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TECHNOLOGIES FOR THE PUBLIC UNDERSTANDING OF THE PAST: EPOCH'S CONTRIBUTION

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Abstract (EN)

The paper presents the reasons, objectives and current activity of EPOCH, the European Network of Excellence on computer applications to material cultural heritage, now in its second year of existence. The project has developed a number of showcases for such applications, involving Data Standardization and Capture, Virtual and Augmented Reality, Multi-modal Interfaces and e-Tourism and is now undertaking the task of creating methodologies and carefully carved pieces of software to fill gaps in the production pipeline of cultural communication.

Keywords: Standardization, Data Capture, Virtual Reality, Augmented Reality, Multi-modal Interfaces

Zusammenfassung (DE)

Man stellt hier die Gründe, die Zielsetzungen und die laufende Aktivität die EPOCH, das europäische Exzellenznetze auf den EDV-Anwendungen auf das materielle Kulturerbe vor, die in seinem zweiten Jahr Existenz aufrechterhalten. Das Projekt hat bereits eine Reihe von Beispielen solcher Anwendungen entwickelt, die die Vereinheitlichung und den Datenerwerbung, die virtuelle und erhöhte Realität, die multimodalen Schnittstellen umfaßt, und geht jetzt, Methodologien und der Software zu schaffen, um die Lücken im Prozeß der Erstellung der kulturellen Mitteilung zu füllen.

Schlüsselwörter (DE): Vereinheitlichung, Datenerwerbung, Virtuelle Realität, Erhöhte Realität, Multimodalen Schnittstellen

Résumé (FR)

On présente ici les raisons, les objectifs et l'activité courante du ÉPOQUE, le réseau européen d'excellence sur les applications informatiques au patrimoine culturel matériel, qui en est à sa deuxième année d'existence. Ce projet a déjà développé une série d'exemples d'applications comportant la standardisation et l'acquisition de données, la réalité virtuelle et augmentée, les interfaces Multi-modales et va maintenant créer des méthodologies et du logiciel pour remplir les lacunes dans le procès de production de la communication culturelle.

Mots clés: Standardisation, Acquisition de données, Réalité virtuelle, Réalité augmentée, Interfaces Multi-modales.

I. EPOCH: scope and goals

1. Why EPOCH

As it is well known, computer graphics have been used since more than ten years to enhance and valorize Cultural Heritage. Particularly for archaeological sites or museums and historical monuments, these applications were dictated from the need to explain to visitors in a simple, attractive and understandable way why those remains, often broken potsherds or deserted ruins, are so important and interesting. In other words, explanation to the public is a powerful help for going beyond the mere aesthetic contemplation of ancient artefacts - almost inapplicable, for instance, to prehistoric lithics - or the fascination of sites - almost absent from a field of scattered stones, the usual appearance of most archaeological excavations. So captions, panels and guided visits, useful in any museum context, are indispensable when material culture is concerned. Archaeology and history need much more interpretation and explanation - and a different approach - then art galleries, where most visitor limit to appreciate the "beauty" of the exhibits: an attitude which may turn a visit of archaeological sites or collections a frustrating experiencee.
Computer graphics use a code and a metaphor nowadays familiar to visitors. They communicate in a form that attracts their attention, as a movie or interactive multimedia, and bypass the problem of understanding difficult terms (too often used in captions by curators more concerned with scientific correctness than comprehension by the public), or decoding complex messages as those incorporated in a map or a diagram. As demonstrated by popular TV programs, visualization is a key factor to escape from the conception of archaeology as antiquarianism or, worst, the quest for lost treasures (AKA Indiana Jones). So far, so good. But, in the hands of technicians, computer graphics applications to material cultural heritage may quickly turn into unfair treatment of information. Influenced by the assertive power of images and the authoritativeness of computers, the public may be led to give to visual reconstructions of lost palaces and cities the same reliability of 19th century photographs of demolished buildings. Perhaps for the naivety of the engineers in charge of creating computer graphics, whose Aristotelian conception of the universe requires that something is or A, or not A, the uncertainty and fuzziness inherent to historical research disappear once results enter a computer. This has been denounced by scholars (???) and is slowly starting to be taken into account into visual

applications, often more in the intentions than in results. The difficulty here is to conjugate effective communication with correctness, avoid oversimplification but also the informational noise and consequent confusion arising from a message with multiple, or alternate, meanings. Work on a reliable communication code to visually communicate fuzziness is still ongoing.

