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PRESENTATION OF THE DIGICULT SURVEY OF NEW TECHNOLOGIES IN THE SCIENTIFIC AND CULTURAL HERITAGE SECTOR

Abstract. We paper present several new information technologies included in a recent survey of the EC-funded DigiCult project. It concentrates on radio frequency identification tags (RFID), innovative human interfaces, games technologies, virtual communities, virtual reality, robotic avatars and mobile communications. These technologies not only help in better organisation of the cultural and scientific heritage institutions, but also imply new forms of interaction with the users. Most of the innovations are still not implemented in our region and we hope that this presentation will raise the interest of the cultural and scientific heritage organisations to them.

Keywords: information technologies, cultural and scientific heritage sector, radio frequency identification tags (RFID), virtual reality, innovative human interfaces, virtual communities, games technologies, tele-presence, mobile communications

1. Introduction

The cultural and scientific heritage institutions meet several challenges related to the introduction of new information technologies in the recent years:

- Implementing systems that are prone to handle the increasing volume of heritage content to be digitized and presented in adequate forms.Providing access to the treasures of the World cultural heritage based on interoperation between its various sectors.
- Addressing problems related to the archiving and preservation of cultural heritage content.
- Offering personalized, interactive ways to the heritage content.

The technologies that are now in use in the sector cannot meet these challenges. The recent survey of the DigiCult project funded by the EC [1] is focused on new technologies that can be implemented in the cultural heritage sector. Such technologies are emerging at an impressive pace and the aim of the survey is to present those among them that could have a positive impact on the cultural sector. The project is focused basically on technologies that are in an early but promising stage of deployment, on technologies that requite further

development and repurposing or on technologies that have been already successfully implemented in other domains and can be easily transferred to the cultural heritage sector.

2. Structure of technology watch reports

Each technology watch report in the survey provides information structured as follows:

- An introduction containing general answers to basic questions such as how the particular technology works, where is it used and what problems do it address. In addition such topics as the state of standardisation and the current scope and future development of the technology are discussed.
- Brief description of particular technology basics such as principles of operation, technical characteristics, etc.
- Discussion on the possible implementation of a particular technology in the cultural heritage sector. Case studies are provided to illustrate different aspects of already existing applications while scenarios are presenting possible ones.
- Discussion on the benefits and the risks resulting from the implementation of a particular technology in the cultural heritage sector.
- Considerations on specific aspects when using a particular technology in the heritage sector such as: costs, policy and organisational framework, required infrastructures and organisational measures, staffing levels and user base issues.
- References – Printed, Online.
- Appendices such as list of abbreviations, glossaries, technology key players and suppliers, comparison tables, etc.

Our paper focuses on some new technologies, candidates to be used in the heritage sector. Some basic principles of operation are provided together with considerations on the possible benefits and risks of their implementation. New technologies are summarized and described according to the different application areas they are covering, namely:

- management of objects and collections (RFID) ;
- new ways in human-computer interaction (innovative human interfaces) ;
- expansion of the awareness and knowledge of heritage content through edutainment packages and other strategies (games technologies) ;
- presentation of the cultural heritage on a scale which tends to become global (virtual communities and collaboration);
- new ways of visualization of heritage sites, landscapes and buildings (virtual reality);
- tele-presence at heritage sites (robotic avatars);
- new ways of presenting the heritage content (mobile communication).

3. RFID

Issues related to the management of holdings are among the core concerns for cultural heritage institutions. This area could be compared to the supply chain management in the business sector. Time of delivery, cost and prevention of losses are key factors in both cases. However, improvements of these characteristics are restricted by the traditional technologies used for tracking items. The most popular technology, known as bar-coding, has its limitations. The necessity to process items with human intervention (leading to limiting space and time constraints) plays a significant role. In addition bar codes are easily damaged.

An increasingly popular alternative to bar-coding is the use of *smart labels*, a technology based on radio frequency identification (RFID). Radio frequencies are used to read information on devices known as *labels* or *tags* that can be affixed to or embedded into virtually any object and that either reflect or retransmit the radio-frequency signal.

