouds using tools such as MeshLab.



(a)Scanning from 3 different views (b) reconstruct 3D model

Figure 3. The process of building a 3D model from 3 different views

EXPERIMENTAL RESULTS

1. 3D RECONSTRUCTION

We test our algorithm on a variety of objects or sculptures, including a wood carving of a bear, a male head model, a female head model, a model of Michelangelo's David, an Indian god sculpture, and longhorn horns. Figure 4 gives the result of the 3D reconstruction of those sculptures. There are several existing tools/software to show the 3D models, here we use KScan3D[1]. For each sculpture, we display its 3D model without color (up) and with color (down). For each object, we take the data from 20~30 views with a hand held Kinect. Results show that the rendition is quite satisfactory. In practice, the user can take data from additional views to get a more accurate and detailed rendition.

[1] http://www.kscan3d.com/

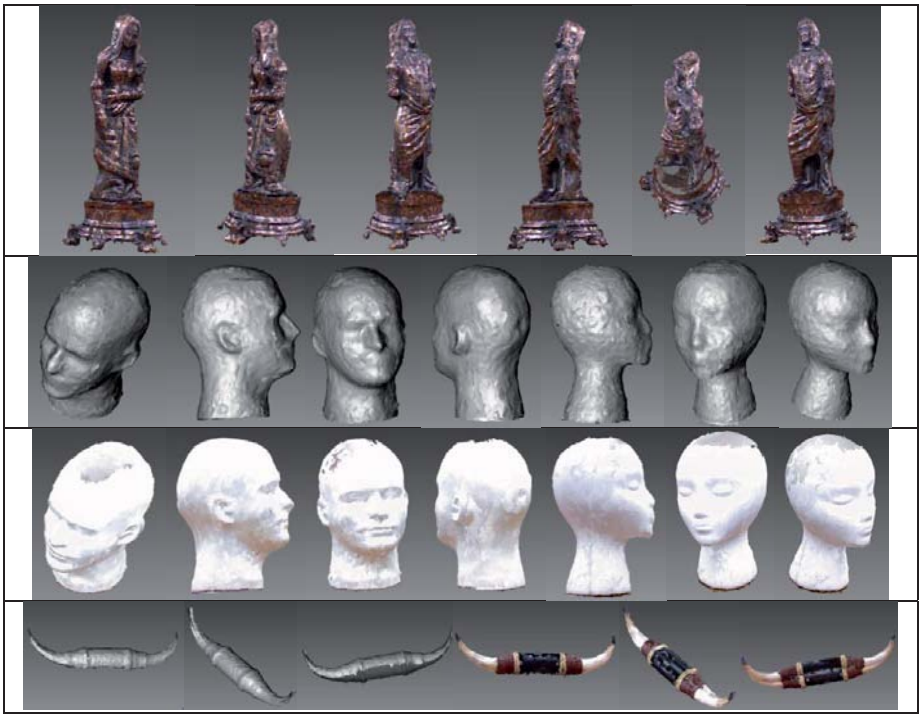


Figure 4. Reconstructed 3D model viewed from different views.

2. MEASUREMENTS

With the reconstructed 3D model, we can take measurements of the object without touching the real object, especially with parameters that would be impossible to measure from the depth image of a single view. In this section, we analyze the accuracy of measurements from the 3D reconstructed model using the head sculpture as an example. We take 3 parameters of the head sculpture: width, length, and depth, illustrated in Figure 5.

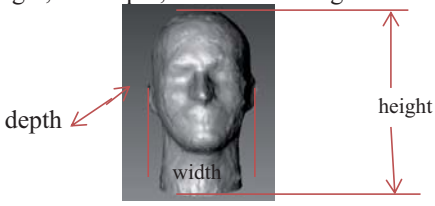


Figure 5. Measuring the parameters of the model

The physical measurements of the parameters and the measurements from the reconstructed 3D model are shown in table 1.

	Physical measurements(mm)	3D model(mm)	error
Width	173	178	2.9%
height	292	293	0.3%
Depth	219	204	-6.9%

Table 1. Measurements of the 3D model

The measurements of the raw point clouds have some bias from the physical measurements. The error of the 3D model measurements mainly comes from the following aspect: first, the calibrations of the views have errors. Second, the depth sensing itself has errors, the depth value fluctuates. This error is unavoidable, but we can reduce it by taking multiple experiments and calculating the mean. Third, the reprojection of the pixels in the depth image

back to the real world coordinates has errors but such errors can be eliminated by parameter tuning. Note the physical measurements done manually have errors as well. In practice, we find it much easier to take measurements from the reconstructed 3D model than to measure the real objects. In addition, the measurements taken from the 3D model are relatively accurate.

CONCLUSION

Although range sensors have been around for decades, the practice of 3D rendition using the old sensors is quite expensive and requires a great deal of work. During recent years, the technology in sensing and graphical display has improved dramatically. This paper shows that with the cost-effective Kinect sensor, we can render the 3D model of objects in a convenient, easy, and inexpensive fashion. Results show that using data from only 30 views, we can reconstruct the full surface of the 3D objects with satisfactory precision, which we can observe from any view, and take measurements. This rendition technique can benefit a variety of applications, including virtual reality, 3D telecommunication, 3D scanning, gaming, indoor space exploration, and so on.

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INTEGRATING REAL 3D DATA AND HISTORICAL SOURCES FOR THE DIGITAL RECONSTRUCION OF FIVE HINDU TEMPLES

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Abstract – A virtual reconstruction of a set of five tower temples belonging to the archaeological area of My Son in central Vietnam, is shown. The novelty of the methodology proposed is an integration of actual 3D data collected on the site through various 3D capturing technologies and a set of historical and archeological sources and considerations. The paper shows how with a proper interdisciplinary process where technical experts in 3D capturing and digital modeling technologies interact with archeologists, reality based models may give an active feedback to the archeological reasoning, allowing to hypothesize a reliable virtual reconstruction.

INTRODUCTION

In the last decade the use of 3D acquisition techniques in the archaeological field has allowed to widen the scope of the geometric survey process, providing both high resolution reality-based digital models and suggestive 3D digital reconstructions of architectures anymore existing, as support for a careful interpretation of the existing ruins. A weak part of this latter is represented by the lacks of scientific reliability on the reconstructed model.

The methodology here proposed is based on a first extensive 3D documentation of the site in its current state, followed by an iterative interaction between archaeologists and digital modelers, leading to a progressive refinement of the reconstructive hypotheses. This approach has been verified on the ruins of five temples in the My Son site, a wide archaeological area located in central Vietnam. Created by the ancient Cham civilization active in Vietnam from 4th to 18th century, it has been listed as UNESCO World Heritage in 1999. The 3D acquisition and modeling of a specific set of five temples, indicated by the archaeologists as "G group", is here presented and methodologically discussed.

METHODOLOGY

Although the process supporting the transformation from a set of 3D point clouds to a polygonal model is well known since more than a decade [3, 4], it has been progressively improved to better suit the Cultural Heritage field [5, 6, 7].

The reality-based digital model had a double purpose in this project. On one hand it allowed an accurate documentation of the current site status, on the other hand it was a starting point for a digital reconstruction. Differently from the reality-based models, the archetypal reconstructive digital models suggest a diachronic analysis [8], stacking on the possibility of "seeing in the past".

The path from reality-based to interpretative models is not so widely developed, for this a precise iterative feedback strategy was defined, in order to check each important interpretative step during the virtual reconstruction through a sequence of archaeologist's controls on the modeling evolution, starting from a volumetric simplified version to the best detailed one.

3D SURVEY

As known, several factors may affect the quality of 3D data acquired by a range device. In particular logistics and weather conditions become crucial, specially if the survey project has to be planned far abroad. The range sensing device adopted was the Focus3D (Faro) system, a Continuous Wave (CW) laser scanning with detection of phase shifts. In addition "Structure From Motion" (SFM) techniques were experimented, but at the time (Feb 2011) this promising technology was not yet developed as today, therefore it was only tested on a few artifacts. The device used for this purpose and for general image capturing, was a digital Single Lens Reflex (SLR) camera Canon 5D Mark II.

a)

b)

Figure 1 – Critical 2D and 3D image acquisition: a) 3D laser scanning of the G4 ruins; b) image acquisition of the kalan (G1) taken from from G2 in a precariously balanced situation.

The acquisition process was divided in three different step. In the first one the scanner was positioned at 7 meters from ground, acquiring 4 high resolution scans of the whole architecture and the surrounding DTM area. Than a long sequence of architectonic acquisitions was realized around the building and integrated with a detailed one devoted to survey the decorated basement. To avoid the shadow effects generated from the basement, an additional sequence of 3 meters height scans was carried out.

The second step considered the DTM acquisition, locating the whole architectures in a common reference system. The other architectural buildings presented a simpler geometry than the Kalan, for this reason a simpler acquisition process was adopted.

	Resolution			Size
	Coarse	Medium	High	(points x 10^6)
G1 (Kalan)	7	43	22	126
G2 (Portal)	/	9	/	21
G3 (Assembly hall)	/	8	/	15
G4 (South building)	/	13	/	31
G5 (Pavilion for the foundation stone)	/	6	4	4
DTM	49	/	/	27
21 Finds	/	/	60	2
Total	**56**	**79**	**86**	**226**

Table 1 –Number of point clouds acquired at different resolution

The last phase was based on the 3D high resolution acquisition of archaeological finds, discovered near the temples and classified inside the store-room of the local museum.

The photographic campaign was devoted to support the texturing process. Only some set of images were taken for testing SFM, obtaining good results in the 3D capture of the G5 foundation stone, overtaking the laser scanner measurement uncertainty that made impossible the readability of the tiny geometric detail [9].

REALITY-BASED MODELING

Every cleaned scan was aligned by means of the ICP algorithm implemented in the Leica Cyclone 3D processing software. The resulting point clouds were then decimated at 1 cm sampling step, leveling all the over-sampled portion of the architecture and lowering the amount of 3D data. Each point cloud was subdivided in sub-units, meshed uniformly and post-processed, than remerged in a complete polygonal model.

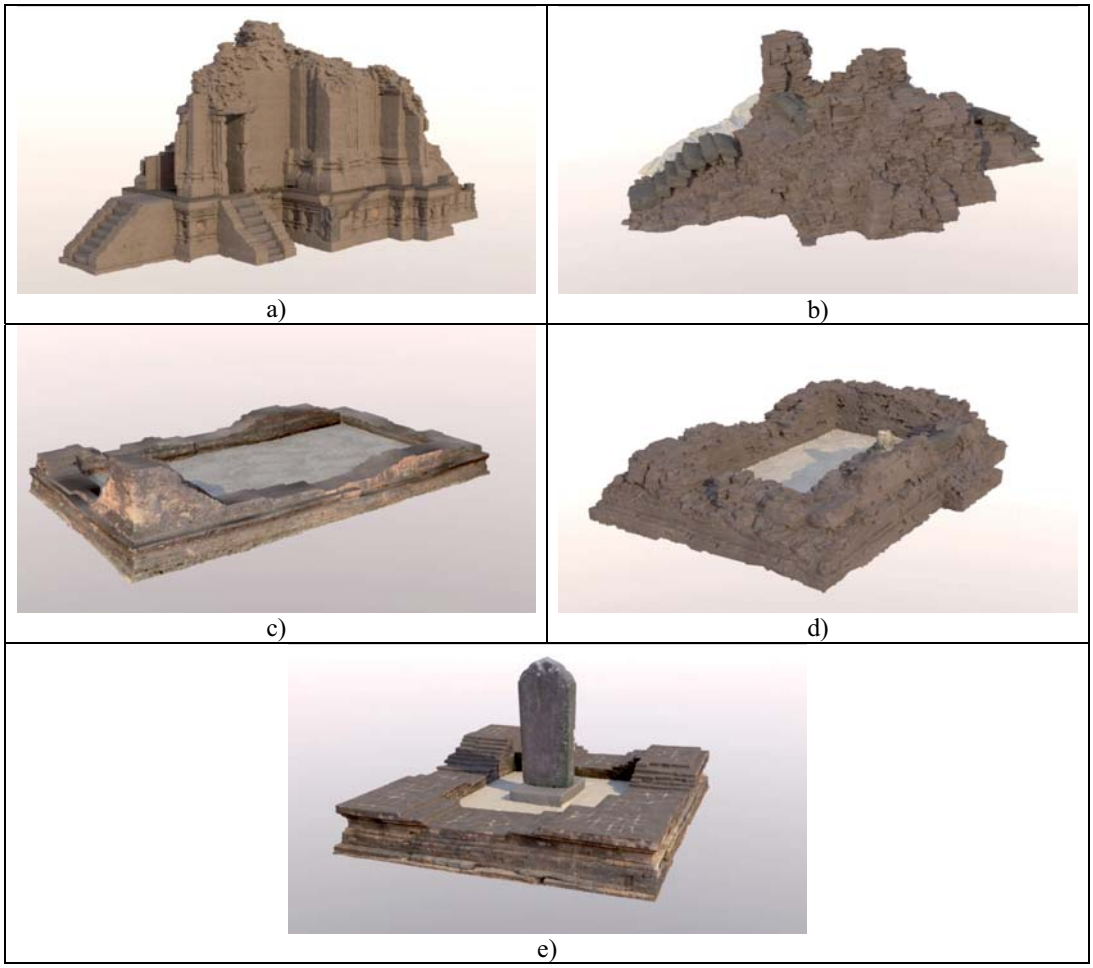


Figure 2 - Reality-based models of all ruins in the G group texturized with the actual images of the buildings: a) G1, the main temple; b) G2, the entrance portal to the holy area; c) G3, the assembly hall; d) G4, the south building; e) G5; the kiosk of the foundation stone.

This process allowed to build a 1 cm resolution geometry of all the five buildings in the G Area, a 10 cm resolution DTM of the hill where G Area is located, a set of polygonal models of sculpted finds with a geometrical resolution of 2 mm.

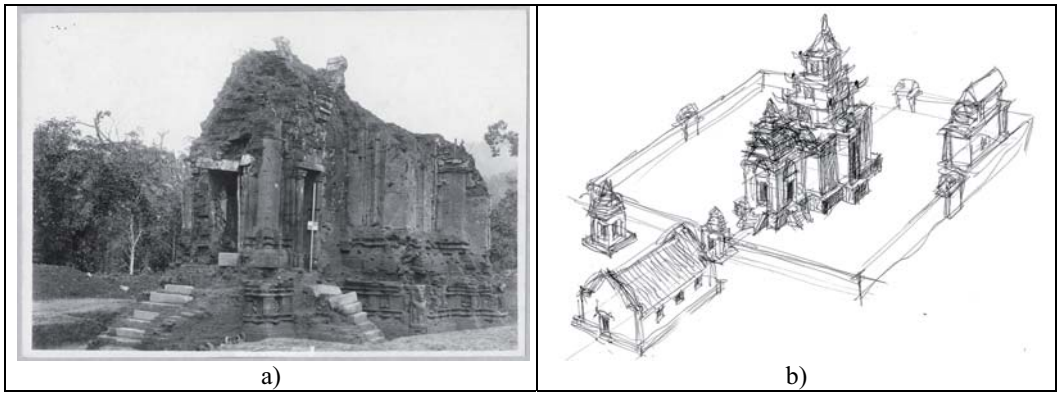
At the end different approaches were followed to texturize such reality based models. As shown in Figure 2 in the models representing the worst conserved buildings, a seamless shading pattern originated from real images was chosen (Fig. 2b and 2d respectively). For the Kalan temple and for the well-preserved architecture (Fig. 2c and 2e respectively) most of the texturing was done with the actual images of the ruins projected on the model.

In addition the whole scene was modeled using the low resolution DTM, some library models of trees and a spherical panorama captured from the top of Kalan,

The approach followed for acquisition and modeling of the sculpted findings was similar to that employed for the architectural structures, but an optimized post-processing procedure was analyzed to preserve the geometrical details.

RECONSTRUCTIVE MODELING

The reconstruction phase started from the geometrical information contained in the reality-based models of both the single buildings and the whole aligned scene, sectioning the digital artifact with planes along the three main directions x, y z. The reality-based digital model was also used for checking possible incoherencies introduced during the reconstruction procedure. In addition, the creation of reconstructive models was also based on the integration between bibliographical or iconographical sources and acquired 3D data.



a) b)

Figure 3 – Historical and iconographical documentation: a) photography of the temple collected by Henri Parmentier at the beginning on ‘900; b) preliminary sketch of the whole area by Pierre Pichard

In addition, a further iconographical research was done, researching the common stylistic elements present in other coeval Cham’s architectures. Interpretative drawings from Pierre Pichard, one of the most known experts of Cham architecture, were also used (see Figure 3b).

After historical and iconographical comparisons, an height in the range between 15 to 20 meters was agreed by the experts as suitable for the Kalan temple. In addition to this rough approximation, the evaluation of the religious role of each building allowed to refine these measures, identifying 7 meters as suitable high for the gateway and 16 for the Kalan one.

As for the decorative elements, it was necessary to redraw some broken elements which were hypothesized coherently with the iconographical sources. The same virtual reconstructions were made also on several other decorations.

The following step of this work was the reconstruction of the architectural structures starting from the existing geometry. The approach used was to interleave a phase of technical

construction of the shapes with a strong critical revision by the experts of Cham archeology for generating feedback and corrections before moving forward to the following step.

Than the latest architectonic refinements were applied and all the sculpted decorations digitized in the store-room were located in the supposed right places. The introduction of these decorations constrained the architecture structure, trying to fit them in their hypothesized positions.

In the final step the different texture mapped architectural models, including all their decorations, were merged in a single three-dimensional virtual reproduction of the G group.

Figure 4 – Reconstruction of the whole group G with its surroundings.

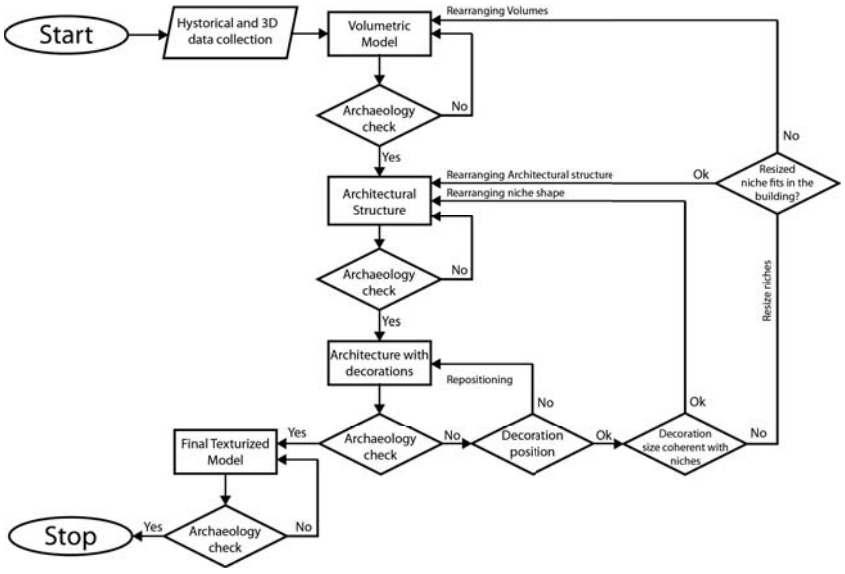


Figure 5 – Final schema of the suggested process based on reality-based 3D feedback.

CONCLUSIONS

This paper describes a process of acquisition and modeling applied to create a virtual reconstruction of lost architectures located in a striking context, the My Son archaeological area in Vietnam. Inside a common used 3D acquisition and modeling approach some different topics are discussed, suggesting both optimized procedures for data processing and communication. In particular, as synthesized in Figure 5, an iterative methodology is suggested to support the interpretative modeling step, simplifying the feedback on virtual models by the archeologists.

As future development it would be interesting to explore an enhanced communication level between the different historical and technological experts, based on social networking instruments, and annotations on renderings or directly on 3D models.

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AN INTRODUCTION TO GAIT RECOGNITION

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Abstract - This paper gives a brief introduction to gait recognition and discusses its possible applications in visual arts and biomedical engineering. Gait is the way one walks. It can work at a distance and with low resolution, where other biometric modalities often fail. Thus, research on gait has gained popularity in surveillance applications in the past decade. This paper describes a typical gait recognition system and reviews two popular approaches. We present some gait recognition results on a public database to facilitate discussions of important issues. Finally, we discuss potential applications of gait analysis in visual arts and biomedical engineering.