Cultural (visual) communication is even more difficult for controversial items, as for instance those incorporating religious or political content. In these cases, a correct approach needs to take into account the different cultural perspectives and show the alternate interpretations.

Also on the technical side, things are uneasy. Due to the organization of funding, many projects on computer graphics applications to cultural heritage have been implemented as stand-alone. Often the process of realizing such a project is the following. Technologists and humanists group under the leadership of either (usually the former) and submit a proposal to some funding body: local authorities, national funding agencies or ministries, or the European Commission with its research programmes. A project has a life cycle and a time span with deadlines at which results - in this case visual cultural communication - have to be delivered. So in most cases projects are monads, which use state-of-art technology and take into account historic and cultural research, but care little of the upstream and downstream developments, that is what can be fed into the project development by previous work or what the project may feed into subsequent steps, external to it. Ad-hoc solutions and absence of standards are examples of such misbehaviour, which is caused by the way funding is distributed: good interfaces with potential preceding and following steps of the production chain of cultural communication, unless explicitly required are unnecessary effort in a competitive call perspective, and are therefore taken into little or no account. Additionally, at the end of the project there is no reason to maintain the project team, so the partnership dissolves, to recombine, perhaps in a different mix, on other projects.

When one attempts at industrializing the whole cultural communication pipeline, bottlenecks and duplication of work show up, and the lack of stable organizations committed to interdisciplinary activity produces its nasty effects: there is, in fact, a misconception of interdisciplinarity as addition of experts of different disciplines that prevents from creating permanent interdisciplinary teams. So fragmentation is the main problem affecting both technology and the organization of work.

As David Arnold has wisely noted for project funding in this field, they have better chance of success if they concern the core of a discipline instead of dealing with border sectors, and the

same holds for academic or research careers: professionals central to the individual disciplines will tend to be appointed to manage, evaluate and review project proposals or job positions. Thus project proposals, or candidates, will often "fall between two stools" and will be probably affected by the "please call at the other committee" syndrome.

The above considerations became the common patrimony of a number of researchers who stated them in several papers (see, for instance, Ryan, 1996) and started actions to overcome the fragmentation described above and to research ways to make computer visualization applications to cultural heritage more culturally reliable. A debate started at VAST2000 (Frisher et al, 2002), was carried on at CAA2002 (for instance in Jablonka et al, 2002 and in Niccolucci & Cantone, 2002) and, separate but convergent, at VAST2001 (as shown by several papers in the proceedings Arnold et al, 2001) and in subsequent VAST conferences (Arnold et al, 2003; Chrysantou et al, 2004) as well as at CAA conferences. In early 2003 there was a community not only sharing such exigencies, probably the patrimony of a much wider circle, but willing to operate to address them. At this point, enters EPOCH, a winning project in the 2003 EU FP6-IST first call (http://www.cordis.lu/ist/), expression of this community of users, stakeholders, technology and humanities professionals.