The use of smart tags in the cultural heritage sector leads to enhancement of work processes and improvement of customer service. The introduction of smart labels in fact means not only a faster way of checking the status of a particular item, but in many cases leads to a rearrangement of data processing structures within the organisation. Timeframes of the traditional services change, but also the mode of information processing (e.g. avoiding queries to databases).

Factors that are currently limiting the implementation of this technology in the cultural sector are: *price* (investments in *specialised hardware* - readers, printers, tags and in *staff training* are required) and *low level of standardisation* (the physical data interchange is standardised, but this is not yet the case for the data structures).

The implementation of RFID offers substantial benefits such as: *reduced supply chain costs* (through less human intervention, automatic items tracking), *enhanced customer relationships* (spending less time on checking items and higher accuracy) and *improved efficiency* (through better organisation of data management processes).

A number of organisations in the sector have already adopted the smart label technology. On the one hand, the technology helps to cover traditional work processes, such as check-in, check-out, anti-theft control, inventory and asset management. Thus libraries, archives and museums may benefit from the technology in managing their everyday work. On the other hand, innovative guiding services are provided and interesting new studies of visitors' behaviour are being launched.

4. Innovative Human Interfaces

The processes and devices used to interface between humans and computers have been a concern of computer scientists since the birth of computing itself. Recently, the human-computer interaction (HCI) undergoes a process of rapid development and can be best characterised by three primary features, the *user-centred design*, *the appeal to multiple human senses*, and *the struggle for portability*.

This paper cannot cover all aspects of the human-computer interaction. We shall emphasize only on a few technologies that are already implemented or are expected to be implemented in the cultural heritage sector.

4.1. Visual technologies. Touch screens combine the visual output with easy data input. These devices are very popular for applications which do not require complicated data input and already have their clear place in the museums.

HMDs (Head mounted displays) can be considered as wearable monitors. The stereoscopic vision is achieved via the combination of two little LCD or CRT monitors (one for each eye). In addition these devices could include a head tracking device that replaces or complements standard input devices and some stereo-headphones.

Liquid Crystal-Shutter glasses transform the way the user sees the image on a standard monitor. The function of the glasses is to prevent the left eye from seeing the image dedicated to the right eye and vice versa. They contribute to the development of semi-immersive virtual environments.

CAVE (Computer Automatic Virtual Environment) consists of up to six large screens arranged in a cube. Stereo graphics are projected onto each, and several users can stand in the

middle of the cube. If additional head-tracking technology is applied the perspective would change with the change of users head position.
New display technologies have been launched in the recent years (based on *electronic ink*, *organic light-emitting diodes* and *light-emitting polymers*) that should lead to the creation of power efficient and even cheaper displays for all sorts of computer devices.

4.2. Auditory technologies. Speech input (or speech recognition) systems allow spoken utterances (letters, words, phrases) to serve as input to a computer. When the system "hears" an utterance it recognizes, it sends a pre-defined character or group of characters to the computer. The computer accepts this input just as if it had been typed on the keyboard.

4.3.Technologies exploiting several senses. Wearable computers can be considered as intelligent assistants that augments memory, intellect, creativity, communication, and physical senses and abilities. They can facilitate cultural heritage visitors in orientation and study of collections, starting from consulting a guide and ending with possibilities for immersion in an augmented reality environment.

The Eye Mouse is the simplest device using brain actuated control. People with extreme disabilities obtain the opportunity to control a computer simply by moving his or her eyes or head. The "eye mouse" is an ocular prosthetic that allows the cursor to be positioned by looking and hands-free pointing.

More sophisticated brain actuated devices combine eye-movement, facial muscle, and brain wave bio-potentials detected at the user's forehead. Signals detected by sensors in a headband are amplified, digitized and translated by a decoding algorithm into multiple command signals, creating an efficient, intuitive and easily learned hands-free control interface.

The cultural heritage sector has several reasons to follow carefully these new developments. Their implementation can provide visitors with tools for:

- Observing collections not currently on display;
- Studying collection items which access and handling are restricted;
- Acquiring additional information on the collection items;
- Creating personalised tours which could be used in future visits and for additional study at home.