1 MOTIVATION OF GAIT RECOGNITION

Gait recognition [1], [2], the identification of individuals in video sequences by the way they walk, has recently gained significant attention. This interest is strongly motivated by the need for automated person identification system at a distance in visual surveillance and monitoring applications in security-sensitive environments, e.g., banks, parking lots, museums, malls, and transportation hubs such as airports and train stations [3], where other biometrics such as fingerprint, face or iris information are not available at high enough resolution for recognition [4]. In particular, the Defense Advanced Research Projects Agency (DARPA) has launched the Human Identification at a Distance (HumanID) program to develop automated biometric identification technologies to detect, recognize and identify humans at great distances [5]. Furthermore, night vision capability (an important component in surveillance) is usually not possible with other biometrics due to the limited biometric details in an IR image at large distance [4].

Gait, the peculiar way one walks, is a complex spatio-temporal biometric [6] that can address the problems above. In 1975 [7], Johansson used point light displays to demonstrate the ability of humans to rapidly distinguish human locomotion from other motion patterns. Similar experiments later showed the capability of identifying friends or the gender of a person [8], [9], and Stevenage *et al.* show that humans can identify individuals based on their gait signature in the presence of lighting variations and under brief exposures [10].

Gait is a behavioral (habitual) biometric, in contrast with those physiological biometrics such as face and iris, and it is viewed as the only true remote biometric [11]. Capturing of gait is unobtrusive, which means that it can be captured without requiring the prior consent of the observed subject, and gait can be recognized at a distance (in low resolution video) [12]. In contrast, other biometrics either require physical contact (e.g., fingerprint) or sufficient proximity (e.g., iris). Furthermore, gait is harder to disguise than static appearance features such as face.

2 A TYPICAL GAIT RECOGNITION SYSTEM

Figure 1 depicts a typical gait recognition system. A camera captures a raw gait sequence by observing a subject in the view and this raw sequence is then pre-processed to extract a gait sequence for feature extraction. Binary gait silhouettes are usually extracted through background subtraction, where a background model is estimated from the input raw gait sequences and then it is subtracted to get the silhouettes [13]. The extracted silhouettes are then cropped and resized to a standard size.

After the preprocessing, features useful for discriminating different persons are extracted from the normalized gait sample. In the recognition stage, the extracted features are matched against those of enrolled ones in the database, using classifiers. Finally, the system outputs the identity of the input when a match is found with sufficient confidence or indicates an unknown identity otherwise.

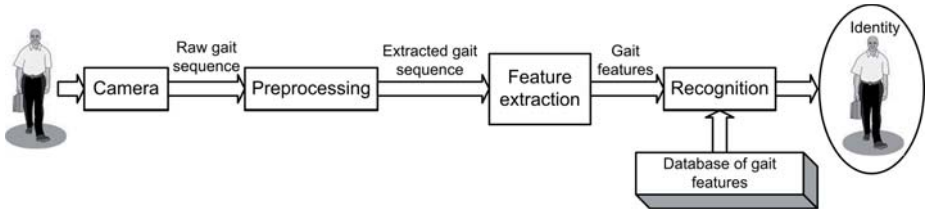

Fig. 1. A typical gait recognition system.

3 TWO POPULAR GAIT RECOGNITION APPROACHES

There are two general approaches in gait recognition: one is appearance-based and the other is model-based [14]. Their fundamental difference is the gait representation. An appearance-based approach considers gait as a holistic pattern and uses a full-body representation of a human subject as silhouettes or contours. In contrast, a model-based approach considers a human subject as an articulated object represented by various body poses. Although the model-based approach takes advantage of our prior knowledge on human gait and it is more sound, reliable recovery of human body poses (model parameters) from raw gait sequences is a very hard problem that has been studied in the human tracking or pose recovery literature [15], especially in outdoor conditions. Therefore, the appearance-based approach has been the most successful in reported literature. In the following, we discuss some representative works from both approaches.

3.1 Appearance-based approach

Most of the gait recognition algorithms proposed are appearance-based [3], [16]–[20], where silhouettes are obtained through background subtraction and treated as holistic patterns. Some works use the silhouettes directly as gait representation [21], [22] and some others use the average silhouettes as gait representation [18], [23]. These gait recognition algorithms extract structural or shape statistics as features from silhouettes, e.g., width [17], contours [3], [24], projections [25], and motion patterns [26]–[28]. There are also methods based on dense optical flow [29], which identify individuals by periodic variations (phase features) in the shape of their motion.

Recently, there is an increasing interest in tensor-based processing of gait sequences [30]– [38], motivated by the fact that the natural representation of a gait object is tensorial (multidimensional) rather than vectorial (one-dimensional) . Tensor is the higher-order extension of vector and matrix. For example, the multilinear principal component analysis (MPCA) algorithm extracts features directly from tensorial (three-dimensional: row, column and time) representations of gait, and it has been combined with the linear discriminant analysis (LDA) and boosting [30], [33] to achieve excellent gait recognition results.

3.2 Model-based approach

Model-based gait recognition algorithms are usually based on 2-D fronto-parallel body models [39], [40] and target to model human body structure explicitly, with support from the anthropometry and the biomechanics of human gait [41]. Body model parameters, such as joint angles, are searched in the solution space through matching edges and region-based information (e.g., silhouettes). The search methods are either exhaustive [39] or in a Bayesian hypothesis-and-test fashion [12], where proper dealing with local extrema is an important problem. The estimated parameters are either used directly as features or fed into a feature extractor (e.g., frequency analyzer) to obtain gait features.

There are also works on coarser human body models. For instance, the work in [16] fits several ellipses to different parts (blobs) of the binary silhouettes and the parameters of these ellipses (e.g., location. and orientation) are used as gait features. Another work proposed a full-body layered deformable model (LDM) [42], inspired by manually labeled body-part-level silhouettes [43]. The LDM has a layered structure to model self-occlusion between body parts and it is deformable so simple limb deformation is taken into consideration. In addition, it also model shoulder swing. The LDM parameters are recovered from automatically extracted silhouettes and then used for recognition.

3.3 Recognition

Once gait features are extracted, standard pattern classification algorithms can be employed for recognition, e.g., correlation (similarity measure, template matching) [21], *k*-nearest neighbor classifier [30], *k*-nearest center classifier [33], support vector machine (SVM) [44], hidden Markov Model (HMM) [4] and Dynamic Time Wrapping (DTW) [16].

4 GAIT RECOGNITION RESULTS AND CHALLENGES

In this section, gait recognition performance is illustrated on the USF HumanID Gait Challenge data sets version 1.7 [21]. This database consists of 452 sequences from 74 subjects. For each subject, there are three covariates: viewpoint, shoe type and surface type. The gallery set contains 71 sequences (subjects) and seven experiments (probe sets) are designed for human identification as shown in Table 1. The gallery set contains the set of data samples with known identities and it is used for training. The probe set is the testing set where data samples of unknown identity are to be identified and classified via matching with corresponding entries in the gallery set.

The identification performance is measured by the rank k identification rates [21], where the rank k results report the percentage of probe subjects whose true match in the gallery set was in the top k matches. The gait recognition performance of the following four gait recognition algorithms, together with the baseline algorithm [21], are presented in Table 1: HMM [17], linear time normalization (LTN) [22], gait energy image (GEI) [23], and MPCA+LDA [30]. In the table, the rank 1 and rank 5 identification rates are listed for each probe (A to G). The best results for all the probe and rank combinations are highlighted by boldface font in the table.

	Rank 1 recognition rate (in %)					Rank 5 recognition rate (in %)				
Experiment	Baseline	HMM	LTN	GEI	MPCA+LDA	Baseline	HMM	LTN	GEI	MPCA+LDA
A (view)	79	99	94	**100**	99	96	**100**	99	**100**	**100**
B (shoe)	66	**89**	83	85	88	81	90	85	85	**93**
C (view+shoe)	56	78	78	80	**83**	76	**90**	83	88	88
D (surface)	29	35	33	30	**36**	61	65	65	55	**71**
E (shoe+surface)	24	29	24	**33**	29	55	65	**67**	55	60
F (view+surface)	**30**	18	17	21	21	46	**60**	58	41	59
G (view+shoe+surface)	10	24	21	**29**	21	33	50	48	48	**60**

TABLE 1 Gait recognition performance on Gait Challenge data sets Version 1.7. The difference of each experiment condition from the gallery condition is indicated in parentheses.

From the results presented, we can see that the viewpoint and the shoe type have much smaller impact on the performance compared to the surface type. In [21], it is pointed out that the surface covariate impacts the gait period more than other covariates. Two possible solutions are suggested in [21]: one is to predict the change in gait with surface type and the other is to find other gait description insensitive to surface type.

The work in [23] is along the first direction. In addition, it is shown that the lower 30% of the silhouette accounts for about 75% of the identification rates, suggesting the importance of the lower portion for recognition. Similar results are also shown in [45], [46]. Another insight is that interactions of the foot with the walking surface could be one source of the problems.

5 POTENTIAL APPLICATIONS IN VISUAL ARTS AND BIOMEDICAL ENGINEERING

Gait analysis could be useful for visual arts involving human motions. In the filmmaking industry, human motion capture and transfer are expensive processes, usually utilizing lots of markers. The development in automated gait analysis could help to reduce the cost of human motion capture and also enable motion capture and transfer in scenarios where it is difficult to put markers. Gait analysis technique can assist the development of human movement analysis in certain sports activities and dance movements. Computer-based gait analysis can be used by computer visual artists in capturing and analyzing motions of subjects for whom it is impossible to put markers, e.g., interesting clips on the internet rather than captured by themselves. The knowledge gained from gait analysis can then be used to create computer-based visual art.

Gait analysis techniques could be used for analyzing pathological gait, e.g., evaluating the severeness of gait disorders and studying the effects of corrective Orthopedic surgery. Analysis of pathological gait could assist the study of causation of symptoms and compensations for underlying pathologies, e.g. for epilepsy or stroke patients. Development in computer-based automated gait analysis could help in making diagnoses and intervention strategies. This could play an important role in rehabilitation engineering and healthcare, such as clinical rehabilitation of patients of stroke or spinal cord injuries and diagnosis of disorders [47]. Besides clinical applications, we can also use gait analysis for professional sports and dance training to optimize and improve athletic or dancer's performance.

6 CONCLUSIONS

Gait recognition is the identification of people by the way they walk. It has the unique advantage over the other biometrics in surveillance applications where the recognition needs to be performed at a distance and only low-resolutions videos can be captured. From the results reported on the Gait Challenge data sets, advanced gait recognition algorithms have achieved high recognition rates on gait sequences captured under the same surface, with variation in viewing angle and shoe type. On the other hand, the recognition on sequences captured under different surfaces, different carrying conditions, and different time is still very challenging. Besides security surveillance applications, studies on gait, especially the model-based approach, can benefit the visual arts study and creation, and also the medical field and healthcare.

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VIRTUAL GALLERIES - MUSEUMS AND RELATED INITIATIVES

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MUSEUMS OUTSIDE MUSEUMS: DISTRICTS OF KNOWLEDGE

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[ABSTRACT. Digitalizing deals with the problem of memory. We are going through a terrible cultural, economical and social crisis because of the idea of memory we are dealing with. We are confusing the storage of information with the project of memory (of good memory). We think that data (and big data in particular) are neutral. On the contrary, we have to underscore that database is always a text, with its vision, with its ideological interpretation of reality. Above all, a database is, anyhow, expression of a social and economical culture; but, at the same time, it supports and promotes specific social and economical realities.

From this point of view, communication should become more and more a dialogue, a conversation between different subjects; and social media, actually, may empower this use of new technologies.]

[KEYWORDS. Cultural heritage, Museums, Memory, Social Media, Communication, Augmented Reality, Territory, Digital Storytelling, Knowledge]

DIGITALIZE REALITY

We don't know the consequences of the impact of new technologies on cultural heritage. We believe that the digital dimension is not in itself a solution, but it is, however, a wonderful opportunity, if you are working on projects and ideas.

Digitalizing deals with the problem of memory. We are going through a terrible cultural, economical and social crisis because of the idea of memory we are dealing with. We are confusing the storage of information with the project of memory (of good memory). We think that data (and big data too) are neutral, are something to be preserved. We have to remember that database is a text, with his vision, with his ideological interpretation of reality, and especially, of social and economical and – why not? – ethical organization.

From this point of view, the 'conversational communication' with our reality (the way we ask questions to the world we live in) is the main critical point of the effort we are doing to give answers the present, historical crisis.

At the *Communication Strategies Lab*, in the context of projects aimed at enhancing the cultural heritage, we are constantly working on crucial questions, to find a proper approach to the problems: *What does it mean to digitalize? What are the consequences of it? Digitalizing generates new social, economical, political textuality? What is the textuality of digital databases? The repositories are texts, what are their grammars?*

The answers we have been carrying on in our Lab are always processed in research projects. Here to follow, two of them: one related to the *Museum of Natural History of University of Florence*, one of the most important in Europe; the other one (*San Casciano Smart Place – I Fantasmi del "Principe"*) related to a new marketing strategy for the San Casciano in Val di Pesa area (Chianti).

MUSEUMS OUTSIDE MUSEUMS

So far we have pointed out that digitalization means nothing – costs a lot with very poor results – if it consists only in digitalizing the existing reality. Because digital knowledge comes, anyway - even if we are not aware of it -, from a project, and strengthens and promotes a specific organization of our reality.

The digital world is an incredible symbolic environment for experimentations, simulations; but at a condition: as long as you start from an analysis of realty with the project of making substantial changes. This is the most important difference between 'digital' symbolic and 'mental' symbolic: only the first one can - must - change reality, interacting with things and people. This is the main meaning of interaction, collaboration and cooperation.

In this respect we have to imagine museums outside museums. Museums (and Universities) have always played the fundamental role to select, collect and preserve knowledge.

To preserve this social role Museums can not confine themselves to embrace new technologies as gadgets that can make the visit more attractive (multimedia, augmented reality are much more than special effects) or replace real tours with 'virtual' visits.

Museums need to rethink themselves ontologically, to avoid wasting the innovative possibilities offered by new technologies. We are facing the end of an old system, but we are the players, the protagonists of the rise of *the* new one [Toschi 2011].

Museums should break the walls (both physically and symbolic) that separate them from real territories, in order to create new interactions between their digital stories (storytelling) and 'physical' experiences.

A relationship that mainly feeds on objects and on the large amount of knowledge Museums offer. Technology that opens up the most promising prospects in this direction is Augmented Reality [Communication Strategies Lab 2012].

Augmented Reality gives the opportunity to assign innovative meanings to cultural heritage: the possibility to add informative layers to the 'phisycal' territory, remediating [Bolter, Grusin 1999] and recontextualizing documents and objects in the original areas or making them appear where they may reveal unexpected perspectives.

Interactions created by projects of convergence, dialogue, and - why not? – conflict, can attribute new symbolic meanings. They strengthen their communicative identity and symbolic power. These interactions, if well designed, can generate knowledge; otherwise unthinkable [Toschi 2011].

This idea of communication as a tool-source for knowledge creation has not to be limited to museums (1). This generative paradigm can be applied to cultural heritage in two other ways:

- (2) 'high' cultural heritage (literature in particular) and its opposite,
- (3) 'low', the 'folk' cultural heritage (*genius loci*, but also ancient knowledge, traditions, local history, etc..), often not easily recognizable.

CASE STUDY 1: MUSEUM OF NATURAL HISTORY, UNIVERSITY OF FLORENCE

The *Communication Strategies Lab* began working with the *Museum of Natural History of University of Florence* redesigning the strategy of its website (www.msn.unifi.it/). Redesigning the website also means rethinking the organization of the Museum, which according to the vision of *Communication Strategies Lab* was supposed to be a hub for the knowledge of the entire University of Florence.

There is a relationship between the *Museum of Natural History* of University of Florence and new technologies. The Museum has the largest collection in the world of wax anatomical models, made between 1770 and 1850, a collection conceived as a three-dimensional treated for teaching anatomy: the most advanced technology of the time to spread and generate knowledge. The intention of the *Communication Strategies Lab* is to recover the original innovative vision of teaching through a renewed sense of three-dimensionality, as offered by Augmented Reality:

- recreating the historical and environmental context of each object;

- locating each object (geo-referencing) in the areas they came from.

A three-dimensional learning enviroment - as big as the entire geographical area covered by the collections of the Museum - usefull to study the science of the earth, the history and culture of the people, and any other topic of the assets of the Museum. The museum outside the museum becomes a district of knowledge.

Concept of re-contextualization of objects in the territory they come from
Source: http://proto-knowledge.blogspot.it/2012/02/vision-of-classroom-of-future.html

CASE STUDY 2: SAN CASCIANO SMART PLACE: I FANTASMI DEL PRINCIPE (THE PRINCE'S GHOSTS)

The project *San Casciano Smart Place – I Fantasmi del Principe* (The 'Prince''s ghosts) is part of a line of research outlined in these pages centered on redefining the relationship between the 'digital' and the 'physical' territory.

On the occasion of fifth centenary celebrations of *The Prince* by Niccolò Machiavelli, the CSL has created and designed a digital ecosystem of geo-referenced contents, accessible through an Augmented Reality app for smartphones and tablets.

The project is focused on San Casciano in Val di Pesa's territory (the municipal administration is the main partner of the project) with a double objective: first to experiment innovative ways of territorial marketing [Caroli 1999; 2006] and second to enhance an already rich but still not systematized cultural heritage (high culture but also low culture).

Celebrations have therefore been interpreted as an opportunity for the creation of innovative territorial marketing strategies:

1. through Augmented Reality, geo-referencing and contextualizing information, strategies whose potentiality has already been highlighted in the preceding pages.

2. through the choice of contents used, capable of supporting local economy – paying particular attention to farms and tourist accommodations – in an historical-economical-social conjuncture in which they are forced to redefine their communicative and symbolic identity [Castells 1997].

The second objective of the project *San Casciano Smart Place – I Fantasmi del Principe* is even more ambitious. It deals with systematizing an immense heritage of knowledge using the digital tools already mentioned. Knowledge which is the result of a long interaction between 'high' (Machiavelli) and 'low' culture (*genius loci*, traditions, knowledge of the rural world, etc..) (very typical of the Chianti region).

The deep sense of this project is to go beyond the logic of crowdsourcing [Estellés-Arolas, González Ladron de Guevara, 2012] in the direction of communitysourcing

[Kapin, Sample Ward 2013; Heimerl, Gawalt, Chen, Parikh, Hartmann 2012]. A new territory (not only digital, not only physical) is going to rise. We have the task to design it and to make it happen.

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Bringing back the "Fontana di Sala Grande" to its original setup according to Bartolomeo Ammannati's project

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Abstract

The work presented here will show the story, the procedures and the methodology operated to rebuild the "Fontana di Sala Grande" from Bartolomeo Ammannati to its original composition, digitally working on the remains and reconstructing the missing parts, to reach the final result represented by the current, permanent, exhibition of the complete group in the Bargello Museum. A meaningful attention will be given to the digital reconstruction of the "what if" version of the "Salone dei Cinquecento" with the fountain placed in. In this research an accurate investigation supported by digital survey and modeling resurrect a monument.

INTRODUCTION

In the middle of the XVI century, in Florence, Bartolomeo Ammannati was working on a monumental, rich and sensual fountain. This sculpture was planned to be placed in the "Sala Grande" (the ancient "Salone dei Cinquecento") inside Palazzo Vecchio. The sculptures composing the fountain were: a Venus, a couple of allegoric Arno and Arbia rivers, a Juno goddess, two peafowls and the figures of Prudenza and Fiorenza. For some reasons, maybe because of technical troubles, maybe because of some rethinking about the place, the fountain was mounted in the Pratolino Villa and later brought to the Boboli's Garden; after a long period of decay it was finally placed in the National Bargello Museum, to rest dismantled as single elements for a long time. In the late 70's Detlef Heikamp worked on some relevant studies about it, proposing the first reconstruction hypothesis of the original composition.