2. What is EPOCH

EPOCH (http://www.epoch-net.org) is a network of about 90 European institutions including university departments, research centres, cultural institutions, national and regional agencies managing cultural heritage and small and medium enterprises. It is funded by the European Commission until March 2008 and its strategic objective is overcoming the fragmentation and improving the quality of the applications of computers - not only computer graphics - to material cultural heritage. As such, its scope includes monuments, museums and sites. Its activity includes surveying and reporting on relevant issues, such as user needs, technological advancements, the policies of European states as far as research in this field is concerned, the training of students and professionals, and so on. Reports are published in print and electronically on the web site. Another sector is concerned with analyzing available tools, methodologies and software, finding gaps in the production pipeline of cultural communication and filling them with newly produced pieces of software, conventionally named NEWTONs. Standardization of procedures, data

formats and technology is a further task. Finally, promoting training and dissemination of results, including their implementation, complete the panorama.
Not all partners are directly active: many of them participate in the network by availing of its services, determining its choices and defining its research agenda. The network is managed by a Board of Directors and an Executive Committee of four people, and is coordinated by Prof. David Arnold from the University of Brighton (UK).
One of the goals of the network is to spread knowledge beyond its borders. For this reason, all its products are Open Source and freely available to the public. Implementation of its results is fostered and supported in several ways.

II. Technological results

1. Available results

During the first year, the work inside EPOCH has produced a number of reports already available or in print. They include the first report on Training Offering and Needs in Europe (TONE), which examines the current situation of University training in related fields in the so called EU25, i.e. the 25 Member States of the enlarged communit, and.the report on the State Of The Union on policies, practices and research in related fields (SOTU), which is in print. Other reports cover users' needs and the state of the art of applied technology, and are being reviewed for final delivery. All are available on the project web site.
Apart from this, the most interesting product of first year's activity of EPOCH are the eight showcases. They consist of pilot applications of available information and communication technology to specific heritage cases and provide exemplary applications that can be easily repeated in other contexts. All the necessary technology is already available.

2. EPOCH: the showcases

EPOCH's eight showcases include the following:

On Site Reconstruction Experience: visitors see virtual reconstructions of disappeared monuments superimposed on the scene through AR glasses, giving a feel for the original appearance of a site in situ, stressing the authenticity of the remains

Multimodal Interface for Safe Presentation of Valuable Objects: offers museum visitors an intuitive tool for the exploration of objects not physically present, by manipulating a touch-sensitive replica and seeing the original object visualised in 3D (annotated multi-media information is activated by touching parts of the replica)

Tool for Stratigraphic Data Recording: demonstrates a state-of-the-art tool that can assist archaeologists in the systematic recording of their excavations through detailed 3D capture and representation of stratigraphical layers.

Multilingual Avatars: designed to raise awareness of the potential of underpinning technologies in modelling and rendering of wide-ranging, highly-detailed scenes, combined with multi-lingual avatars, responding through natural language and combined in a low-cost real-time system.

e-Tourism through Cultural Routes: creates a new form of web supported tourism, through cultural routes, digital souvenirs, e-business and a distributed network of IT enriched sites

Avatar based interactive storytelling: interactive storytelling from database through talking head avatars, with personalisation and high quality synthetic voice

Archaeological Documentation for the Semantic Web: demonstrates the archaeological community the advantages of integration by creating an effective documentation system for archaeologists, based upon digital libraries and visual tools

Image-based Modeling: demonstrates the cultural heritage community that 3D acquisition and modelling do not necessarily call for expensive devices, and can become part of normal archaeological practice.

All the documentation concerning the showcases is available from the web site. Here we will shortly report on some of them, those more concerned with communication.

On Site Reconstruction Experience presents an AR system where visitors see virtual reconstructions of ancient monuments superimposed on the scene. This gives visitors and researchers a feeling for the original appearance of a site, and this experience is provided in situ. The viewing unit may consist of a Head Mounted Display, a camera and a laptop. Its optical tracking algorithm is capable of identifying the visitor's position among several pre-selected viewpoints. This allows for the integration of real and virtual scene elements on the head-

mounted display and facilitates the comprehension of the visited site. Another version uses an AR telescope for the same purpose. The system has been applied to the nymphaeum at the upper agora of the ancient city of Sagalassos, about 100 km to the north of modern Antalya in Turkey. Sagalassos was a prosperous city from early Hellenistic times until it was struck by a devastating earthquake in the 7th century. More than 90% of the building elements have been found during excavations since 1994, albeit more often than not in a seriously damaged state. The finds have been documented through a large set of photographs and drawings, which have been used to build a photo-realistic 3D model.