The introduction of these new interaction technologies will allow users to navigate through collections following their preferred learning style. The appearance of many novel interfaces must be met with intensive measurement of the health risks which can be caused by the physical peculiarities of the devices, or by the effects of immersion in Virtual Reality worlds. These discomforts may manifest themselves physiologically, psychologically, or both.

5. Games Technology

In general terms games are software products that use various input devices to interact with and a screen for visualization. They are run typically on game playing systems which can be: personal, portable or handheld computers, specialized consoles or mobile phones. Personal computers and consoles are the typical hosts for video games.

Games can be divided according to their genre, the online or offline mode of playing, and the involvement of one or more players. In the last years Massive Multiplayer Online Games become more and more popular.

Most essential for the development of games in the recent years are the development of computer graphics, virtual environments and multi-agent systems. Expanding popularity

gain the so-called *edutainment* applications, which combine the entertainment with educational elements.

One obvious trend of work related to cultural heritage institutions is producing games with historical setting which might be precisely prepared involving artefacts from the museums and libraries. Such games could increase the knowledge of players on the historical settings and could provoke the interest to visit respective collections.

The development cycle for computer games is too heavy to believe that museums and libraries will make their own department issuing games. The more realistic approach is to combine the expertise of museum and library specialists with the practical knowledge of developing companies specialised in the games technologies.

Another issue related to computer games that require multiple platforms is the way they can be presented in the museum environment. Compared to other objects on display, to be shown comprehensively, they would need older computer equipment or simulation of old games on new machines, which is a difficult task.

Games are specific product with very wide target audience. They are still underused by cultural heritage institutions which definitely should look for ways to incorporate knowledge on their collections in this environment through edutainment and other initiatives.

6. Virtual Communities and Collaboration

Modern information technologies offer a broad range of tools supporting communication. The urge to get closer to people located all over the world, nowadays can be fulfilled in various ways. The oldest technologies from this class offered asynchronous tools such as the e-mail and mailing lists to distribute messages within a group. Later, synchronous tools gained great popularity not only as means for personal amusement, but also as channels for building professional contacts. With the implementation of peer-to-peer technologies the possibility to share resources in a new manner, using the computers of community members instead of server machines was added to communication.

These developments opened two important new possibilities:

- to attract people from all over the world to study or present cultural heritage artefacts through intensified communication;
- to build consortia with other cultural/scientific organisations in order to present the cultural heritage on a scale which tends to become global.

In addition, virtual community technologies can contribute to goals such as better and faster professional development; collecting and discussing feedback from visitors of virtual and real collections. Another class of technologies is targeted to offering new experiences in sharing a visit to museum, for example, in a new way – using devices which allow the communication with another person.

It is difficult to imagine what changes could imply all these developments. Availability of *more* resources does not mean *better* resources. More communication in a virtual world does not increase necessarily the emotional intelligence and do not prevent from alienation in the real world. The understanding of this raises the responsibilities of the specialists and organisations from the cultural and scientific heritage sector to consider carefully the options and to provide resources of the best possible quality for the emerging communities.

7. Virtual Reality

3D technologies include the VR (Virtual Reality) technology and many similar languages and techniques: Java 3D, *QuickTime Virtual Reality* (QTVR), *Rich Media 3D* (RM3D), the new Extensible 3D language (X3D), Open Graphics Library (Open GL). Dedicated viewers/browsers are needed to view and explore virtual worlds. VR can be considered also as a general term that encompasses different programming languages (Java 3D, VRML) and techniques. Each of them has its own pros and contras and has to be carefully estimated when selected for a given application.

Movie and video games companies are leading the way in the development and implementation of this technology The possibilities offered by the Virtual Reality Modelling Language (VRML) to create training applications, have been used in the engineering and the military sectors. As to the heritage sector the VR technology has already been successfully applied as standalone applications in theatre studies and archaeological reconstructions. With the development of Web-distributed VR, other applications for 3D technology such as multi-participant performance, interactive television and real-time virtual exploration have attracted the interest of the cultural heritage research.