A DIGITAL WAY TO READ THE MONUMENT

The first approach to this group of statues has been fully digital: a complete survey plan was prepared with the intention to develop digital media as a tool of knowledge and investigation. This was a complex and challenging research and it took almost one year to be completed.
The working group has been able to verify the effectiveness of this operational methodology, starting from the measured data. The operating conditions and the timeline program of interventions to prepare the exhibition have necessarily conditioned all the steps of survey and data processing. However, the flexibility of the used methodological approach has made possible to meet all the demands of the working group to define the new setup of the statues.

The process of data acquisition was carried out using five different research directives:

1) the creation of a digital 3D model composed by continuous surfaces, suitable to represent the group of statues with enough realism to provide data and information on metrics about the position and shape of each subject;
2) the realization of a series of 2D drawings aimed to the reading and to the disclosure of aspects related to the new setup for the incoming exhibition;
3) the creation of 3D digital models suitable for the realization, using systems for 3D printing , of a scale model capable of providing an additional verification on the hypothesis of reconstruction;

4) creating the base for the reconstruction simulation and give all the needed support to the planning of the real reconstruction ;
5) producing a set of digital 3D models usable for the simulation of a hypothetic repositioning of the fountain in the “Great Hall” in *Palazzo Vecchio*.

The individual elements, spaced one from the other, did not allow a complete survey intervention without considering to close an area of the museum for all the time needed to move, survey, and then place back the statues.
This was not considered as a possible option because of its meaningful impact over the museum activities. So the phases of data acquisition were conducted in two distinct sessions. All the figures offered a good condition of visibility and accessibility in the frontal and lateral parts. The backs of the statues, on the contrary, were so close against the wall to make them not easily reachable. So two different survey were chosen: a first, global one, based on a Cam2 Faro Photon 120 phase shift laser scanner, an instrument able to acquire useful data up to a long distance, with a panoramic field of view, the point cloud obtained from this first survey would be aimed to produce a small scale version of the whole group of statues, while, at the same time it would allow to have an accurate version of the complete courtyard wing.
This first “coverage” of the monument was quite complete, but it was also capable to show clearly a "map" of all the parts afflicted by occlusion spaces or not fully documented.
After an accurate check of the first survey, a second laser scanner survey campaign was planned; it was made with a more accurate scanner, based on laser-stripe technology, limited in its operative range, but capable to reach the “hidden” parts of the statues because of its small size. Later in the developing of this research a third and last survey campaign was programmed, once again using the laser-stripe unit, this was done only after the displacement of the statues (few months before the exhibition opening), so to be able to document all the elements remained hidden until that moment. The first laser scanner surveys had the purpose of the creation of a three-dimensional digital model as complete as possible and to be achieved in the shortest possible time. During the processing of the data it comes out that in some parts of the statues, the marble surface characteristics had significantly altered the metric quality of the scanner, significantly inducing a high level of noise. The laser scanner used in the second and third campaigns was a Nextengine, an instrument based on laser-stripe technology, and was mainly focused on the statues of *Cerere*, *Arno* and *Arbia*. This new survey allowed to fill the gaps remained unsolved in the previous campaign. The drape of Cerere and the upper surface of its head, which was originally in contact with a further marble element -now lost like it happened for the arch parts- was fully investigated with specific survey in the second and third campaigns.

THE RECONSTRUCTION AND THE MODELING PROCESS

The data gathered in the digital survey campaigns were characterized by a certain different nature: on the one hand there was a digital model made by pointclouds obtained by phase shift laser scanner, and the other a model digitally constituted by a network of polygons obtained from the Nextengine scanner. The geometric detail provided by these two technologies is quite different, so it was necessary to pay a certain attention during the integration of the different dataset. This was mainly done finding common geometrical elements between the different meshes. The steps involved in the generation of the numerical models of the statues were constantly monitored, to avoid an excessive geometric simplification and trying to obtain the best possible result from the laser scanner data.

THE DEFINITION OF THE REINTEGRATED PARTS

To make this task possible, an accurate investigation was needed: the edges of the extrados of the arch abutments were still existing in the statues of *Arno* and *Arbia* and so they were used as

the guiding elements to link up a detailed design and develop the curvature of the arch. The definition of the arch has required a careful study of the geometry present in the statues and a thorough analysis of many correlated elements. The continuous discussion with scholars and historians from the research group working on the project has allowed a continuous monitoring of the achieved results, helping them along their developments and validating the final choices. In the first instance the process was based on a two-dimensional reconstruction, a procedure based on "exclusions" where the lost arch has been hypothesized curved according to circular and elliptical shapes.
The model was also investigated by applying mathematical regression procedures. This was a complex process, it led to the exclusion of possible non-circular shapes for the missing parts; to start the process a large group of points, gathered from the remains of the arch along the statues representing the rivers, were used to calculate an extensive equation fittings. The regressive procedure confirmed that a full circular or a polycentric shape was the most probable geometry for the original arch.
As a parallel procedure, various geometrical reconstructions were tested, mainly based on constructions made by circular arcs. After an accurate study, made in collaborative way by the whole research team, a definitive version was chosen as the best suited to reconstruct the original aspect of the fountain: this last solution presents an arch with three centers, developed according to a conical surface with vertex placed behind the complete group.
The ribbed surface which constitutes the extrados of the latter had to fulfill several conditions, including: the continuity of tangency and curvature from the stumps, had to be generated from circular arcs, the thickness of the arch had to change (since the bases of support provided by the statues are different), the total arc could not be symmetrical, since the supports provided by the two statues lie at different heights, with different and broken lying.
The very complex rebuild procedure was based on a continue modeling and drawing alternated to continue confrontations in the research group, the geometrical results, at first recognized as a good solution were left according to real building needs, like the operative distance between statues, while it was not possible to imagine each statue touching the other (a simple collision between two of these heavy marble blocks would have caused a serious damage now like five hundred years ago). The final modeled arch shows an inclination about 85 degrees from the horizontal plane (exactly 85.4019°).
When the reconstruction was completed a 2D drawing of the model, with all the statue composed in a representation of the front and a representation of one lateral side was graphically compared with the previous reconstruction made by Detlef Heikamp, resulting in a significantly coincident curvature front and characterized by the same inclination of approximately 85 degrees, this was an interesting confirmation of the overall quality level reached by this research.

FROM THE DIGITAL TO THE PHYSICAL MODEL

Once the shape of the arch has been proven a new preparation phase of digital models representing each individual statue took place: a physical model of the overall group was produced by rapid prototyping, this maquette intention was to have a scaled model illustrating the draft reassembly. A final test before starting the project of reconstruction with the real statues. The 3D printed model, made of synthetic material composed predominantly by white nylon and glass, has been developed in the same real parts of the group of statues, obtaining a 1:10 scaled version of the whole fountain and allowing an immediate visual feedback with a material realism capable to result more effective than any 2D image rendering.
At the same time the digital model of the arch has been developed in specific versions to be used for the realization of the element of reconstruction in real scale and for the use within structural analysis software to define the static behavior the new structure. The real reconstruction of the fountain was quite a complex task, while there were various starting points to be accurately planned.

The starting needs and intents were:

1) Preserving the statues, avoiding any suffering to the half a millennium old sculptures.
2) Creating a “light” structure to support the arch, avoiding large single elements.
3) Produce a final result correspondent to the virtual one.

In the final reconstruction the missing marble element placed between the Cerere head and the arch would remain an empty space and the arch in itself would have a certain distance from the rivers statues, to be fitted with resins and avoiding any direct contact between the iron structure and the ancient marble. The building yard of the reconstruction was really a big effort, while some lacks in the understanding and in the skills from the operating workers put the overall result in the risk of a failure. A huge work was done to convert the digital models into operative drawings and only a continue presence of some member from the design and research team on the building yard allowed the final result to be completed. The exhibition opening took place on the 10th of May 2011, the new setup of the fountain was made giving all the statues back to the Ammannati’s original design.

Fig. 1 – from left to right: the statue of Arno, Cerere and Arbia in the previous setup. Point cloud of the original setup from the first digital survey. The fountain with its new setup.

A VIRTUAL RECONSTRUCTION

Even if the fountain have found again its configuration, there is still something to be explored in its reconstruction, and it’s its hypothetical positioning inside the “Great Hall”. In 1560 Vasari began the operations to transform the “Great hall”. His building yard dismantled the cover made by Cronaca and he started working on the masonry for the elevation and the hall ceiling. About this Vasari called it "a terrible venture ... and of such importance". The choice of having a fountain in the Throne Room is rooted in the binding water-power. The presence of water was a parameter determining the magnificence and wealth of kings, emperors, princes and prelates. The water then cools, entertains, fills the rooms with its noise and conveys the concept of Medici omnipotence, with the fountain celebrating the infrastructure works of the aqueduct which fed the fountain itself. Until that time Florence was drawing water from wells and cisterns, but the new aqueduct created a new large water system. This was compared with the Roman aqueduct of Hadrian, underlining the parallel between Cosimo I and the roman emperors. But for Ammannati a meaningful problem was the brightness of the room. In addition to low-light condition, as noticed by Michelangelo, the room had a disproportionate size: 38x100 *braccia* (about 22x53 meters). The big difference between its “before” (Sala Grande) and “after” (Salone de' Cinquecento) is the height of the ceiling, which was about 12 meters at the time of the Ammannati’s project against the 18.5 meters reached after the Vasari's redesign. Although the extensions of the room allowed Sala Grande to be among one of the largest in Europe, the ratio between the length and height did not make it beautiful.
The entrance of light was allowed only by the openings in the walls of both the heads, which could not fulfill the need for lighting, with the result that the center of the hall was always a

dark area. According to these reasons is now possible to understand why Cosimo decided to start the expensive work of raising the ceiling. Vasari settled up the new proportions, which gave breath to the hall, the new measures allowed to open a series of windows in the lacunar ceiling (then completed by frescoes). The appearance of the room at that time was extraordinary, even for the new light that had not such strong and well suited intensity for the vastness of the hall, but considering that the eyes of the people of the Renaissance were not trained in artificial light, it is likely that the Vasari's openings offered a type of light that could be appreciated. Probably Ammannati had studied the problem of the light in this room trying to face it using his scenography previous experiences, mixing them with his sculptor behaviors, knowing the peculiar importance of light, true source of life for statuary. It is now possible to imagine the Ammannati's Fountain in an environment completely different from the actual one: dark, low and wide. Light is a crucial point of the entire project and it must be remembered the other essential element: the water, like a mirror reflecting light within the room and lights up the statues like a reflector. It is difficult to describe with words what could have happened between the water and light.

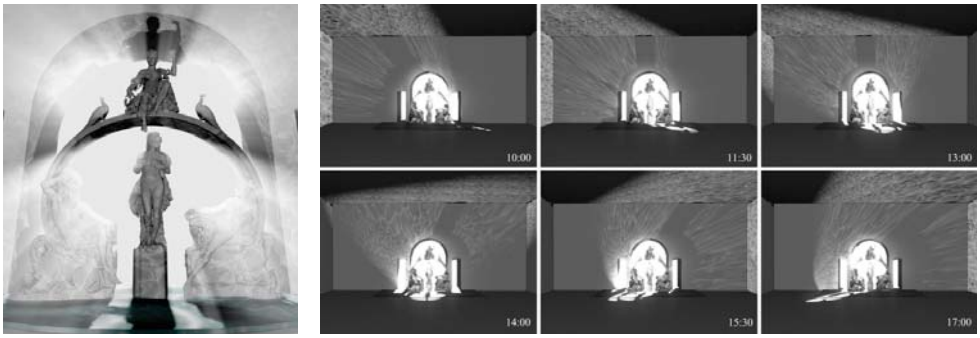

Fig. 2 – Hypotesis about the lighting effects inside the "Sala Grande" with the fountain placed in front of an opening system according to a possible Ammanati's project.

It goes without saying that the different composition and integration of architecture, sculpture and water determines the final effects of each components. This approach based on composition to this possible, alternative reality of the "Great Hall" does not aspire to have scientific basis, but is close and has the same logic of an expositive project operated in the 2011 exhibition. The hypothesis of the architectural configuration of the apparatus of the South wall of the "Great Hall" with its fountain of Giunone, represent an exercise in composition that is based on the research on the study of architecture and proportions of the sixteenth century.
There are neither data nor documents that allow a type of reasoning that tends to the historical reconstruction. In the manner of those artists who faced travel to Rome to study ancient re-drawing the remains of the ancient buildings and imagined their reconstruction, it was attempted to recreate the context of the Fountain Ammannati through fragments and suggestions. An exercise it is not possible to know the final result, while there is no confirmation whether it is right or wrong, and proposals tend to infinity and give back the many possible variables.

A TEAMWORK RESULT

The reconstruction of the Fountain for the "Great Hall" of Bartolomeo Ammannati was more than anything a research and comparison which involved scholars and researchers working in different fields: each of them, while addressing the problem from their specific area, has brought to this collaboration as an essential piece to the achievement of the overall result, now visible to all. It must be remembered that because of its interdisciplinary nature, the

working group has been able to identify and categorize the many problems of this reconstruction. A group in which art historians, conservators and architects, have gradually refined the result that today is shown permanently at the Bargello Museum. Even in its seemingly elementary shape the reconstructed arch encompasses the story of a collaborative experience that was rich and effective, because it was an experience centered on the will to give back this piece of art to the original Ammannati's artistic meaning.

ACKNOWLEDGMENTS

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THE CREATION OF A MULTIMEDIA INFORMATION RESOURCE «THE CHURCH OF THE SAVIOR ON ILYINA STREET IN NOVGOROD THE GREAT»

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Questions of preservation of the world cultural heritage is interesting for any civilized person, regardless of his profession, sphere of interests, age. From the moment of creation of works of art is inevitably exposed to the destructive effect. Various factors are natural, climatic, technological, human-made - lead to significant changes, losses or to the complete destruction of a work of art. It is a constant irreversible process of the destruction of architectural monuments, art, historical documents, books... no doubt, a great spiritual value for us and future generations is even a tiny fragment of the original preserved ancient painting or a part of the architectural details, but we're not able to stop the natural changes of form, material, color. In addition, for the arts and art studies it is necessary to have adequate integrated presentation of any of the monument in the context of his time.

Necessity to use computer technologies comes from the practical needs of science and education.

Permanent dynamic development of modern computer technologies, the equipment and the software allows you to achieve unimaginable results. We know that many countries have established resources, allowing to present the cultural heritage of these countries in its entirety in a digital format. in those countries there are new and new developments, supported by government programmes and major scientific funds.
In recent times not only abroad but also in Russia more and more efforts and funds are allocated for the development of innovative projects, devoted to the problems of preservation of cultural heritage, aimed at creation of information sources, virtual museums, large-scale educational portals, representing in the Internet museums of many Russian regions.

In these activities it makes sense to have a systematic approach, allowing to develop one direction after another. The specificity of tasks necessitates coordination and exchange of experience of specialists in the field of art, architecture, restoration, history, history of art, computer technologies and modeling, Museum studies.

In Saint-Petersburg state University a number of scientific-research programs is under development, including the use of innovative technologies in order to create the best conditions for the preservation of the cultural heritage. These projects unite the major cultural institutions, museums, libraries and archives.

The main objectives of such projects is the popularization of Russian culture and art, preservation of documentary heritage, archives, creation of electronic catalogues and libraries, the development of educational portals. The most modern technical equipment, designed for the benefit of culture, spiritual development and enlightenment, greatly facilitates access to the objects of cultural heritage.

These include projects involving the creation of a multi-component of the multimedia environment - the system of online resources with use of technology of «augmented reality». Currently there are very few analogues to the level of solutions offered by this technology, as well as to the composition and interactivity of its elements.

To date, the team of developers created several variants of such resources on certain monuments and architectural ensembles, which enjoyed high assessment as a Museum workers, specialists in IT-technologies, as well as users.

Augmented reality (augmented reality (AR) - the latest technology, which is used in the cinema, on television, as well as in medicine and the military technics. This technology can be used effectively in the modern museums, urban exhibition projects in the tourism sphere, in the field of education.

Multimedia resources combine several advanced technologies: the technology of augmented reality (AR), GPS-navigation and recognition of QR-codes. In particular, they supported smartphones on the basis of platforms iOS and Android and may be available in Android Market and the App Store, as the most common.

One of the main tasks of the project is the introduction of modern technologies in the Museum and educational sphere, supporting the world trends in the use of the technical equipment of establishments of culture.

Resources created will allow the visitors of museums, monuments, architectural and landscape ensembles not only to make an independent excursion, but also to visualize how an ensemble or a monument looked in the past century, to see the already non-existent objects and details and be supported by text or audio comments.

One of such resources, developed in recent years, devoted to unique world-famous Church, located in Veliky Novgorod.

The Church of the Transfiguration of the Savior on Ilyina street.

The Church of the Savior on Ilyina street - a temple in Novgorod the Great, built in 1374, the only temple in the world, where we can see the frescoes of the hand of Theophanes the Greek. The temple was painted in the year 1378.

The temple was built by the inhabitants of ilinskoy street (and why has this name). The stone construction was preceded by a wooden Church known from the XII century thanks to the unique image of the Mother of God «the Sign», preserved up to our time. Now the icon «of the Sign» is stored in the St. Sophia Cathedral, being one of the most significant and venerable sacred items of Novgorod.

The Church of the Savior on Ilyina, as a characteristic building of its time, stands out in its magnificent monumental and elegant splendor. It is build in the common to the Novgorod architecture of the XIV century type of four-column square in the plan of the temple with one of the altar apse, and one dome. The external decor is different rare wealth.

Novgorod Chronicles mention the painting of the temple. A noble Novgorod boyar - the commissioner of the works, invited one of the greatest masters of his time to paint the Church. Theophanes the Greek was by that time famous of Constantinople painter.

Painting of the temple has been preserved not completely. The greater part of it was

destroyed during the numerous fires and repairs, however, that has been preserved - is the only remaining in the world monumental work of Theophanes the Greek. But even the small part of the painting allows to appreciate the General plan of the ensemble, and the unique style of Feofan.

Fully preserved is only the painting of the dome and the drum. At the Zenith of the dome we can see the medallion the Almighty Saviour. Undoubtedly, this is one of the most famous old Russian frescoes, preserved to our days.

In the main space of the temple are preserved only a very small fragments of frescoes (although it is possible that found yet not all the surviving fragments).

Frescoes in the Holy Trinity chapel at the choir in the North-Western corner of the temple remained well preserved.

Theophanes the Greek created his own, very unusual manner of printing. This includes in particular a very expressive style of Byzantine painting of the XIV century, which brightly manifested in Novgorod (the Church of the assumption on the field and of St Theodore Stratilates). Feofan has created the strongest images in the Orthodox art.

The Church of the Savior on Ilyina

Multimedia resource «The Church of the Savior on Ilyina».

On the basis of historical materials is created multimedia source of information, which includes the materials of the Church of the Savior on Ilyina, as well as historical and cultural context of the time.

Virtual excursions are in detail illustrated by archival photographs, original documents, drawings. Visitors can get acquainted with research on history of arts, literary works, dedicated to the monument, interesting historical facts. Along with detailed description of all the sights, you can get access to many of the scientific - research materials, dedicated to the object.

This resource distinguishes a multi-level and multi-functional character, the opportunity to improve in time, the ability to extrapolate methods as applied to similar cultural-historical and architectural-artistic objects, involvement in the work on the project specialists of the different profile, focus on the wide dissemination of the product studies in various forms of embodiment.

The creation of a single information source, on the basis of multi-layer historical reconstruction, helps to understand and to feel the conditions, when this or that monument of architecture, historical building was created, to feel the connection to time, to rebuild the past, to recover the missing data for each monument, complementing traditional database on art. If there is sufficient baseline data, it is possible to introduce a monument in the various stages of construction and development, disassemble and demonstrate variants of reconstruction, clearly show the features of planning decisions. That is, multi-computer reconstruction, made in the form of interactive model based on the technology of «augmented reality», gives the opportunity to see not only on the particular monument, but allows to obtain information related to this monument, submitted by the people during the whole time of its existence.

This technology is characterized by a comprehensive approach to the formation of sightseeing information resource dedicated to the monuments and Museum collections. Creation and demonstration of virtual objects, historical reconstructions, interactive exhibits, a reconstruction of already lost fragments gives the opportunity to move to a qualitatively new level of study and preservation of the cultural heritage.

The e-passport.

One of the most important results of the project is creation of so-called «e-passport» of the object. It is a system of architectural drawings, executed in the exact architectural and geodesic measurements, to which pictures with the fragments of the paintings with original textures are overlaid. On the basis of these drawings it is possible to create three-dimensional three-dimensional model of the monument.