The pre-rendered 3D reconstruction is superimposed on the user's real view to generate the on-site reconstruction experience. The motion of the visitor's viewpoint is tracked by the system and the reconstruction image is continuously adjusted to the actual field of view.

Fig.1: The Sagalassos nymphaeum: top, the present state; centre, the reconstruction model; bottom, the superimposed reconstruction as appears in AR

Multimodal Interface for Safe Presentation of Valuable Objects faces the problem of safely and effectively exhibiting objects of art having a substantial value for their uniqueness, exceptional craftsmanship, precious materials, or historical significance. For such objects, access must necessarily also be restricted due to security factors and the object's fragility, and the value deriving from symbolic or historical significance is not always apparent to the eye.

The showcase creates a presentation methodology that provides a viable alternative to displaying valuable original objects, yet provides a way of offering nearly unrestricted "virtual" access and provides a compelling and innovative way to tell the story of the object for a general audience. It is based upon a replica of the object which serves as the interface to explore the object. Through the use of an orientation sensor integrated in the replica, the object can be visualized on a computer screen in precise coordination with the angle it is held or rotated by the visitor/user and the user feels the shape and details of the object and sees the virtual representation of the object in the screen, behaving exactly the same way as the replica. By adding touch sensors to the surface of the replica in significant areas of interest, the user can explore the meaning of the object. Touching a feature on the replica brings up a story on the screen that explains some facet

of the meaning and history of the object. For example, if the object bears an inscription, the user can learn what it means, and what message lies behind it, by simply touching the text. This tactile interface allows visitors to experience and explore the object in an exciting and innovative way - that would certainly not be possible with the original artifact. As duplication of the object is easy and inexpensive (replicas are built using rapid prototyping techniques), copies of the virtual object can be shown at multiple locations in one exhibition or at multiple exhibitions at the same time. The showcase has been applied to an ivory medieval artifact from a Belgian museum. Future implementations are planned for an Etruscan sarcophagus (possibly to be reproduced in smaller size) with pictures of the Amazons, from the archaeological museum of Florence, to illustrate the details of the pictures, and for the creation of a tactile exhibition for visually impaired people, in which the interface provides tactile and audio feedback.

Multilingual Avatars uses avatars to enhance the visit. The first one is applied in an urban context (the case-study has been developed for the German medieval town of Wolfenbüttel). It shows the application of several distinct technologies: rapid modelling of repetitive components of a virtual scenery, as buildings of no particular historic value in an urban context, or trees; avatars as talking guides to the visit or moving autonomously as part of the reconstruction; and multilingual speech according to user's preferences.

Fig.2: A scene from the reconstruction of Wolfenbüttel; the figures in the square are avatars.

In *Avatar based interactive storytelling* virtual humans introduce the visitor to the history of a monument (in the case-study, a medieval abbey in Belgium) and tell him stories built upon the

content of a database where items of information are stored and put together to create the story according to a script. Scripting is easy and requires no technological skill.

Fig. 3: A scene from *Avatar based interactive storytelling*

Finally, the showcase *Image-based Modelling* does not concern a solution for presentation but is worth describing here because it provides tools for 3D data acquisition without using a 3D scanner. It is based on a breakthrough technology for the creation of 3D objects and scene modelling using only images and expensive equipment. The first phase of this method consists of a set of consecutive, automatic steps that lead to the calibration and the pose of the camera for every image. A sparse set of feature points that describe the scene is reconstructed in 3D as well. In a second phase a dense stereo matching algorithm is applied to the images. As a result, dense depth maps are obtained for every image, and from these data textured 3D models can be built, with the advantage that surface texture is directly extracted from the images. Besides having been used for the virtual reconstruction of the destroyed Bamiyan Great Buddha statue, availing of previous images and photogrammetric analysis, the method has been applied to other examples of complex artefacts as medieval and renaissance marble statues. The methodology appears particularly suitable for materials, as black marble or highly reflecting metals, not particularly suitable for 3D scanning.