Up to now the use of VR and other 3D technologies have been limited by the severe requirements they place on computer resources. With the constant improvements in computer price/performance ratios the perspectives for future implementations of VR in the heritage sector are optimistic. If used effectively VR reduce the artificial distances between users and artefacts. The possibilities for manipulation of virtual objects and the exploration of no longer standing buildings and changed landscapes increases considerably the learning venture, both in terms of educational use and of user enjoyment. A technique called “augmented reality” combines the VR-type reconstructions with photorealistic backgrounds. Head-mounted display equipment in virtual exploration and learning will improve the sensation of full immersion and participation.

8. Robotic avatars

The introduction of new media technologies in recent years has changed considerably the way exhibits in museums and galleries can be accessed by the visitors. The electronic publishing offers additional sources of information on the exhibits mostly in the form of pre-recorded images or video streams. However this approach is static, pre-programmed and non-interactive while the update of the constantly changing content information is a time consuming and expensive task.

An alternative way of accessing museum or gallery exhibits is by means of mobile platforms (robotic avatars). Robots representing patron’s avatars can be controlled through the Web in order to move through the museum’s space and to visit selected exhibits thus providing tele-presence tours. Museum exhibits can be accessed virtually at any time from every part of the world. At the same time robots can be used as on-site guides offering either group or personalized tours.

Robotic avatars offer substantial advantages over current technologies used in museums and galleries:

- Instead of non- interactive and pre-programmed presentations a virtual presence is offered to the visitor who, depending on his interests, benefits from an individual access to a huge Data base consisting of graphics, images, text and audio.
- Instead of low quality pictures and videos the visitor enjoys a personalized tele-guided tour being able to select preferred viewing parameters.
- In the case of robotic avatars changes in museum content doesn’t require additional expenses as with multimedia presentations.

- Professionals who do research over particular exhibits benefit by avoiding the necessity of often on-site visits
- Robotic avatars become exhibits by themselves helping for a seamless acceptance of new technologies.

9. Mobile communication

To facilitate access to exhibits and visitors' experiences and learning, cultural and scientific heritage institutions traditionally present the information on the spot through labelled exhibits and docent-led tours as well as through a variety of printed materials. Digital technologies are presented most typically by multimedia kiosks and portable pre-recorded audio guides.

Publishing information on collections on the Internet or creating virtual collections gives the visitors a chance to study information on the collection they are intending to visit in advance, which facilitates learning. Yet, studying this information precedes or follows the actual visit to the exhibit.

Current mobile access technologies are a powerful tool to make the cultural institutional information resources available simultaneously with the visit. Their basic applications in the cultural and scientific heritage sector are currently of two types. The first one offers better orientation in the picture what happens in a specific geographic location—a feature that especially appeals to cultural tourism sphere, but also to indoor collections. The second one supports the process of obtaining information on specific items on display, which might be considered as a further development of the audio guides.

The current mobile technologies that could be applied to the cultural heritage institutions include devices (such as PDA's and cellular phones) and new communication protocols (bluetooth).

In contrast to the use of audio guides or other specialised devices, which had to be maintained by the cultural heritage institutions and borrowed by the visitors, the current mobile access devices are very often owned by the visitors. What is necessary is to provide wireless connection to the right information and suitable content.

Thus visitors benefit from guides offering a new level of personalization. They now have the chance to follow the most suitable learning content matching their interests, and to mingle information on the collection with WWW content, at the most suitable speed. Mobile access devices are already applied in a number of institutions, basically in museums and open-air exhibits, such as archaeological sites. Yet, this field is expected to undergo serious changes in the years to come. A great concern currently is the understanding of the difference between the wireless and wired network approach. The wireless applications need development of new information architectures and imply specific human-device interaction challenges. The basic promises they bring are those of radically improved personalisation and connectivity, which was never experienced before in the cultural and scientific heritage sector.

10. Conclusion

The new technologies presented above address various issues of interest to the cultural and scientific heritage organisations.

In Bulgaria, the various institutions look for solutions on the introduction of new technologies on their own; the efforts are thus being dissolved and far from any standardisation. It would be more efficient if there would be a national body similar to the

National Centre for Digitisation in Serbia and Montenegro, which would assist various organisations by providing know how, demonstrations, expert advise, specialised equipment and staff training.

References

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