Also, an accurate three-dimensional model can be created by means of three-dimensional scanning, but in this case, the obtained materials will require additional processing. Undoubtedly, the large scale scanning greatly facilitates the task of fixing the object. But we are talking about a quite complicated, considerably lost surface with a basis of plaster with fragments of the paint layer, damages, cracks, etc. In the created model a random crack will be displayed as active as an element of the author's painting, forming a complex texture of the painting surface. The digital copy is created by way of mechanical scanning will be useful for restorers only for purely scientific fixing of the walls. In order to create an artistic perception, a digital copy must be significantly reworked «by hand». As the main principle of any work of art is the principle of composition, where secondary elements are supporting the main theme; therefore, only by the same approach of creative selection should be applied to copying of a work of art as well..

Such a «map» of the interior, in the first place, allows you to capture the current state of the painting, clearly and systematically show any changes that have occurred in the past and future years of research and restoration interventions, the natural loss, as well as discovered new fragments.

The«e-passport» or a digital copy of the monument can be considered as the optimal form of storage and recording of Museum objects. So this resource can be used during restoration work as the main document of the monument.

The e-passport allows you to make changes and adjustments to the extent of scientific-research works.

The Eastern wall of the Church, preserved fragments of frescoes
The South wall of the Church, preserved fragments of frescoes

The creation of the analog reconstruction.

Like many of the monuments of old Russian architecture and art, the Church of the Savior on Ilyina repeatedly was exposed to destructive influences. As we know, most of the monuments of Novgorod the Great, suffered during the time of the Second world war. However, the unique architectural ensemble of the painting of the Church of our Savior on Ilyina, preserved only in fragments, was lost much earlier due to numerous fires and repairs. Remained is a small amount of archival photographic images containing some additional information to Supplement the current state of the painting. We can create a fairly accurate reconstruction of the painting of the Church of our Savior on Ilyina, based, mainly, on the art history and the materials of the restorers and archaeologists. Also, we know that there are monuments analogs, quite close in time, the style and manner of performance.

In this case the recovery of the painting is the task which is possible to solve, for lack of documentary evidence, only by means of art-analysis. The purpose of such a reconstruction is the visual reconstruction of the monument, creation of the atmosphere, of the image. The choice of a conceptual approach to reconstruction, as well as specific methods, depends not only on the degree of conservation of the property or technological opportunities, but also on the dimensions and future visual perception of a work of art. This is art-aesthetic essence of

reconstruction.

In practice analog reconstruction of the combined experience of the specialists of different professions. Historians, art historians, architects, restorers participate in the process of reconstruction. Practical realization of the works is the responsibility of the experts in each functional field: artists, architects, specialists in computer graphics.

Completed reconstruction became the basis of the multimedia resource on the Church of the Savior on Ilyina.

The altar
The altar, reconstruction

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ROME MRV

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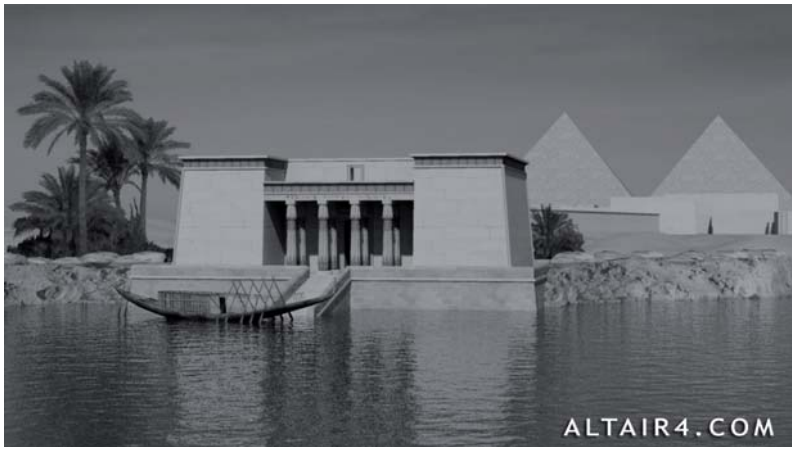
Abstract: Time Window is an MVR (Mixed Virtual Reality) system based on time windows opened by the application onto the main monument areas, which allows you to view the condition of an archaeological site, urban area or monument, in the various moments of its history, with an interactive overlap, fading over between 3D reconstruction and their current appearance.

Ancient Egypt in 3D APPlication allows to explore the major Egyptian archaeological sites, displaying the appearance they had in ancient times.
Through a simple graphical menu you can move around on a map of the Nile and see the main archaeological sites: when an area has been selected you can access to its detailed description, supported by photos and videos, and also by interactive graphic reconstructions that go around the monuments, fly over the city and show the evolution that they have had up to the present day, using the "time machine".

You can also enter the temples, explore and move within the various archaeological sites, with a detailed navigation.
The work is intended to focus on the urban tissue of ancient Egypt, restoring the greatness of sites as the city of Thebes and the funerary complex at Giza.

At the moment the application includes the sites of Alexandria, Giza, Saqqara, Deir El Medina, Dendera, Karnak, Luxor, Deir El Bahari, Medinet Habu, Philae and Abu Simbel.



Giza, Cheops' ritual boat - Old Kingdom

VIRTUAL 3D VISIONS:

Karnak, Sanctuary of Amon - New Kingdom
Karnak, Sanctuary of Amon and hypostyle Hall - New Kingdom
Karnak, Temple of Khonsu - New Kingdom
Deir el Bahari, Mortuary Temple of Queen Hatshepsut - New Kingdom
Deir El-Medina, village of workmen responsible for the construction of the Pyramids - New Kingdom
Deir El-Medina, temple of Hator - New Kingdom
Deir El-Medina, funeral monument of Sennedjem - New Kingdom
Abusir, entrance from the Nile to the monumental complex - Old Kingdom
Philae island - Late Period. Temple of Isis
The lighthouse of Alexandria - Ptolemaic Era
Giza, Sphinx and pyramids of Cheope, Chefren, Micerino - Old Kingdom
Giza, Cheops' ritual boat - Old Kingdom
The "Step Pyramid" complex of Djoser - Old Kingdom
Denderah - Ptolemaic Era
Denderah, Temple of Hathor and hypostyle Hall - Ptolemaic Era
Luxor, Temple of Amon
Thebes, whole reconstruction of the capital of the Upper and Lower Egypt - First Intermediate Period/New Kingdom

VIRTUAL EGYPT in 3D (80" Video Demo):

http://www.youtube.com/watch?v=nXN0Z7YUnVA
http://www.youtube.com/watch?v=3Uhxs6NWwXc

Karnak, Sanctuary of Amon - New Kingdom

Philae island

Rome MVR is a new application to visit Rome across the ages and see what it looked like in the various periods thanks to the Time Window system.

Time Window is an MVR (Mixed Virtual Reality) system based on time windows opened by the application onto the main monument areas in town, which allows you to view the condition of an archaeological site, urban area or monument, in the various moments of its history, with an interactive overlap, fading over between 3D reconstruction and their current appearance.

If the application is used in the vicinity of areas for which time windows are available, the MVR system, which avails itself of Gps, compass and gyroscope data, provides us with an updated and geo-referenced overview of the area; if you move the i-phone, the image follows our movements pointing to the monuments within our field of vision.

Thanks to the "*salto nel tempo*" ["time leap"] mode, it is possible to view the most ancient historic phases slowly fading, which allows for easy understanding of remains from the past. The proximity of other time windows with regard to our position is indicated by a tool which shows how to reach a new vantage point.

If the application is used far away from the areas in question, or if you do not wish to follow the automatic indications or the compass and gyroscope functions, it is possible to select the area from the list or from the map. Moreover, the manual mode allows you to display an overview of the area simply by moving a finger on the screen.

The core of this application consists in the best and most rigorous 3D reconstructions currently available. Its original contents have been designed on purpose by the Altair 4 Multimedia team, with its architects, archaeologists and artists who have thirty years of experience in the area of cultural heritage enhancement, working in collaboration with the most prestigious Italian and international universities and research institutes.

The application will therefore avail itself of continuous updates thanks to research progress in the areas of history and archaeology, as well as to new spectacular reconstruction processing, with new Time Windows opening onto the Eternal City.

Areas currently available: Colosseum, Roman Forum, Palatine, Imperial Fora.
ROME MVR VideoDemo:
http://www.altair4.com/videos/applicazione-iphone-roma-mvriphone-app-rome-mvr/?lang=en

http://itunes.apple.com/it/app/rome-mvr/id446800370?mt=8

http://www.youtube.com/watch?v=w32SAZ3PN98&feature=youtu.be

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INTEGRATING MUSEUM ARCHIVE AND TOWN AN APP FOR A FORTIFIED TOWN

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Museerne i Fredericia

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Abstract

Fredericia is a planned town, founded as a fortification, a town in which the military has always been the raison d'etre. In order to populate the city the King of Denmark/Norway granted the town privileges that religious refugees from other areas in Europe, such as Huguenot's from France and Brandenburg, and Catholics and Jews were allowed to settle, and furthermore openly to practice their faith. This was a radical move in the period of post-confessionalism, and in a kingdom were it ultimately was punishable by death to practice e.g. Catholicism.
Recently the museum and the archive in Fredericia have merged. This has opened new possibilities for telling the story of the town from different perspectives.
In consequence of this merger we have discussed the overall strategy of the consolidated organization, and ended up focussing on two major issues. On one hand the interaction between military and town; and on the other the town's culture of tolerance and multiconfessionalism.
We have used this opportunity to create an app that integrates text, pictures, film, maps, and geographical games into – hopefully – one experience to tell these stories. The project is currently being approved by Apple, to be launched in May this year, and integrated with a new homepage, that also involves user interaction. This will be ready in June. The paper describes these two projects and the thoughts behind the concrete solutions chosen.

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HTML RESPONSIVE DESIGN AND APPS FOR MUSEUMS: NEEDS AND OPTIONS AT MUSEO GALILEO

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Abstract – The new mobile technologies offer an unprecedented opportunity for museums to disseminate their heritage, but entail also new challenges that require a special commitment in terms of economic and human resources. Strategic choices concerning the development of apps or HTML5 web sites optimized for mobile devices (web apps) must take into consideration not only the specific needs of the single institutions but also some technological limits such as the lack of accuracy for indoor location awareness. Another challenge to overcome, both in technological and political terms, is the integration of owned content with different data sources and external local services.

INTRODUCTION

The evolution of the web in the last years and the spread of new mobile technologies, such as navigation systems embedded in modern devices, have allowed museums to offer new types of services, thus representing an extraordinary opportunity to disseminate culture.

In its first phase the web was an opportunity to present content at a distance especially to people that would have never been reached otherwise. In a second phase the web has made possible a more active involvement from users at different levels, from simple and spontaneous comments to most qualified and organized contributions such as Wikipedia. Today the smartphones era has led to a brand-new phase, where the content is customized for the user and is always available, whenever and wherever it is necessary. Obviously this new phase opens a range of unprecedented issues concerning privacy and controls that are the main focus of recent discussions in civil society and it will certainly lead to the definition of new norms regarding rights and rules of conduct between users and service providers.

A digression on these topic is beyond the scope of this article; however it is noteworthy that until now users have shown great appreciation for these types of services, and therefore there is a constantly expanding market of users hungry for novelty.

STRATEGIC OBJECTIVES

Given the state of the market analyzed in the previous paragraph, and considering also the difficult economic situation that involves Europe nowadays it is essential that public institutions, including museums, review their strategies to better invest the public funds they receive. In this sense, the European Union has indicated (and therefore is funding) the need to enthuse the young generation to scientific culture that, especially in Italy, has always been considered subject to the humanities, an unfortunate choice that has led to serious consequences for the development of our economy, losing the European primacy of research and production of more advanced (and profitable) technologies in favour of other countries.

In addition to these aspects it should be noted that museums, including art galleries and science museums, have a key role in attracting tourists, an activity that is essential in our national economy.

Based on the above considerations a series of strategic objectives arise:

- attract new visitors, especially young people
- facilitate access to museum collections
- enrich content with information belonging to other agencies or institutions (e.g. tourist info and data from other museums) in order to provide integrated services in the local area.

The achievement of these results requires an effort distributed among various key players and also (but not only) relies on an intelligent use of new technologies. Given the novelty of these systems, museums must be committed to developing new languages and new forms of communication to achieve the expected goals.

EXPECTED RESULTS

In accordance with the general trend, the museum experience cannot disregard technological assistance, that can both boost the users interest and raise the profile of the institution with new audience. A series of surveys, conducted since 2009 [1] involving more than 2500 institutions across the globe, but primarily in the U.S., show that in 2012 more than 70% of the museums offered or planned to offer a mobile guide for free, while only in 10% of cases this was accessible exclusively on payment, corroborating the fact that most of the institutions has never felt the economic upturn as a primary objective of the system. There is also a general tendency to progressively abandon the use of devices rented by the institution in favour of visitors' own smartphones/tablets. Therefore there is a need to produce more flexible services that operate in less controlled environments, and this fact plays in favour of the use of HTML5 instead of specific apps. The reasons are also to be found in reduced complexity and cost of development and maintenance. Museums in general seem to move towards an increment of in-house content production, the definition of a long-term strategy for mobile, the development of websites optimized for smartphones/tablets and a special attention to young audience and social networks users.

More concretely, in terms of technology, museums can move on several fronts, adapting their websites to be accessible from mobile, producing apps for smartphones and tablets to support the visit of the museum, creating applications that provide cultural information related to the area and ensuring the integration of their data with those of other entities.

Considering the logic of economies of scale, it should also be convenient to develop these systems in a federated environment established among various institutions, not only in order to minimize costs, but also to provide truly integrated and higher quality content. We realize that this is a complex problem both in organizational and political terms, but it is a path that we will be forced to follow.

Traditional Web sites vs. mobile

Web sites designed to be used with PC/laptop provide a large amount of information, with a layout that hardly fits mobile devices, especially due to their layout richness. To overcome this problem, it is necessary to work on the content and its presentation that must adapt to the specific characteristics of mobile devices. Furthermore web sites, even with HTML5, fail to fully utilize the various sensors that are available (GPS, inertial sensors, etc.).

Outdoor services

Outdoor scenarios are those that benefit the most from the new devices, and in fact many services have already been developed for them, especially with apps. The limit in this case is, at the present moment, the integration of services from different suppliers. It is a world in constant evolution, where services have already been identified and implemented, but lack integration with existing services.

METHODOLOGIES

In order for services to be usable in a smartphone/tablet two operative modes can be identified: smartphone apps and HTML5 responsive design.

Apps for smartphones and tablets

Mobile apps can take full advantage of the sensors of a smartphone/tablet, but present some difficulties. Content organization is not based on a descriptive language interpreted by a browser, but must fully manage the interface. Furthermore they depend not only on various operating systems (Android, iOS, etc..) but also on their different versions, a problem that also affects the production costs. However, apps are still the most powerful way to interact with the user and are crucial to retrieve data from multiple sources simultaneously. Unfortunately, with current devices, localization in interiors -which would be extremely useful for museum purposes- is not yet possible with the required level of precision.

HTML5 responsive design

A possible solution at relatively low cost may be the creation of a website in HTML5 and CSS3 that automatically adapts the interface depending on the size and resolution of the device in use. The approach can be that of progressive enhancement, which aims to present essential content on less powerful devices, while progressively enriching the experience by providing more content to more powerful devices. This technology allows, at least in theory, to use a single application for all devices, from smartphones to PCs and for all operating system. With the evolution of browsers and their ability to access smartphones services with integrated technologies like PhoneGap [2], this solution could be a valid strategic choice.

Characteristics and critical elements in museum contexts

Regarding museums (and exhibits) there are some specific aspects that suffer from the lack of appropriate technologies. In particular, it would be very useful if the application were aware of the exact location of the user in order to simplify the items selection. Unfortunately, the accuracy of current positioning systems may be sufficient for museums that expose just a few items per room, and at a certain distance from each other, but it is not efficient for situations where there is a high density of objects, even becoming totally useless for museum showcases. Code reading systems, such as QRcode or NFC, although valid from an identification point of view, are visually very invasive and often impractical. An approach based on the analysis of the power of multiple Wi-Fi or Bluetooth access points seems promising, but even in this case, the approximation is in the range of meters and therefore unsuitable to identify the items inside the showcases. There are also methods based on the use of multiple sensors (Wi-Fi, accelerometer, compass, etc.) but since these sensors are subject to the accumulation of errors, their precision becomes soon unreliable.

In any case there is no “perfect solution” since each institution's needs are different, considering not only the location of objects and their proximity to one another, but also the building age and the state of its infrastructures. It is also important to keep in mind that the

majority of museum visitors prefer the most straightforward and simple solution, which in most cases is the now standard audio tour keyboard with numbers and object icons.

Linked Open Data and Permanent identifiers

For a better integration of services the following technologies, although not specific to the mobile world, are also very useful: Linked Open Data and Permanent identifiers.

The LOD is the technological solution that allows the integration of different data sources and is therefore fundamental for the development of external and internal services. In the case of museums, and even more for information on places of cultural interest, this can be used to add links to historical, logistics and entertainment resources.

The Permanent identifiers, although not strictly necessary, could be employed to facilitate the creation and the long-term maintenance of the connections between resources, in particular when using material from several different sources.

Examples

In the domain of apps and web apps there are already thousands of applications - including some very valid ones - and their number increases day by day. Among them we can mention the web app at the MOMA in New York that, with an effective and neat interface, offers not only a valid aid to understand the collections but also a range of services of practical nature such as admission information and online ticketing.

The Smithsonian [3] choses a different approach, offering a wide panorama of apps for Android, iPad and iPhone and also web apps aimed at different types of users thanks to specific and well diversified content. Among these there are also attempts to create games for children, like MEanderthal [4], an app that allows to morph one's own portrait into the face of an early human.

A different category of apps includes both the "Museum of London - Streetmuseum" [5] and the Italian "Visito Tuscany" [6] that utilize augmented reality to show the places as they were on old photos and for the identification of sites via camera and GPS.

There are some underway experiments with regard to indoor positioning: for example the Fernbank Museum of Natural History in Atlanta uses an app called “Meridian” [7] to give directions inside its premises.

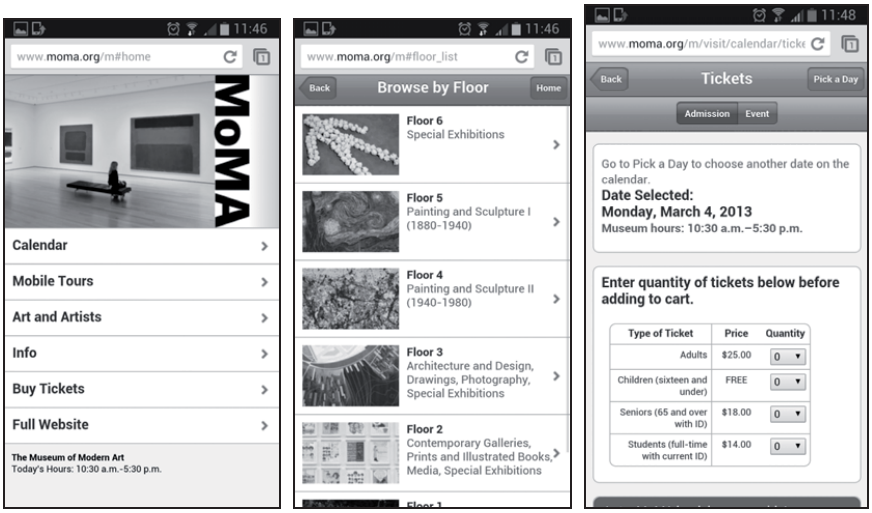
Apps like “Huntzz - Treasure Hunts” [8] exploit the playful aspect of the treasure hunt in several museums, opening a number of possibilities that have yet to be fully explored.

CONCLUSIONS

For the Museo Galileo, as for all the other museums, new technologies based on smatphones/tablets offer a wide range of challenges and opportunities. The provision of additional information -compared to traditional tools like museum captions- and the new interactive experience should raise the profile of the institution, which in turn will attract more visitors by making the visit experience more satisfying. Obviously these objectives require a certain commitment in terms of human and economic resources in order to produce new content, create an infrastructure for its consultation, keep the services up to date, encourage visitors to use the system and make it sustainable.