In conclusion, EPOCH's showcases have been very well accepted by the heritage community, to which they have been presented in several occasions.

The apparent advantages are the availability of a tested methodology, a technology and software which is very often free of charge, and the support offered by experienced teams. Further implementations depend only on data availability: when these are available or it is possible to

secure the limited funding necessary for data acquisition (a small part of the total application), there are concrete plans for realizing additional applications.

3. Ongoing work

After the showcases, EPOCH has undertaken the creation of NEWTONs according to priorities established by the partnership and resulting from a large consultation of stakeholders. An overall budget of about 700.000 Euro has been mobilized for this activity, which will have an overall duration of up to 24 months.

Proposed NEWTONs include the following applications.

One concerns virtual humans, proposing tools for populating environments with interactive avatars and crowds for cultural heritage applications. The tools will be OpenGL compatible and released as Open Source. A second tool deals with context aware delivery of cultural heritage information using mobile devices. This has been the object of several R&D projects but the advancement of technology require an assessment of results; for instance, the wide commercial availability of 3G phones brings visualization features on mobile phones within reach. Calibration and underwater 3D modelling are the subject of another project. This is a much needed tool, since underwater sites are obviously the most difficult to visit and to explain. A good solution may consist of virtual visits, for which appropriate methods of 3D model creation are necessary. A similar problem is dealt with by another tool, researching new, versatile and ubiquitous approaches to the creation of 3D models. This is complemented by an EPOCH multimedia "kiosk" where all the production tasks concerning 3D models are integrated. Finally, data standardization is the subject of the last NEWTON. This deals with the mapping of current data structures to international standards and mainly concerns texts and databases. It has therefore no immediate implication on visualization, but may evolve in this direction in the future. Other important issues, as the relations with gaming, have been acknowledged and earmarked for being reconsidered in a second turn of tool creation.

Together with existing technology, the creation of this set of tools is aimed at creating a smooth route for cultural communication production, starting from data acquisition and storage, their enrichment, storytelling and finally communication to the public.

Visualization maintains a great part in the pipeline process, which is now seen as consisting of several paths, sometimes proceeding in parallel and sometimes sequentially. It is hoped that this will provide humanities technologists (or technological humanists) with the toolbox they need to create a better and clearer communication and to facilitate awareness and comprehension of our heritage.

III. Conclusions

Work is still continuing and no final conclusion can be drawn as yet. However, the reactions of interested parties are encouraging, particularly among heritage professionals and, in part, at the decision making level.

To quote again David Arnold's words in his keynote speech at the Graz Workshop "European Cultural Heritage: RTD Challenges Ahead" in May 2004 (synthesis on http://www.joanneum.at/eculture/):

> "Traditional CH professional activities have been relatively recently exposed to ICT which needs to develop a lot further to become accepted as an integral part of work processes. Continued interdisciplinary support should be viewed as an essential plank in the technology transfer process as well as in securing effective R&D for Cultural Heritage applications."

Thus it is vital for the European society, so deeply based on its history, to keep the pace with a rapidly changing world also in the cultural heritage sector. In a world where teenagers confess their love to their sweetheart by SMS, cultural heritage cannot be confined in a dusty corner. On the other hand, it is necessary to find a way to embrace technology without becoming superficial and oversimplifying, nor limit to improve the inner working of technological tools and forget the social implications.

"Many important challenges lay outside the production pipeline", as Neil Silberman stated in his key-note lecture at VAST2004 (Silberman 2004); and the consciousness of this fact should help us avoiding turning, by means of technology, cultural heritage into theme parks.

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