The future development of a local integrated museum system could result in technological developments thanks to the use of augmented reality and a better connection among data coming from different sources that will be able to cover not only the cultural aspect of a visit but also its logistics.

FIGURES AND TABLES



Left to right: Main menu of New York MOMA mobile website. The floor index at MOMA. The online ticket shop at MOMA.

..

Museum of London – Streetmuseum app. Camera view of the present day street taken by the smarphone with an old image in overlay.

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ACCESS TO THE CULTURE INFORMATION

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CNR RETRIEVAL OF IMAGES FROM HYPER-SPECTRAL DATA THROUGH INTERACTIVE NETWORK ACCESS (CRISTINA)

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Abstract – The IFAC-CNR hyper-spectral imaging system acquires cube-images at very high spatial and spectral resolution in the 400-900 nm range. The obtained data are used to study the composition of artists' materials, for true-colour reproduction of paintings, and for documenting the characteristic of the underdrawings and *pentimenti*. The current reluctance to make more than limited use of cube-images is due to issues related to the need for efficient filing and computing systems and to the lack of specific image processing skills. The experimental client/server platform developed at IFAC-CNR can be a solution to the hyper-spectral data using issue. The proposed IFAC-CNR platform is presented in this paper.

INTRODUCTION

Plane and/or satellite hyper-spectral imaging techniques have been applied to the study of resources in the country [1,2] as well as to soil survey and mapping [3,4]. These techniques also have been used for the diagnosis and documentation of works of art, mainly focused on paintings [5-8].

The hyper-spectral imaging system assembled at IFAC-CNR is able to acquire cube-images at very high spatial (about 270 dpi on the object plane) and spectral (over 400 bands) resolution in the 400-900 nm range [9]. The obtained data are used to study the composition of artists' materials through their spectral characteristics as well as for reconstructing true-colour reproductions of paintings. Moreover, the electromagnetic radiation in near infrared allows researchers to obtain documentation about the preparatory drawings, *pentimenti*, and previous restoration works, making this type of analysis a valid instrument for art historians, curators, and conservators.

At present, however, the availability of such cube-images is not taken advantage of because of two major limiting issues. The first issue is that the huge mass of data provided by the acquisition system (the CNR-IFAC instrument produces about 140 GB/m^2) makes the data distribution problematic. Currently data sharing usually is accomplished through physical transportation on a hard disk or, in a very sub-sampled form, on a DVD. This approach greatly limits the diffusion of data and imposes long transfer time procedures. Also, the replica costs are high unless the data have been drastically reduced in spatial and spectral resolution. Moreover,

even if the diffusion of the wide-band connectivity might suggest having a central station for storing all the recorded data, the global costs in time and energy for transferring data of such dimensions are still very high. In addition, this approach usually would not permit scientists to consult about or to elaborate on the data in a real-time mode from common internet locations/points. The second issue is that analysing this kind of data requires efficient filing and computing systems and specific skills in image processing. Furthermore, in this specific field, unlike elsewhere, the users do not need the entire data set, but only portions of it obtained as results of well-defined and homogeneous processing operations [6].

In this context the achievement of an experimental client/server platform, which keeps the filing and processing burdens on the server side and which makes possible the execution of remote standard processing operations through simple web graphical user interfaces could be the solution to the issues associated with using hyper-spectral data in the cultural heritage field. An experimental system of this type is described below.

CRISTINA

CRISTINA (**C**nr **R**etrieval of **I**mages from hyper-**S**pectral data **T**hrough **I**nteractive **N**etwork **A**ccess) is a web-based platform for the management of aggregated data related to hyper-spectral measurements on artworks.

The platform is centred on a database with the functionality of data organization. It is not necessary to locate the aggregated data on the same server of the database; they can be distributed over the internet. A set of tools provide access to the database, and they implement the management, visualization and elaboration of the data [10].

Data organization

Data in the database are organised in a tree structure: the first level is the artwork. The second level is associated of a certain number of elements to each artwork. At the third level each element is a link to a series of measurements groups. Each measurements group is an aggregation of spatial synchronized data, which can be superimposed and compared by both visual inspection and image computation techniques. This means that a reference picture (typically a RGB image), which is shown by default on the data viewer, has to be associated with each measurements group.

This type of data organisation allows researchers to manage both single- and multi-parts of the studied artwork (through elements distinction) by accessing different measurement sets acquired on the same artwork, for example before and after a conservation intervention (through the distinction of measurements groups).

User data access is achieved through a browser which allows data research on the database with several parameters: the browser returns research results and shows a reference thumbnail for each artwork's element; thus the direct access to the visualisation tool is obtained by selecting the desired element.

Visualisation

The visualisation tool is a web application based on IIPImage [11], an advanced system for viewing and zooming ultra high-resolution images. The client-side viewer, a JavaScript application called IIPMooViewer, interacts with the FCGI server application, IIPServer. The server application produces images in the IIPImage exchange format from pyramidal images (TIFF or JPEG) and sends them to the viewer, which takes care of right re-composition and visualisation of the images.

Side by side with the visualisation tool there is a structure for the superimposition of layers on the displayed image. Then these layers can be used to superimpose any kind of data spatially synchronized with the base image, such as images from different acquisition systems or spot/punctual measurements data [12]. Furthermore, an interface for using server side utilities for extraction and elaboration of data from files containing the measurements is available; these routines dynamically interact with the visualisation platform through AJAX-FCGI methods.

Regarding the visualisation, the features available at this time are (Fig. 1):

- presentation of superimposed images and cross-fading effect for a visual comparison of different images;
- presentation of the reflectance spectra extracted from the hyper-spectral data for point of images selected by user;
- presentation of data acquired with other devices (*i.e.* FORS measurements [12]).

Figure 1: a screenshot of the visualization tool with a superimposed layer containing references to a punctual measurement.

Available elaboration tools are:

- extraction of single spectral images, sub-bands, and their composition in false-colour;
- elaborated images using multivariate methods like Principal Component Analysis (PCA) or spectral angle mapping (SMA) for the mapping of pigments;
- extraction of original measurement partition for user specific elaboration;

Data access

All operations performed on the data are controlled by a permission management program based on the type of user. Thus, the system grants access only to a specific section, depending on the user-specific privileges. Presently, there are three different access levels: administrator, standard user, and advanced user.

The standard user has a base access to the system capabilities, such as:

- browse data;
- visualise data;
- request the insertion of new data into the system or perform computations using already loaded data.

The advanced user has all of the standard user capabilities and, in addition to them, he is allowed to:

- have access to a basic computation instruments set, like the tools for the extraction of images from cube-files or for sub-images extraction;
- load new data onto the system.

The administrator has access to all privileges on the system and is able to (Fig. 2):

- load, edit or delete users;
- load edit or delete data;
- access all of the available computational instruments.

The system offers all of the features of an HTML 5.0 based web interface compatible with most recent browsers and mobiles. Furthermore, the entire system is designed to minimise data exchange between client and server, which also minimises the computational resources needed by each. For this purpose, whenever possible, most computationally expensive elaborations that involve the entire object area are saved, archived, and directly accessible for future use. For computationally simple elaborations, like the extraction of the spectra in a point of the image, and for elaborations related to single points or portions of the object area, the elaboration result is not archived. Finally, most elementary computations related to visualisation of results are delegated to the client.

Figure 2. A particular of the administration interface.

Future developments

The main development foreseen in the immediate future is the expansion of the computation and visualisation instrument set to better respond to user feedback and requests. Moreover, the migration to the vector graphic system for diagram visualisation, including the addition of new capabilities, such as graphics superimposition or trace addition, which will provide a more intuitive comparison of results, is already scheduled.

More broadly, this means that the tools available in the experimental hyper-spectral imaging system can be adjusted to meet the management, access, and computational requirements for the analysis of all type of hyper-spectral data.

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"PENCO SYSTEM"

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The project provides an innovative support to the study, filing and diagnostics of the manufacts of art by means of a file of historical-iconographic information and a software.
The hub is a database, including the features which have characterized the iconography of a "subject" in the long run. The system can detect the features characterizing a definite historical period and a localized geographical area, thus allowing to identify the age and the area the manufact derives from.
The filing method can be applied to any subject, from the holy to the profane one and to any type of manufact. The images can be filed.
The result of the iconographic research will be able to be compared with two other databases: the one of the historical documents and the one of the chemical characteristic of pigments as well as of the executive techniques.

INTRODUCTION

The preservation of the artistic manufact has to be meant as "protection" of its two-sided historicity: thought as physical consistency , but also as rediscovery of the historical meanings.
In fact it exists thanks to the commit's will and to the artist's will of transmitting a message which is doomed to win over the passing of time.
The birth of a strategic synergy between art and technology represents an essential support to encourage the application of dedicated "microtechnologies" which can reach and put as "common factor" the benefits deriving from two completely different worlds.
The "Penco System" derives from the primary need to recover all the historical information aimed at finding the path of a manufact.
The *usability of the information* and the *retrieval of the lost elements* represents an essential support for the optimization of the work of the experts.
In fact, the limits of human memory on one hand and the importance of the retrieval of the lost historical information on the other hand represent the solution of the problems which appear as a critical element of a highly nevralgic field.
The direction of innovative techniques, aimed at the rediscovery of the lost historical elements allows the retrieval of a double-sided historicity of the work and makes that **knowledge** possible which is essential for its **estimation.**
The estimation of the Cultural Heritage and the usability of the ordered information, represents the milestone to encourage the **cultural exchanges** and the plan strategies dedicated to the **re-qualification of the territory** and the **enhancement of tourism** on international scale.
The *method* characterizing the "Penco-System" can also be applied to the Eastern Cultural Heritage.

Peculiarities and synergies deriving from a homogeneous and user-friendly filing.
The *iconography* represents the *grammar* of art: the iconographic rule can be intended as an essential codifying element, aimed at the detection of the represented theme and this is why it can applied to any type of handwork.
The *technology* provides an up-to-date instrument in the field of art, addressed to optimize the "*state of the present technique*".

The *organization of the data-base* of the "Penco-System" allows to identify and make all thet information possible , which is essential to put the manufact into a particular historical period or into a localized geographical area.
The method can be applied to any subject: **from the holy to the profane** and to **any type of manufact** (paintings, statues, frescoes, miniatured codex, etc.).

The project
The project "Discovering the work of art Penco-System" is an initiative aiming at making the work of historical iconographic diagnosis of any examined work easier and more complete, by the use of modern information instruments aimed at tracing the greatest deal of reliable indications correlated with the work itself.
The great deal of information found in texts and documents are brought to intelligent comparison just in the minds of a few expert scholars of this field. Sometimes, due to obvious human limits, there is a lack in the wide knowledge of information so that we run the risk of making any consideration scarce both on a qualitative and on a cognitive level.
In order to overtake this hinder here is the realization of an instrument as flexible and dynamic as a software procedure, oriented to the study, the diagnosis and the comparison of allegorical meanings, technical, historical and characteristic data of the work.
The project consists of a new procedure of diagnostics allowing to fix a deal of "*certain elements*" about the examined work of art and which will be a more correct and above all a more circumscribed point to cope with the following studies.
By "*certain elements*" we mean all that information, "at the present state of the technique" are trusted in the individual professionality of the one who is about to face the study of the work.
But, unfortunately, in most cases the results of the diagnosis are contrasting even among scholars of the same level. This problem often depends on the fact that one of the most objective difficulties consists of the research and the retrieval of the greatest possible deal of that information which will then "orient" the study phase.

Technical description
The project "Discovering the work of art", by means of an informatized procedure and thanks to the patrimony of a very precious database, allows us to "rediscover" a significant deal of historical information lost in the long run and exposed to the forgetfulness of human nature.
It consists of a graphic interface (which can be used "in loco" or by the internet) that thanks to the use of relational databases, classification algorithms, comparison and research of information based on data recursive visit schemes and of simple artificial intelligence instruments allows us to retrieve information about a work or a subject by the introduction of some elements or characters.
These parameters, called "input", can be varied and completed by the equipe leading the software management during the enlargement of the research/study, even thanks to the information produced by the software itself. The procedure gains a sort of interactivity when the inserted news is able to bear a correlation with other ones.
The process takes place again and again up to the end of the data visit capabilities by the algorithms.

Interests, functions and innovativity
The "Penco-System" is oriented to provide a service that, taking advantage of the synergies we have at the "present state of technique" and harmonizing them in an intelligent comparison, has the aim of making the diagnostics of works of art (information retrieval, study, filing, etc) more "innovative" and "technological".
The project relies on a complex information file-we will define as "*certain elements*"-which is the result of objective historical data and which is not exposed to arbitrary protest.
Therefore, for this reason the diagnostics realized by the system "Discovering the work of art" can deal as a "warranty" since the information that will be elaborated will build a heritage which would

have otherways given out to the waste of significant human energies as well as to the danger of meeting those oversights and forgetfulness which often brought to the “diagnostically” wrong way.
Therefore, the project boasts of a strong innovative contents as well as of the prestige of a major “safety”about diagnostics. These elements surely represent that aspect of usefulness and functionality qualifying the service. We should keep in mind that in the field of art the use of information procedures represents itself an innovative instrument
Moreover, just because of the characteristics featuring its working procedure and “its own” mechanism, the range of mistakes gets suitably reduced as to warrant encouraging and assuring results about the “safety of the diagnosis”. What we mentioned above is safe even from the point of view of a stricter respect of the subject of the work of art and its historical reality. The higher functionality, giving out to a more competitive diagnostics, since it is advanced and organized, becomes useful from all of the professional points of view, thus offering a safe service, which can be tested and fulfilled in a quicker way than the present one. It uses instruments and techniques such as the computer and the organized data files, procedures such as the “intelligent comparison” of the information and its systematic re-exam, thus coming to the retrieval of those characters belonging to history-therefore subject to be lost in the long run- and to the discovery of new information. The latter are derived from an ordered procedure (algorithm), therefore not subject to oversights and able to verify contradictions and to integrate old information with new deductions.

Data Base Structure
The first data base is structured by means of many cards containing the files of all of the iconographic data featuring a subject, recognizing the characteristics according to ages and geographical areas, within these cards we can find a dynamic file including the manufacts of the most important artists who dealt with the subject.
These works have already been known and studied and they are the same ones we derived the iconographic study (subject of the research) and the list of the attributes (media to carry out the research) from.
We briefly refer to the attribution of the mentioned works to the filing purpose, to their original location, and whenever they do not coincide, to the present one. We also list important works which we know they exist although their location is unknown (lost works). By the interrogation of this database, the system allows us to identify the subject pictured in the work in study and by the comparison of the attributes it suggests a probable age of execution and a geographical setting.
For instance, if a saint has been worshipped just in a specific town and has the characteristic features of the representations marking a certain century, it will not be possible to set the work elsewhere or to date it back to a preceding age.
Therefore, the system underlines that these manufacts cannot belong to artists who never reached those places or those commits justifying their execution. As a consequence, we cannot list hereafter all of the synergies which can be applied to the system, since the fruitions are many and different and the strong innovative character will suggest new ones in the future.
That is why we decided to introduce just a sample enclosed to the term of the present document.

An example: hypothesis of identification of a character of the Universal Judgement of the Sistine Chapel.
Obviously we cannot illustrate all of the functions the research system by an example the great deal of applications characterizing the innovative contents and potentialities. Nevertheless, the following hypothesis is the result of the iconographic research criteria of the “Penco-System” applied to one of the most famous masterpieces all over the world and, for this reason, it aims at showing how the support of an informatized system can provide a precious contribution which has to undergo the estimation of the expert scholars.

In the text "*The revealed Sistine – Iconography of a masterpiece*" Professor Hendrich W. Pfeiffer, S.J. elaborates a very careful iconographic interpretation of the frescoes in the Sistine Chapel.
In the section concerned with the Universal Judgement and, in particular with the "identification" of the characters of the "Confessors", the scholar describes the figure of a mighty "crossbearer" which represents the one who correlates this group of figures with the one of the martyrs.
Professor Pfeiffer recognized, in the mighty man, the figure of Simon from Cirene (even called Cireneo); suitably identified as the one who supports other "pains", since in the Gospels they tell us he was compelled by the roman soldiers to help Jesus, overdone by the lashes, to bear the cross on the way to the Golgotha (see Mt. 27,32).
Charging the weight of the cross on himself, Simon heals the human beings from sins.
On the right side of this motive we can recognise a female figure, which has not yet been clearly identified by the expert by far.
Eventhough this woman is set in the extreme side of the Judgement, she seems to play a significant role from the point of view of Michelangelo's composition form.

Ditail of the Universal Judgement by Michelangelo (Sistine Chapel)

Her image, eventhough in the backstage, is represented thoroughly and it is set just behind Simon, who, addressing his face towards her, fairly seems to take his attention away from the overwhelming storm pervading the composition of the Judgement.
The link between these two characters is clearly underlined by the contact with the cross, since the maiden is represented in the very act of "*kissing the wood*".
Ultimately, this figure is pervaded by the yellow colour of the rational discrimination, repeated both by the colour of the whole dress and by one of her hair.
The iconographic features we found have been elaborated by the research method of the "Penco-System", which, as you will see hereafter, marks its possible identification with the figure of Maria Maddalena. The image of the Saint was spread both for its living and strong reality and because the sin, forgiving and rescued by the Saviour Himself, thanks to the power of love, makes her almost a symbol of mankind.
This is why the repented Saint makes its collocation reasonable as well as the reference to the group of the "Confessors". Moreover, it's common that the traditional iconography puts it in relation with the attribute of the *cross*.
To support this hypothesis we should consider that, in the cycles of the life and legend, the gospels tradition often describes Maddalena in the moment of the Saviour's forgiving and remembers her presence in all the scenes of the passion, the delivering and the resurrection, where she appears in the group of the witnesses. During the Crucifixion it is not to recognise the saint, while, *at the bottom of the cross embraces or kisses the wood or Christ's feet*".
The red dress Maddalena often wears in the traditional iconography hints at the symbolic expression of her frail humanity which has led her to a perverse life before repenting and asking Jesus to be forgiven. In the context of the Judgement, which is to be meant and set after her conversion the yellow symbolises her recognition of the past life: sin and rescue for eternal safety.
In fact, the Universal Judgement represents the end of everything and the Judgement of what has passed by.
Eventhough human sensibility cannot and must not be replaced by technology, the inventor of the "Penco-System", result of a true passion for art, really wants to end this hypothesis as in the following.
The cross represents the main symbol of Christian faith, since it refers to crucifixion of Jesus, who, through his passion and death, sacrificed himself to rescue mankind in the name of God's love.

The Universal Judgement, the widest fresco ever committed on a wall, was wanted by someone very important who trusted in an extraordinary artist for its realization.
The Church has encharged Michelangelo to represent, by his painting and an iconographic program, the instrument to "communicate" to all peoples the greatness of the Christian message.
I'm sure that the Universal Judgement represents a precise christian message that the Church wanted to address to the mankind by the majesty of the Sistine Chapel. I.E. that the ammonition and the redemption of the sinners represent the exortation to reflect, in the awareness of the sick who, in the image of Maria Maddalena, symbolize the tears of man kind: since only those who understood the message of God, will gain His forgiveness and will find eternal rescue.
Also Simon, by the torsion of his body, really embodies an "iconographic conceit": he does not only underline the weight of the cross, just to express the strength and the sacrifice for the redemption; but he seems to "draw his" attention away to look at the particular gesture of the woman, who is portraited as almost kneeled behind his shoulders and up to the cross.
In my opinion, Michelangelo, while devotedly celebrating this message of God, couldn't avoid representing in his masterpiece, even the image of Maria Maddalena.
The Saint, that figure of a sinner whose worship was so widely spread, witnessed by the Gospels and widely represented through all art history, is the one who, thanks to her redemption, implored and gained Jesus' forgiveness, thus conquering a place next to Christ.

Second and the third database
Besides, the project foresees that the system "Discovering the work of art" be "instructed" to interact with a **second database** containing the files of all information coming to us by means of historical texts such as "Books of Bills" of the painters and "The Lives" by Vasari or old law acts and "catalogations".
Within these texts we can trace highly precious information about the works made by the most important artists, in what age, for which commits and at which wages. Moreover, we also describe here the pictured subjects with their corresponding measures and the descriptions which are useful to find the works to be filed and the lost ones. Therefore, the interaction between the two databases allows us to realize and monitor a dynamic filing including the localization of known manufacts (with the place they were originally or where they are kept at the moment); to find works previously "identified" in a wrong way and which cannot be found properly and, at least, to find other ones seemingly made but whose placement is unknown to us at the moment.
A **third database**, which is complementary with the two ones we have been mentioning above, is instructed to the purpose of filing the chemical characteristic of pigments and the executive methodologies of the different artists. Even in this case the data are divided into according to the materials used by the different artists, classified according to ages and geographical areas. To this purpose we should consider that some pigments, often more precious ones, were used only by the Master, while the pupils had to be satisfied with a less rich and expensive palette. Moreover, some materials were difficult to be found and were often retrieved just in some geographical areas and, above all, in some ages.
Therefore, the innovative contents are both in the devices used to instruct the working procedure, both in the quality and in the quantity of the results. The last ones form that cultural patrimony that turns out to be so claimed and laborious to be found.
What we have been saying by far can let us guess which unknown work is hidden behind such a harmonized work; where technology takes advantage of history to innovate the study and knowledge of an art so rich in mysteries, connected with one another and set far from our knowledge by the running of time.

Innovative contents and peculiarities of the "Penco-System" synergies and benefits compared with "state of the technique".

"Iconclass, Thesaurus Iconographique"…"*allow to come to identify the work of art from an aesthetic and didascalic point of view, but they do not allow to set in time images that saw the change of their iconographic typologies through the ages*...". Ex.: iconography of Saint Sebastian.

"…*In the iconography of the origin, the Saint is represented as a* ***soldier****. While from the XIV century he is represented as a* ***scarcely dressed young man*** *and* ***target of arrows***". "…***Iconclass does not allow to trace such a distinction***…".

(L. Conti, 2003, "*I Beni Culturali e la loro catalogazione*" Roma, Bruno Mondatori Editore, cap.6).

Limit of the "state of the technique": the ordering of the database just described above, even if it is the same iconographic subject, finds a limit: *the variations of the iconographic representation in time and in the geographical* hinder the correct identification of the represented subject. Saint Sebastian "*with armour*" (iconography dating back before the XIV century) cannot be associated with San Sebastian as a "*scarcely dressed young man and target of arrows*" (iconography dating back after XIV century).

(Just for the database of Saint we realized 1250 cards, including the data derived from 38.000 pages of books).

Intellectual property. Organization of the database. Meant as "…*collection of independent data (available to everyone), systematically and methodically set to the purpose of making them individually accessible by electronic medias (or something else). That is to say: the elaboration of the contents and the research mechanism*…". (law about copyright). **Research mechanism.** Functioning specifications of the information system (electronic media) set to data interrogation. Some of the refinement functions of the research are: synonyms, correlations, weight, etc.

From **1999** to the present there were many **Siae patents in the database structure** and the specifications of the research system.

Patent Demand Italy, European, U.S.A. Title: "Discovering a work of art". Pub. No.: WO/2008/056392. International Application No.: PCT/IT/2007/000778.

Strategic goals: "to know to defend".

The demographic research of the Cultural Heritage is one of the almost critical aspects of this field.

The couple art/technology represents the instrument that makes the efficiency of the essenctial condition: for traceability and type of manufact; possible individuation of the **geographical area** and of the original **age**: methodology in the **data organization**; **capability of tracing the lost historical information** high index of **interface** possibility with other systems.

Monitoring and control of the risk factors and relative safety programme: traceability of the work, control of the legitimate antiquity on international scale, safeguard and safeguarding of the work. Scientific Committee: **Gen. C.C. (R) Roberto Dott. Conforti** (Sipbc President General of Arma the Carabinieri Tutela Patrimonio Culturale).

A version of the "Penco System" was given to the Arma dei Carabinieri Tutela Patrimonio Culturale for the "Leonardo System". Such version was properly realized to encourage the identification and the retrieval of the stolen works (on March 30th, 2005). **Finmeccanica Contract**.

Struggle against crime: the **traceability** of the cultural good represents an essential instrument for the struggle against crime. Scientific Committee: **Com. Gen. Sen. Luigi Dott. Ramponi** (Cestudis President; General Commander of the "Guardia di Finanza").

How to reach the goals: the role of the Universities. The project derives from a primary need of the section of the Beni Culturali: "**to know**" the heritage. It is necessary to be aware that the contribution of technology must stay submitted to the unreplaceable and unavoidable human sensibility; since art represents the expression of the man's best capabilities and the instrument by which we wrote the history of our civilization. That's why the cooperation with the **European University of Rome** is so precious, to the purpose of pursuiting ambitious goals within the valorization of an artistic heritage and to promote cultural exchanges among different countries.

Aknowledgements: for further information click on: www.sistemapenco.com

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INTRODUCING A VIRTUAL REALITY EEG-BCI AND PRIMING-BASED TOOL TO MAKE ART INTERACTIVE: A TECHNOLOGICAL AND LINGUISTIC CHALLENGE

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Abstract. The goal of this paper is to present a first prototype of an augmented reality tool enhancing art fruition, drawing on our previous research results on EEG-based BCI (Brain-Computer Interface) devices and priming. The tool, namely ART, aims to integrate research results and new different technological means to provide users with a virtual tutor accessible through new generation mobile devices. Its ultimate goal is to promote culture exploration overcoming linguistic and cultural barriers. Although the tool is at an early stage it has already proved to be user-friendly, stylish and promising of further future development.

INTRODUCTION

Technology refers to the medium used to involve people in experiencing art. The role of technologies is also important in collateral activities, such as the opportunity to track visitors and understand what they are doing both within the museum and, virtually, on-line.

A very typical phenomenon of our times in Western societies is "the rapid transformation of textual traditions and orders of discourse" [7, p.96]. Any change brings about new combinations, the co-occurrence of contradictory elements, which give rise to a mixture of styles. English is used as a lingua franca (ELF), in terms of the communicative strategies adopted to engage users, especially when expertise, knowledge sharing and knowledge creation come increasingly into play. Linguistic elements are reinforced and complemented not only by ~~usual,~~ traditional visual elements, i.e. colours and pictures, but also by a range multimedia resources, i.e. audio, video, podcasts. All these elements facilitate the comprehension of texts, support efficient communication, and enhance the effectiveness of the interpretation process. In this regard, it will interesting to evaluate the directive, instructive or purely entertaining nature of the contents of these texts. The main purpose is to identify and analyze salient linguistic and pragmatic features, including the use of personal pronouns and verb moods, specialized or non-specialized lexis and style [5, 7, 8]

Given this framework, the structure of the present paper is divided into three main sections. The first part provides an overview of our previous researches on which the presented tool is based. The second part presents the current prototype version of the Virtual Augmented Reality tool. Finally, we discuss possible applications of the designed tool and future further developments.

OVERVIEW AND OUTCOMING FROM PREVIOUS RESEARCHES

A few years ago we have started our research reviewing the state-of-the-art of VR in Cultural Heritage [9]. We have then investigated means and methods to collect, analyse and interpret data [2] from people accessing art to find a way to enhance the visitors' experience visiting.

Our researches have been conducted attempting to jointly use methods from technology, education and psychology with the aim to enhance the public's experience when observing Art.

In order to get conscious and unconscious feedback from users, we chose to use EEG-based BCI (Brain-Computer Interface). The reason for this choice lies in their extensive use in the entertainment and in the scientific communities due to their reliability in collecting EEG data with a high time resolution and to their portability and low-cost. BCIs [1] commercial devices consist in a simplification of the medical EEG equipment, communicating an EEG response to stimuli by WI-fi connection, allowing people to feel relaxed, reduce anxiety and move freely in the experimental environment or in the game.

We performed our researches with particular focus on users' emotional and cognitive response to musical and visual stimuli, with the aim to transfer our result to enhance users experiencing of art.

We performed preliminary experiments to evaluate specific protocols with the aim to test the reliability of both the Emotiv Epoc and the Neurosky Mindwave. We based the considered mental state/emotion labels on the 2D valence/arousal model [17] originating from cognitive theory. This model has been used to determine the apparent mood of music in several works [13, 14] .

To test the generalization ability of the chosen EEG features patterns and associated labels, we elicited physiological emotional responses using music stimuli and sound stimuli from the International Affective Digitized Sounds (IADS) database[1]. In particular, we designed the experiments according to [18], because the two dimensions of emotion mainly considered by researchers are valence and intensity, but there are, in fact, few models related to brain activity taking into account both dimensions. Self-assessment of valence/arousal was therefore performed in the study by each participant and for each sound, using a simplified version of the Self-Assessment Manikin [16]. In this way, we could correctly identify the correspondence of hypothesized mental state response to each sound with the moods declared by the participants. Results showed that brain activity measured at the anterior part of the scalp distinguished the valence of musical emotions both using the Emotiv Epoc and the Neurosky Mindwave. Considering these results, we decided to use the Neurosky Mindwave in future experiments to refine the approach, sacrificing a greater precision for a long-lasting data detection without decay of the involvement level of the users.

In further experiments we investigated the exposure to a visual-perceptive, semantic, or conceptual stimulus influences response to a later stimulus in the context of a Museum of fine Art [4]. Priming is a kind of implicit memory (a sort of tacit memory that is not consciously retrieved or observed). Visual-perceptual priming [19, 20] is defined by enhanced processing of previously seen visual material, relative to novel visual material. The purpose of our research consisted in developing a priming-based tool taking into account the most relevant experimental and physiological findings and applies them to the museum environment.

We submitted individuals to a museum tour where participants individually watched prime stimuli on a screen, under a researcher's supervision, and obtained encouraging results both from the analysis of the questionnaire and from the investigation performed on the EEG signals collected by the BCI device. In fact, in participants who received the visual stimuli, we registered an increase in the attention level corresponding to questions related to the visual stimuli, raising the engagement of memory in the process. These studies represent part of a wider interdisciplinary research project [4, 6, 12, 11] aiming to evaluate the response of humans to visual, auditory and perceptual stimuli, measured with classical methods used in Psychology and Cognitive Science and with innovative brain imaging methodologies, such as, in our case, the EEG.

In other works we tested the user reaction to visual stimuli using ambiguous images from Gestalt [15], monoscopic and stereoscopic movies [6], colours [10] and e-learning environments [3]. Also in this case, using both classical questions-based tests and EEG-signal analysis, we obtained interesting results, confirming the importance of specific colours, shapes and sound, on the one hand to make priming really effective and, on the other hand, to have guidelines to use appropriately 3D Virtual Environments to engage visitors. Results from these studies suggested important guidelines for the choice of supports and devices that are likely to be more appreciated by participants to our experiments. All the obtained results have been used to design our prototype that is going to be presented in the following paragraph.

[1] http://csea.phhp.ufl.edu/media/iadsmessage.html

ART: VIRTUAL AUGMENTED REALITY TUTOR

Significant improvements have also been realized recently in the area of Augmented Reality, extending VR systems with making use of supports for blending real and virtual elements in the same frame. By combining Virtual Reality with video processing and computer vision techniques, AR systems offer a natural view of real scenes improved with virtual objects. Within Cultural Heritage Virtual and Augmented Reality techniques could be significantly useful. Let us consider, for example, that many museums do not have factual room and resources necessary to exhibit their collections. In addition, the nature and fragility of some collections prevent museum curators from making them available to the public. Moreover, the interaction of visitors with the works of art might be very restricted: the works cannot be observed from all angles, cannot be compared with other items, or cannot be studied in different contexts. In this field, Virtual and Augmented Reality provide solutions enabling visualization of 3D digital models of museum artefacts in both virtual and real environments. They also allow visitors to interact with the models in various ways. At the same time, visitors should be able to interact with digital contents easily and naturally in the same way that they can interact with objects in a real environment. Everything that does not display these crucial features will not be understood and will not be accepted. Our study starts from the outcomes of previous researches and takes into consideration the current limit of VR and AR technologies. In fact, if it is true that Virtual environments could enhance visitors' experience, we have to take into account possible constraints basically related to the costs required for the creation of a virtual immersive space and to the impossibility to allow users to interact with one another in the artificial environment, thus limiting the exploration possibilities. In fact, the possibilities offered by VR social networks as Second Life remain, at the moment, limited to those who are already members of the network and require a specific familiarity with the environment "rules" and the mediation a more "traditional" technological support. Our main purpose has been creating something widely and easily accessible, at low cost and, therefore, appealing for museums and in general suitable for exhibitions concerning Cultural Heritage.

For these reasons we designed a virtual tutor accessible by mobile devices and suitable for different contexts. ART is a virtual environment, to which a virtual 3D character can or cannot be associated. It can be operated by smart phones or last generation mobile devices, allowing users to observe a masterpiece with the support of more specific information, historical and geographical references, multi-language translations. Its design is based on priming and cognitive models, both for long lasting learning easy access to information. The innovative feature consists in the fact that, with open-source softwares, a museum or an exibition can create contents easily and following the guidelines resulting from our research, through a guided design process, saving costs and time. In fact, content developers could make the most of the guidelines targeted to save time obtaining a product based on priming and cognitive principles from our research. Besides, they could also save costs because of the use of open-source software. At the same time, the solution does not require any investment in hardware because it is based on a last generation Qcode allowing visitors to scan it with their smart-phones or tablets and visualize into the device information, texts in different languages, images and also (see figure 1) a virtual animated assistant guiding them in a new form of art exploration.

To create the prototype we used a web-based platform to insert any desired contents (texts in different languages, images, videoclips) developed with standard HTML and PHP.

To visualize information through Qcodes, we chose to use Augment[2] software.

With this system a user is able to read the Qcode provided beside a masterpiece and visualize all the information provided, with the obvious advantage of portability of information, thus enabling museums to save costs (i.e., no paper and no software or hardware costs).

[2] http://www.augmentedev.com

Figure 1: on the left a Qcode for the software Augment. On the right an example of an Augmented Virtual Tutor (ART)

Our prototype also provides a Virtual Character, ART, developed in a 3D graphic animation software, as shown in figure 1. ART is an animated 3D character able to show information and speak, if required. We designed it using Blender[3] free 3D graphic software, but is it possible to use any other 3D graphic software allowing to save the model in *Collada* (. dae) format. We developed a version readable both from the Windows system and for OSX and Android. The development has been easy and require IT expertise only for developing the 3D character and possibly the applications for mobile devices such as those using OX system and Android.

CONCLUSIONS AND FURTHER DEVELOPMENTS

In this paper we present a prototype of a virtual augmented assistant, ART, conceived for Cultural Heritage, Museums and Exibitions based on our previous researches on cognitive, priming and languages through classic investigation methods and EEG, firstly conducted with the aim to enhance visitors' experience and involvement.

ART presents the advantage of saving costs and time in developing the solution. Moreover it results appealing to visitors, due to the possibility to implement a 3D Virtual character able to show text and video information and to speak, if needed, to users. The prototype requires an off-line developing process and there is no need for specific hardware to be physically installed beside masterpiece or within the exhibition area: only a Qcode is required to be displayed.

Currently we are testing our solution in a Museum environment, but we are planning to develop a user-friendly visual programming platform allowing to produce the whole process and also suitable for non IT-experts.

One final remark: so far, visitors are already allowed to take virtual tours of a museum or an exhibition, but are constrained to follow a pre-defined path and prevented to choose any tailored-made solution. therefore, there is room for further developments, for a wide array of practical, creative and ludic elaborations, such us the possibility to choose among different characters, to have “special guest” characters (the artist themselves, for example), to book a specific tour in advance and to experience a trial version of a tour in a VR environment, to interact with virtual representations of the works, even modifying or re-interpreting them, to save contents provided by the virtual tour leader and then to use/share them.

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VIRTUAL MUSEUM *ANCIENT FORTRESSES OF THE NORTHWEST OF RUSSIA*: KOPORYE FORTRESS - VIRTUAL RECONSTRUCTION.

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Abstract: The article offers classification of virtual museums and solutions for their set-up with the use of various multimedia technologies. It also details the process of creating a virtual reconstruction of a fortress in the Northwest of Russia, as a part of a project of setting up a virtual museum (web portal).

INTRODUCTION

Virtual online museums open up a wealth of new opportunities, both for museum professionals (international contacts, joint virtual exhibitions, data exchange, joint projects etc.) and for the users (virtual tours, detailed information on the exhibits, self-improvement etc.). At the moment, there are several approaches to the set-up of virtual museums:

1. Virtual tours (virtual walks) through real museums, i. e. a sequence on interconnected panoramic photos (as a rule, they are integrated into the museum website);
2. Virtual museum as a website;
   2.1. Representation of a real museum (with a digitized database of the museum exhibits and other relevant data);
   2.2. An original website (virtual museum) not connected to a specific museum [Fig.1];
   2.3. A virtual 3D space that features the museum exhibits created with the use of specific software.

Subsection

Design and Multimedia Center, Saint-Petersburg National Research University of Information Technologies, Mechanics and Optics, in cooperation with the History and Liberal Arts Departments of Saint-Petersburg State University are working on a project entitled *Multimedia Information System 'Ancient Fortresses of the Northwest of Russia'*. Within the framework of the

project, we are designing a web portal featuring nine fortresses of the Northwest of Russia, all of them are unique monuments of the ancient Russian fortification architecture, forming together a powerful defense system that once protected the borders of the Ancient Rus.

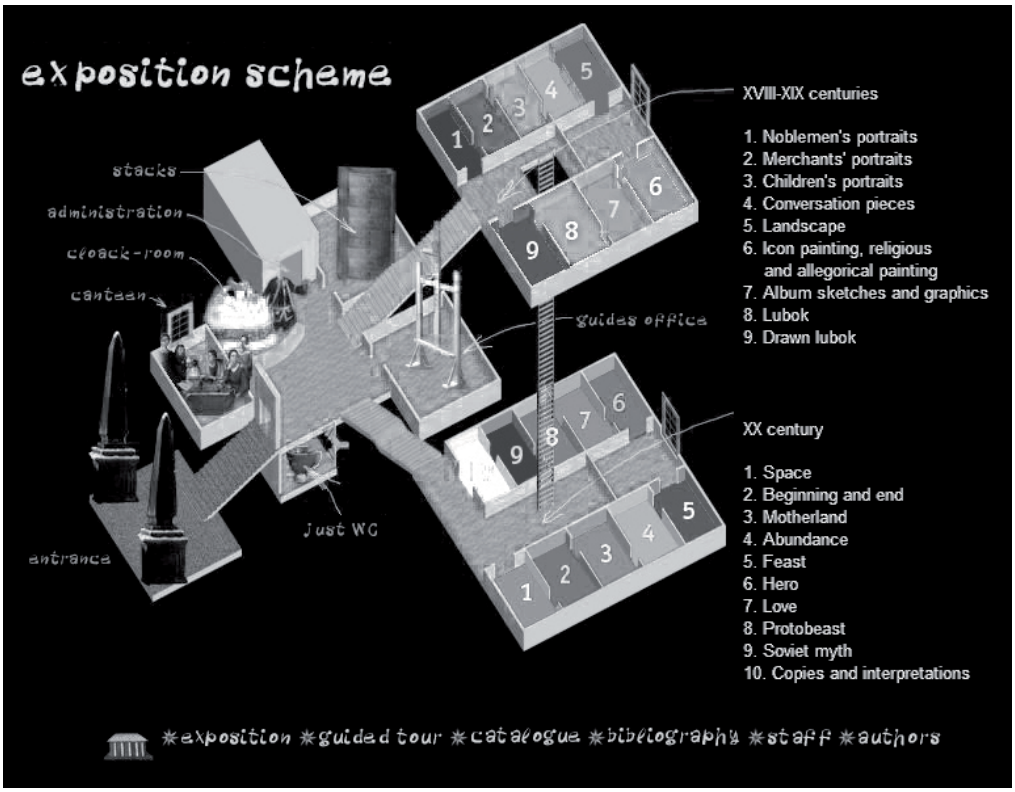

Fig.1 Virtual Museum of Russian Primitive [1]. Exposition Scheme.

Thus our website is not just a web portal with the historic information on the fortresses, but a virtual museum with the virtual reconstructions, photo/video galleries and virtual panoramic tours [Fig.2].

One of the key features of the virtual museum are the virtual 3D reconstructions of several Northwestern fortresses at a certain point in history, with the option of an interactive virtual walk through the recreated object. The 3D location downloaded to the portal in question will be rendered interactive by various animated elements (e.g. the fortress gate will open once you reach a certain point) as well as by the so-called *hot points*, the active areas that provide useful data on various parts of the fortress.

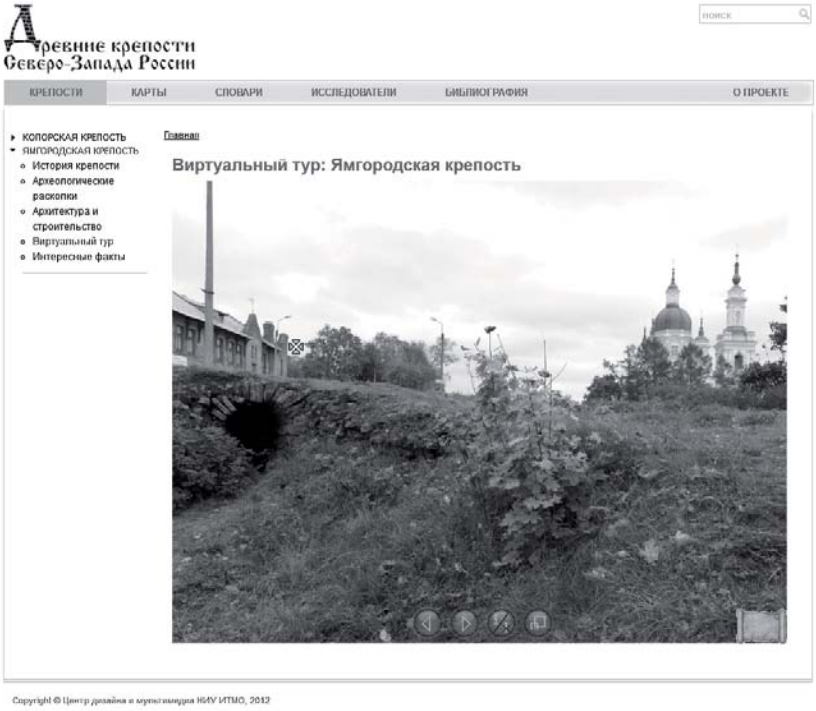

Fig.2 Web portal *Ancient Fortresses of the Northwest of Russia* [2]. Virtual Tour through the Excavation Site of Yamgorod Fortress.

Fig.3 Koporye Fortress. Current View.

A most unique monument is the fortress of Koporye, located at the north-western extremity of Izhora Plato, 9 miles away from the Gulf of Finland [Fig.3].

From times immemorial, Koporye was a key point in the defense system of the southern coast of the Gulf of Finland. Its proximity to the shore increased, rather than decreased, the significance of Koporye as an inland settlement. Apparently, for a considerable period of time it was the only center of Novgorodian rule in the lands inhabited by the Vod' tribe. Besides, the owner of Koporye would also control the highly fertile Izhora Plato. No wonder that from the very beginning of its recorded history the settlement of Koporye is featured as a strategically important military point and a center of a whole area bearing the same name [3].

It is the only fortress of the Northwest that has been preserved in its original way; it has a number of unique architectural features. Four round towers are located at the more vulnerable Northern and North-Eastern sides, two or them protect the entrance to the fortress. The rampart facing the Koporka river stands 130-150 yards from its further bank; it has no towers and creates a so-called 'blind area' [3]. Besides, Koporye Fortress features a system of gateways that is unusual for ancient Russian fortresses, that of two gateways set right next to each other, a system of gates with a large and a small passage and with portcullises for the small and the large doorway [4].

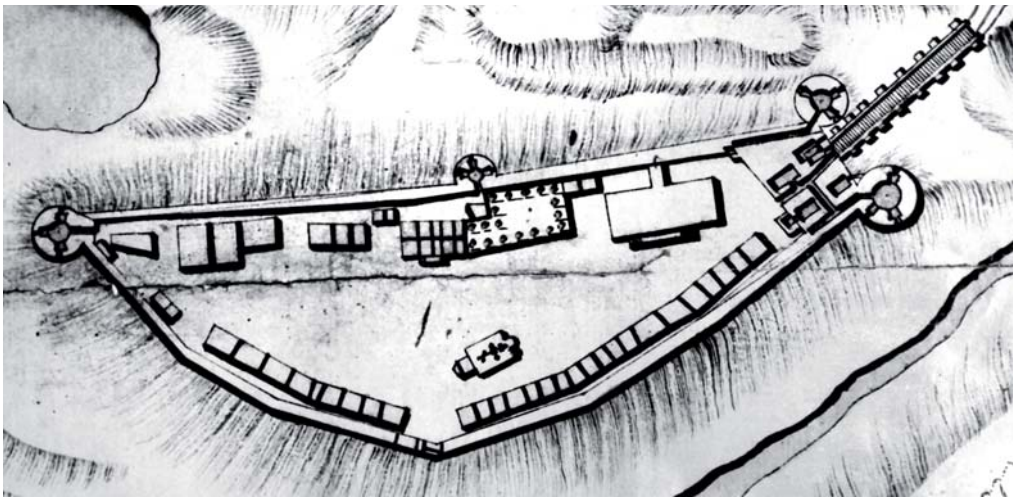

Fig.4 Layout of Koporye Fortress featuring interior structures

In cooperation with the architect and restorer I. Haustova, who has created a portfolio on Koporye Fortress, we have decided to make a virtual reconstruction of the fortress in the early 18th century. Currently we have created a virtual 3D reconstruction of the fortress with the options of a virtual walk through the reconstructed fortress and of a panoramic tour through the present-day fortress.

The following software was used for the 3D reconstruction of Koporye Fortress:

1. Autodesk 3D Studio Max – for modeling and texturizing of the fortress;
2. Unity – for location and incorporation into *Ancient Fortresses of the Northwest of Russia* portal.

Having analyzed the plans, the photos and various sketches of the fortress and the surrounding area, we have divided the process of modeling into the following stages:

1. Modeling of the fortress;
2. Modeling of the structures located on the fortress grounds (administrative building, barracks, stables etc.);

3. Modeling of Transfiguration Church (15–16th cents.).

Since one of the goals of our project is the set-up of a virtual museum, we have additionally modeled various artifacts (weapons, church utensils etc.) and located them within the fortress grounds [Fig.5].

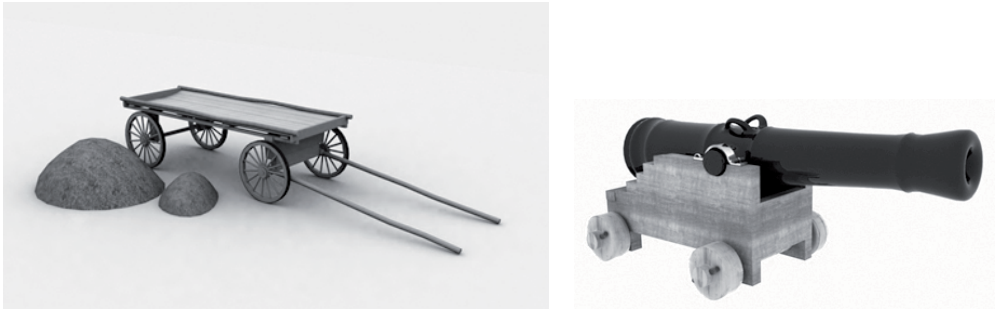

Fig.5 Additional elements in the Koporye Fortress location.

Fig. 6 shows the result of modeling and texturizing of the object, Koporye Fortress of the early 18th cent.

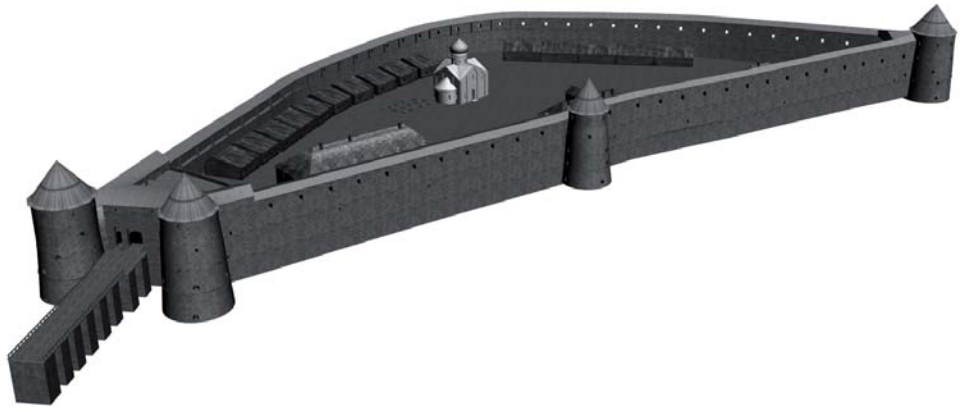

Fig.6 Virtual 3D reconstruction of Koporye Fortress of the early 18th cent.

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DOCART900: A WEB APPLICATION FOR CULTURAL HERITAGE

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Abstract – This work aims at the development of a web application for cultural heritage purposes: an innovative tool for searching and browsing digital libraries of artistic and literary documents. The project performs a critical access to contemporary archives of documents related to well-known 19th and 20th centuries art historians. The system has been designed and implemented by MICC and Fondazione Memofonte, Scuola Normale Superiore of Pisa, University of Florence and University of Udine.

INTRODUCTION

This paper presents an innovative web portal for searching and browsing textual documents, manuscripts or printed contents, relating to some of the leading figures of historiography and criticism of the nineteenth and twentieth centuries Italian art: Giovan Battista Cavalcaselle (1819-1897), Adolfo Venturi (1856 - 1941), Ugo Ojetti (1871-1946), Giulio Carlo Argan (1909-1992) and Cesare Brandi (1906-1988).
The work of searching for new materials has led to the discovery of mostly unpublished texts such as sketchbooks, papers, correspondence, notes, etc.. At the same time, the research activities contributed to the reorganization and classification of such sources.
The tools offered by the portal provides users and scholars a comprehensive view of the historical environment and cultural relations of the world in which the five critical carried out their activities.
The web application allows users to search and filter these documents through the associated metadata as well as by means of controlled vocabularies that were defined and included in the system (places, exhibitions, movements and artistic terms, works, people, and texts), selecting the terms from national and international vocabularies or adding specific information.
The system includes an interface for simple and advanced search, a content management system and a module for the authomatic semantic annotation of texts and advanced visualization of documents.

THE WEB APPLICATION

The web archive is based on a Model View Controller architecture exploiting the Symfony [1] framework.
The application and currently published at http://www.docart900.memofonte.it.
The system consists of three parts:

- an overview of the project and its aims;
- the content management system for publishing and editing documents;
- a simple and advanced search and data visualization engine.

The frontend application (Fig. 1) provides a summary of the archives of the five critics through essential biographies, a gallery of images and general bibliographies. Editors, after the authentication step, can access the backend system consisting of a series of modules that

provide functionality for creating, retrieving, editing, and deleting documents (according to the paradigm of persistence CRUD [2]: Create, Retrieve, Update, Delete).
The two main entities of information available in the system are Sources and Events. The application also allows users to insert and attach images and photos to both Sources and Events (eg digital reproduction of a sketchbook).

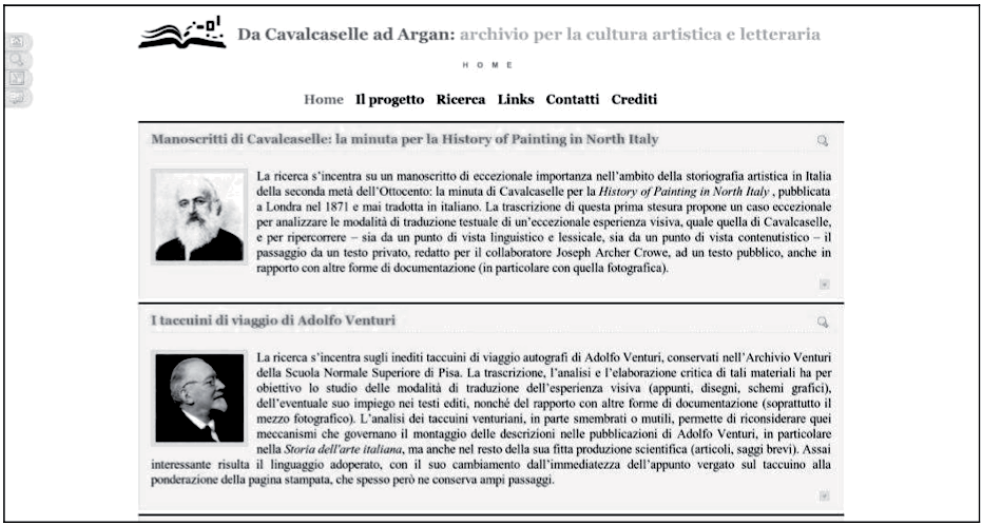

Figure 1. The *Frontend* application

Full-text and Advanced Search

The search form consists of two components: the full-text and advanced search. The full-text search allows the user to find what he wants only by providing a search key. Famous examples of full-text search engines are Google and Yahoo.
The indexing engine used for the full-text search is based on *Lucene* [3]. Lucene is a free and open source library (API) extremely flexible and adaptable to every need of search. The full-text search interface (Fig. 2, top) offers the possibility to choose whether to search for all or just some of the documentary archives (Sources and Events regarding Cavalcaselle, Venturi, Ojetti, Argan and Brandi) and has a simple text box in which the user can enter one or more terms.

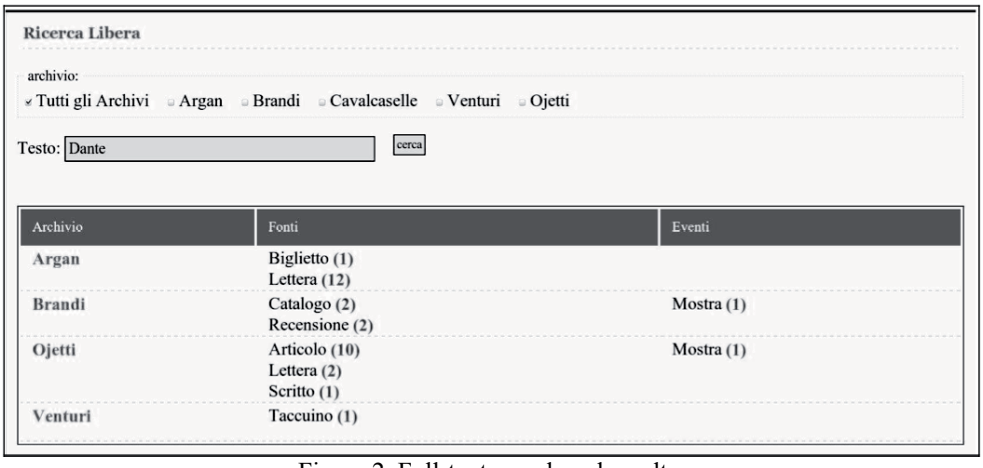

Figure 2. Full-text search and results.

The user can perform complex searches taking advantage of a complete syntax: for example he can enter text in quotes (example: "National Exhibition of Correggio") or using Boolean operators (AND, OR, NOT).
The results of the search are listed first by archive and then by type, in order to provide an overview of the results for the specific query (Figure 2, bottom).
The advanced search, instead, provides the chance to query applying one or more general and specific filter associated to the two major categories Event and Source (Fig. 3).

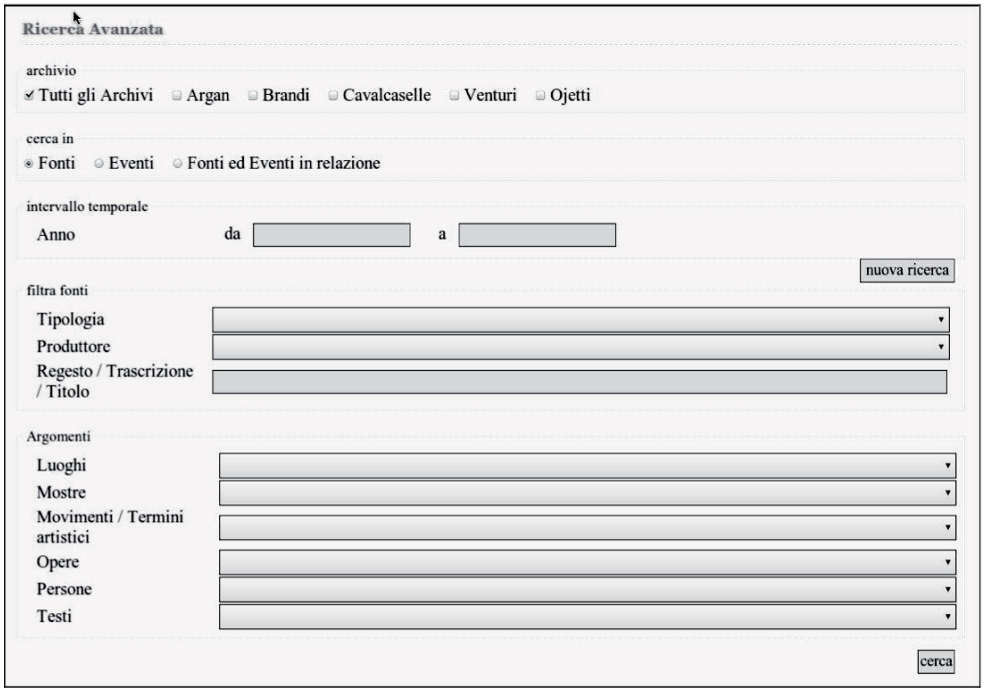

Figure 3. Advanced search form.

Generic filters allow users to filter the results through archival or temporal mode.
Specific search filetrs for Source type are used to filter the documents by type, author, title and so on. An example of a Source search is: “find all the reviews written by Brandi about exhibitions of Picasso”.
Specific search filters for Event type allows users to filter the documents by type, name and location; for example users can search for “all the exhibitions held in Florence in the thirties”.
Finally, ther is a third mode: Sources and related Events. It allows users to mix filters in order to create more complex queries. For example, users can search “reviews written by Cesare Brandi dealing with exhibitions held in Florence”.
The advanced search interface has been developed according to the paradigm of Rich Internet Applications. Selecting the value of any box, in fact, everything is updated in a consistent way without reloading the page.
The result for each resource shows the file, the type of source, the signature, title, date, authors and recipients, and allows the user to quickly understand the contents of the resources identified by the search engine.
Documents are displayed in a tabular layout divided into sections (Fig. 4).
In the top of each card, finally, there are the navigation tool (called breadcrumbs) that allows the navigation through the result list and performs the numbering of the pages.

Figura 4. Document visualization.

Multimedia sketchbooks

Fifteen multimedia sketchbooks constituted by a minimum of 20 to a maximum of 200 cards have been digitized and made available for users through the web application. We implemented a jQuery plugin that provide a useful tool for users to navigate quickly and intuitively through the pages. In the bottom of the interface (Figure 5) there is the list of thumbs of the sketchbook cards: such list is scrollable horizontally through the simple movement of the mouse. When the user clicks on any of them, the relative image is opened and displayed in the browser with the width resolution of the user's screen. He can view different parts of the image that are centered in sync with the mouse cursor position. This allows such material, otherwise difficult to consult, to be quickly and intuitively accessible to the audience.

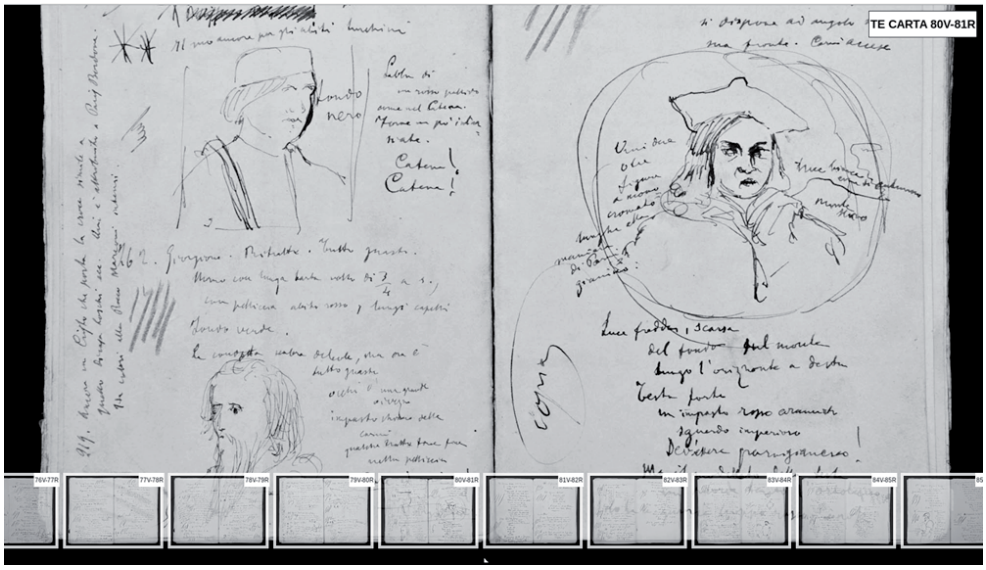

Figure 5. Multimedia sketchbook browsing

Advanced results views

The project SIMILE (Semantic Interoperability of Metadata and Information in Unlike Environments)[4], founded on the initiative of the Massachusetts Institute of Technology (MIT), brings together a collection of open source technologies to support the development of the semantic web.

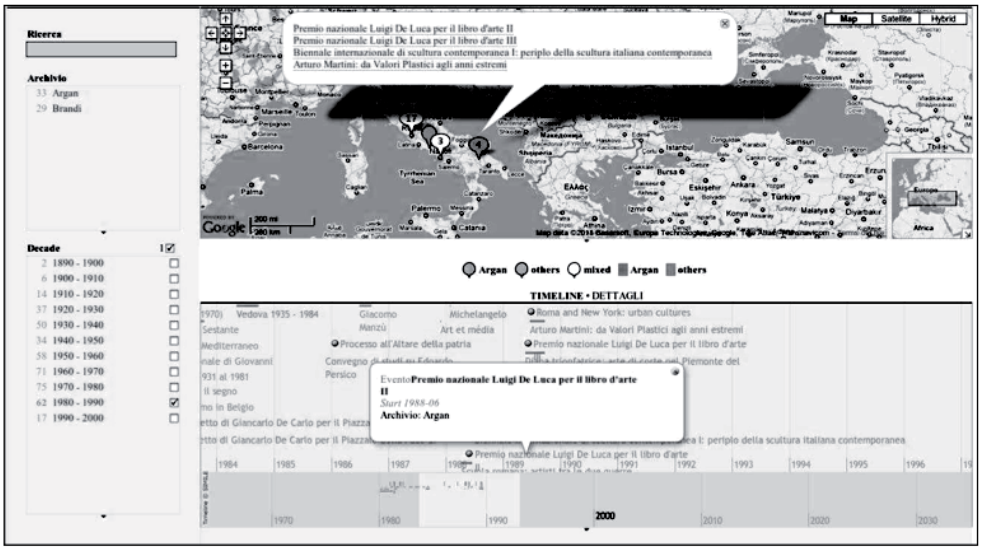

Figure 6. An advanced view using *Exhibit* framework.

The application uses the *Exhibit* framework (SIMILE project) for the implementation of an advanced view of the data model. Exhibit is an AJAX framework that allows the application to create dynamic views of semantically structured data. The browser is totally in charge of the process of generating the views. The functionality of the framework are in fact made available within a web page through the inclusion of javascript files (API). The directives given to it for displaying specific attributes are assigned through HTML elements.
The view shows a geographic (map) and time (timeline) location of events.
Such views (an example is provided in Fig 6) allow scholars to reconstruct the movements and the chronological order of the critical paths in the area for each of the protagonists whose documentary archives constitute the database.

CONCLUSIONS

In this paper we presented a web-based system for managing and searching document archives of manuscripts of literary and artistic nature of the nineteenth and twentieth centuries written by Giovan Battista Cavalcaselle, Adolfo Venturi, Ugo Ojetti, Giulio Carlo Argan and Cesare Brandi. The application provides a simple and advanced search engine and a an advanced semantic view based on the Rich Internet Applications paradigm which allows to place the individual units of quesy results in both temporally and geographically way.

ACKNOWLEDGMENTS

This work was made possible by the valuable contribution of Fondazione Memofonte, Scuola Normale Superiore of Pisa, University of Florence and University of Udine.

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Travel Industry
ICT Vertical Solutions

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Abstract – Travel & cultural heritage vertical market is one of the world's largest industries and represent for 12% of our country GDP. Travel Industry is more 47% than e-Commerce revenues in Italy.

In 2012, e-Commerce in Italy registered a growth rate of 19%, which brings the Italian market at an overall estimated rough value of about 10 billion euro. In this scenario e-Commerce solutions for Travel Industry gain particular benefit from new services related to context awareness and Social Networks and represents an estimated market share of 47% of the total: about € 4,7 billion.

Vertical travel applications hosted in Nuvola Italiana is the great opportunity for the Travel Industry, and provides benefits to tour operators, and industry stakeholders, by developing and hosting travel applications (booking & reservation platforms) and digital contents such as Tour Catalogues - information for visitors including Cultural Heritage.

Telecom Italia (TI) is currently developing and experiencing new services to support tour operators, enterprise applications to offer reliable travel experiences. By leveraging on innovative technologies, TI would like to build a new ICT offer for the Travel Industry & Cultural Heritage market in order to contribute and enhancing country competitiveness.

Tourism represents for our country an inexhaustible source of revenues and visibility worldwide. "Italy" is a brand to enhance and develop with the support of institutions, individuals, and technology.
Tourism is a primary source of income for Italy, contributing to the national GDP (Gross Domestic Product) with 12 %.
The tourist sector in Italy is a "rich" market and represents a strong contribution to the national GDP.
Recently, an important share of the tourist market is evolving in the dimension of personalization, where tourists are choosing their own unique itineraries and experiences among multiple offers and available options.
e-Tourism appears as a promising application domain with the goal of providing an improved and personalized experience to tourist by the application of the latest technologies (both in terms of hardware and software) and information coming from the Web 2.0.
In particular, telco operators can make synergies to offer advanced services for tourists using their mobile phones.
The provision of cloud applications can deliver better services and travel experiences, if properly addressed in tourism ecosystem. The local territories, in fact, can generate great business opportunities for operators if they have the chance to rely on tourism platforms powered by new cloud technologies.
Telecom Italia's Nuvola Italiana provides infrastructure and enhanced hosting capabilities designed around the needs of the travel industry.

Telecom Italia's Nuvola Italiana is the Cloud computing system designed to guarantee the reliability and security required by Travel businesses, thanks to the combination of web and IDC infrastructures allowing the management of the service on an end to end basis, and with high quality levels including network.
Telecom Italia (TI) is currently developing and experiencing new services to support tour operators, enterprise applications to offer reliable travel experiences.
By leveraging on innovative technologies, TI would like to build a new offer for the Travel Industry & Cultural Heritage market in order to contribute and enhancing competitiveness.
The cultural tourism market is moving towards a growing visitor satisfaction. The tourist shows an increasing need to play an active role, integrating the cultural content of the visit with a personal auto-generated content and sharing them with the "traveller community".
At the same time it's becoming possible to develop instruments that give an incentive to visit typical places for culture and great beauty but little known.
Nuvola Italiana platforms are very useful for the provision of services to support urban tourist mobility based on LBS services information. The LBS and social services are now able to plan a real time travel, and participate in actively to the improvement of urban mobility, for example by providing information on traffic conditions.
Telecom Italia considers it important to contribute to the development of a tourism innovative project that help redesign the supply chain of tourism services usable by mobile devices during the trip with information on routes and cultural and entertainment points of interest.
Support for travel industry in verticals markets (hospitality, food economy, tourism transportation, etc) and offering vertical cloud solutions for the national tourism system (cultural and food & wine tours, consortia of agencies, Parks, …) is one of TI's goals and for which it can provide technology and advanced business models. Transportation is an integral part of the tourism industry. It is largely due to the improvement of transportation that tourism has expanded. From a series of trials and public demonstrations, Telecom Italia has created its vision to guide the design of ICT services for tourism sector: the intention is to support the Tour operators and Travel Industry stake holders (which will be TI's direct customers) in the aggregation and development of an eTourism offer for the benefit of all the actors of the value chain, with a Business2Business2Consumer (B2B2C) business model.
In 2012, e-Commerce in Italy registered a growth rate of 19%, which brings the Italian market at an overall estimated rough value of about 10 billion euro. E-commerce is not only an "online shop", but also an opportunity for companies to offer products and services, and an opportunity for consumers to shop in a market place without boundaries.
In this scenario e-Commerce solutions for Travel Industry gain particular benefit from new services related to context awareness and Social Networks and represents an estimated market share of 47% of the total.
In the tourism sector, Telecom Italia has presented "Travel Me", a mobile guide service usable from any type of multimedia terminal (tablet, smartphone). The solution enables users to receive information regarding locations of artistic interest or services, such as monuments, transport, restaurants and hotels in the area where the tourist is located.
The service is made available thanks to the interaction of the user multimedia terminal, through mobile and Wi-Fi networks, with the Telecom Italia application platforms. The information contents are provided with geographical referencing thanks to various locating systems (GPS, Wi-Fi, Mobile Network).
Access to information is obtained by choosing a point of interest shown on a map to which contents of various types can be linked, e.g. videos, photos, text or audio files.
Furthermore an Augmented Reality (AR) application is available. AR is a technology that allows interactive objects superimposition on the smartphone camera view, thus making reality "clickable and connected".

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VIVIT: A SEMANTIC WEB SYSTEM FOR THE PROMOTION OF ITALIAN LINGUISTIC AND CULTURAL HERITAGE

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Abstract – "VIVIT: VIVI L'ITALIANO" is an integrated web based archive of learning resources, texts and iconographic materials which aims to promote the study of the Italian language and cultural heritage among second and third generation Italians living abroad. A huge amount of heterogeneous data has been organized in a structured corpus in order to obtain an efficient storage and retrieval environment. Documents are stored according to both their contents and their semantic description using traditional entity-relationship and a system for storage and management of data with semantic annotation.

INTRODUCTION

The VIVIT project [1] has been developed since 2010, under government FIRB fundings, by MICC (Media Integration and Communication Center) and Accademia della Crusca, with contributions by language research units belonging to University of Modena and Reggio Emilia and University of Padova. The main concept was the creation of a web-based platform for sharing media and documents, along with interactive resources for self-assessment of a user's language proficiency level. The expected user target for the web platform are second and third generation Italians living abroad, to which the content creators wished to offer an in-depth view of Italy, country of origin of their families, and the Italian language for study purposes.

The documents and media resources were produced, edited and annotated by and under the supervision of Accademia della Crusca. To better fit in the view of a user-based web experience, research was led by MICC in the field of social interaction to better understand how to present the given resources and engage user's active interaction with the web platform using the rich internet applications paradigm.

Furthermore a semiautomatic software module has been developed, which performs semantic annotations and entities extraction on the knowledge-base in order to find and visualize domain specific relations in the documents corpus.

Given the collaborative nature of the platform, in which resources from different research units were to fit, choice was made to make use of a CMS (Content Management System) to give editors the possibility of working directly on the documents inside the platform without any supervision from the platform developers. MICC chose to rely on Drupal [2], an open-source and easily extensible PHP based content management framework.

The system: design and development

MICC created the information architecture starting from the source materials, a bottom-up process which was necessary given the variety of topics and materials structure; thus in the

first place it was decided to organize the contents according to the expected level of user interaction in two main categories: contents which can be only read and commented on and contents which require active interaction. The first type includes resources on history of the italian language and society and culture of Italy; the second type includes quizzes and learning resources, both written and audiovisual.

While this structure (articles and exercises) is fairly basic, a multiplicity of categories ("taxonomies") was necessary to create relations between the corpus items: to attain this structured vocabularies, i.e. nested, fixed hierarchical taxonomies, and free, user created vocabularies for content annotation (tags) were implemented via semi-automatic techniques; however, given the highly specialized academic nature of the corpus, the vocabulary system might not be accurate enough to explicit their semantic relatedness: to fix this, the relations between sources belonging to different categories can be defined also by professional content editors through user-defined explicit relations, using dedicated input fields available during the submission process of the documents. This gives the possibility of creating documents relations controlled by the editors and not otherwise self-evident (e.g. the relations between an author and his/her works). The annotation module is used by the system to suggest relatable contents which specialized users (e. g. students or teachers) may select and rearrange in their bookmark lists and share on their profile pages for learning or teaching purposes.

As for the exercises, a variety of advanced interactive solutions has been adopted for recreating and integrate, in the web portal, learning materials which usually are not widely and publicly available online. Several PHP / jQuery based plugins were created in order to enhance

the usability of the interactive systems following the rich internet applications accessibility guidelines. The jQuery plugins build forms and navigation through a series of editor-defined quizzes/questions ranging from cloze tests, multiple or single choice, various types of input fields to image word association exercises; visual feedback is given to the reader on correct/incorrect answers and quiz autocompletion feature is offered as well. Quiz solutions are stored in local and configurable JSON files.

Access levels

A granular level of control over means of accessing and participating to the portal activity has been developed. As far as the core system is concerned, different access levels may be granted on a role-based structure; every user role may or may not have certain content access permissions, while every plugin may implement its own permissions, that is, newly implemented features might be accessible to users on a per-plugin basis. The system administrator is not limited to granting total access to a single role, having instead full control on every feature.

The VIVIT project at the moment allows the following levels of interaction:

- unauthenticated users, able to browse the website and search its contents;
- authenticated users, who can browse, search (with advanced search features), bookmark content and share their bookmarks with other users, send and receive private messages, post comments;
- contributors, who can do all of the above and create/categorize their own content;
- editors, who in addition to the contributors permissions can insert and edit every type of content, including the academic and contributed resources and create specific domain relations;
- administrators, who can do all of the above and modify/implement functionalities.

The final goal is not only to offer resources, but to create a community of users actively engaged with the activity of the VIVIT project, sharing documents in order to create a corpus of personal experiences that might be in the end object of linguistic/social/anthropological studies while at the same time presenting to users different technical means by which properly increase the corpus and the complexity of relations in the knowledge-base.

Social features

Users are offered with the possibility not only of browsing content, but also of sharing it through the most popular social networks or services: at the moment this integration is offered for Facebook, Twitter, Google.

Moreover, the user account creation is been performed via Facebook connect feature (implemented via Facebook PHP SDK): not only this helps the user in avoiding a registration of an account valid solely on VIVIT, but it also helps in keeping potential spammers away, for users are required to have an account that has already been validated on the Facebook platform.

The Facebook connect module allows the user to show his/her Facebook profile name/picture on VIVIT and to present a user logged in via Facebook with a list of Facebook friends, who have an account on VIVIT through Facebook, on their user profile page. This feature improves the user engagement with the system and contributes to the development of a wider and active community. The module consists of a series of APIs centered on Facebook apps development, which leaves room for further VIVIT enhancement.

Text analysis feature

As an integration to the free tagging system and the taxonomy module, the system features an automated topics and named entities extraction (names, entities and dates) service, running as a servlet on the MICC server. The servlet, named “Homer”, allows for direct user input and can output a weighted list of topics, entities, or terms by analyzing a given text or url. The servlet exposes several configurable parameters: users can set filters on entity types, amount of terms to be returned, output file format (JSON or XML).

The following are the main functionalities implemented in the Homer text media processor:

- **language detection:** the service determines the language of the text being analyzed and is a useful pre-processing step for other analysis functions. In particular it is the base to perform stop-word elimination in documents for which the language is not known;

- **stop-word elimination:** the goal is to eliminate all the words that do not bring any semantic meaning, like conjunctions, articles, etc. This process is based on the use of lists of stop-words and requires to know the language of the document to be processed. It can be considered as a filtering process, and is beneficial for other text analysis techniques. In case of language detection uncertainty the computation of detected stop-words is used to disambiguate the detected language;

- **tag-cloud computation:** this service is useful to provide a concise representation of a document. Basically it performs a frequency analysis of the words of the document

and selects the *N* most common words. In order to be effective the stop-words have to be eliminated, otherwise it is very probable that the most common words are picked among them, according to the empirical Zipf's Law;

- **topic detection:** this service selects keywords from a document based on statistical analysis. Using the LDA technique it is possible to select keywords that are not necessarily the most common, unlike in tag-cloud computation. Stop-words are eliminated from the text being processed;

- **named entity detection:** this service identifies classes of specific entities like names of persons or cities. This service is useful to identify important semantic concepts in documents, whether these words are common or not (this latter case is more probable).

VIVIT uses Homer service output for document classification, since it can be considered as a low-dimensional representation of the document, and as input for a discriminative classification algorithm. The list of keywords is also used as annotations or tags, to later retrieve the documents in a repository.

The VIVIT project connects to Homer through the API provided by a Tagging module, passing the main content of the document to the servlet by http. The result of the analysis is returned and parsed as an associative array of terms and weights which is then formatted by the Tagging module and visualized as a list of suggested tags on content edit action, provided the users are granted with sufficient permissions to use the Tagging feature. (Fig. 1).

Additional resources

The VIVIT project (Fig. 2), as part of a larger FIRB project, gives users access to larger scope external resources developed internally at MICC or externally, which are connected to the field of language research and computational analysis; in particular, MICC developed the LIT ("Lessico dell'Italiano Televisivo") [4] [5] [6] and LIR ("Lessico dell'Italiano Radiofonico") web-based archives, that offer audiovisual streams from national TV and radio networks presenting extracts of speech from broadcasts that have been marked up with TEI/XML tags in order to be searchable through their interfaces, also developed at MICC and maintained by the IT department of Accademia della Crusca.

FIGURES AND TABLES

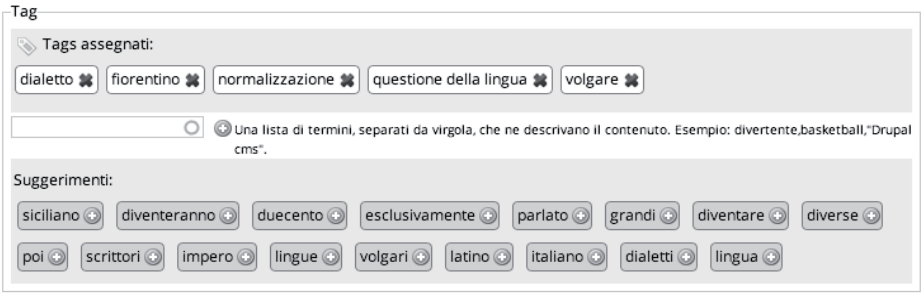

Fig. 1 The Tagging widget, showing results ("Suggerimenti") from the Homer text analysis

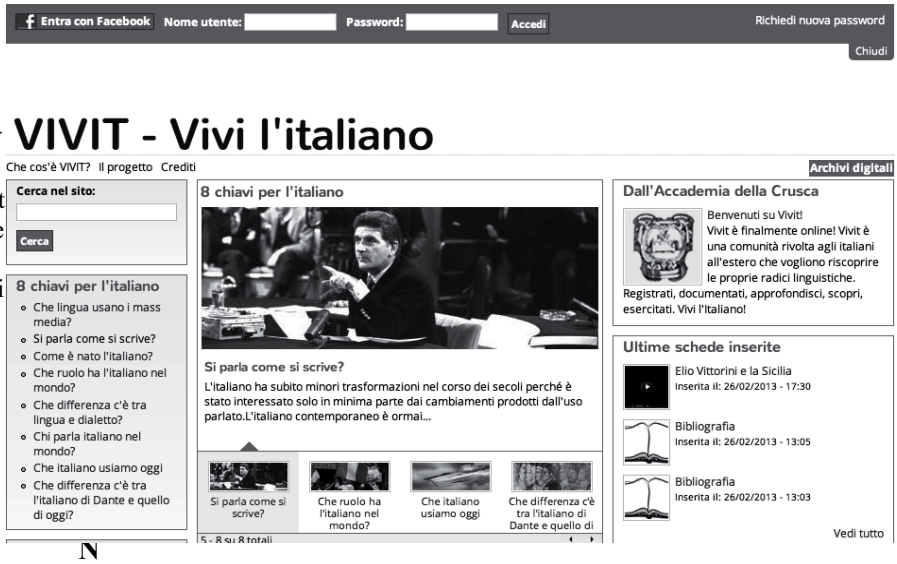

Fig. 2 The VIVIT front page (top portion)

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