MERGING AUGMENTED REALITY BASED FEATURES IN MOBILE MULTIMEDIA MUSEUM GUIDES

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ABSTRACT:

Augmented Reality (AR), a computer science field considered by many as a subfield of the broader concept of Mixed Reality, could alter dramatically the way we interact not only with computers but also with the real environment surrounding us, as well as with other human beings. Augmented Reality has so far been used for applications linked with military training, medicine, maintenance, architecture and urban planning, tourism, and entertainment. This last category embraces museums, considered by many not only as research and exhibition spaces but also as important informal learning environments. Does Augmented Reality has the potential to break into museum and exhibition environments and revolutionize the way we see, approach and comprehend the exposed exhibits, alongside with more traditional interpretation and communication methods? This presentation examines both the state of the art in Augmented Reality Applications for Cultural Heritage and Mobile Multimedia Guides for the museum setting, proposing an Augmented Reality approach for the last. A taxonomy of augmented and non augmented functions is proposed, aspects of the development are presented and reasons that could favor or slow down the integration of Augmented Reality in mobile museum guides are tackled down. The potential mutual benefits both for the Augmented Reality community as well as for cultural heritage professional are also presented briefly.

1. INTRODUCTION

1.1 Defining Augmented and Mixed Reality

Augmented Reality is a relatively recent computer science field considered as a subfield of the broader concept of Mixed Reality. Though the use of the first head mounted display dates back in 1968, the term started to become widely used after 1993, the year that the ACM Communications magazine dedicated an entire issue to the subject (Cohen, 1993). One year later, Paul Milgram et al. (Milgram et al., 1994), in their approach of classifying Augmented Reality displays, defined what was thereafter to be known as the "Reality - Virtuality Continuum" which greatly helped the understanding of the interrelations between virtual, mixed and augmented reality environments.

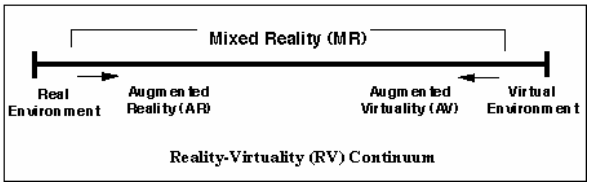

Figure 1: Milgram's et al. Mixed Reality Continuum (courtesy of Professor Paul Milgram)

Mixed Reality environments are characterized by the combination of the real with the virtual. If the real world occupies the left of the continuum, the virtual world stands on the other end. It is however possible to combine elements of the surrounding, real world, in a virtual environment (Augmented Virtuality) as well as to overlay virtual objects in a view of the real world, if the last is observed or seen by means of a video or see-through display (Augmented Reality). It is therefore pertinent to define Mixed Reality (MR) environments as environments in which "real world and virtual world objects are presented together within a single display, that is, anywhere between the extreme of the Reality - Virtuality continuum" (ibid, p.283).

1.2 Hypotheses about the advantages of Augmented Reality

Augmented Reality is thought to present certain advantages over more traditional ways of accessing information (Anastassova, 2007). The co-existence of the real and the virtual could enhance productivity by facilitating comprehension of tasks to be performed, in industry, medicine or education. In education specifically, Augmented Reality has been praised for its potential in the comprehension of physical phenomena, as demonstrated by the European "Connect" project (Horn, 2006). In addition, as the user is assisted by supplementing the existing world instead of creating a new one, the limited level of immersion is thought to provoke fewer problems of cyber sickness. Applications have been so far developed in the domains of military and medical training, urban planning and architecture, as well as for industrial maintenance work (eg in automotive and aerospace industry), entertainment and lately also for cultural heritage.

1.3 Augmented Reality for Cultural Heritage

Augmented Reality visualizations can provide extremely meaningful insights when applied in archaeological or historical parks or museums, not only for the specialist or initiated visitor but also for the non specialist or first time visitor who has a difficulty imagining how a site could initially have looked like.

Fixed Augmented Reality applications have been tested at the Ename centre in Belgium (Owen et al., 2005) as well as in Portugal, Brazil and China (Thomasson, 2006), while experimentations with outdoor mobile Augmented Reality systems have been carried out in the ARCHEOGUIDE (Vlahakis et al., 2004; Vlahakis et al., 2005; Vlahakis et al., 2003) and LIFEPLUS (Papagiannakis et al., 2002) projects.

The complexity of cultural heritage related information is also apparent in the case of museums and other cultural heritage institutions where the visitor often needs to be aware of social, political, cultural, historical, economic or scientific related aspects in order to better approach and appreciate the exposed object. It is for this reason that museums provide visitors with a wide range of interpretation media -textual, visual or auditory- and propose complementary activities in order to help the public elucidate the narratives revealed by the objects composing an exhibition. Multimedia and information technologies have been also employed in this context in various forms among which fixed position Mixed and Augmented Reality installations. These systems were reported to generate enthusiasm among the public (Ferris et al., 2004), encourage interaction and co-participation (Hindmarsh et al., 2002) and favor the social character of the museum visit (Galani, 2005). However rare are still the mobile Augmented Reality applications tested and implemented in the museum setting (Sparacino, 2002).

This is quite unfortunate as museums present certain advantages regarding the overall development of Augmented Reality applications. Unlike applications designed for outdoor use, the museum offers a controlled, laboratory like environment (Damala et al., 2007). Documentation, research and interpretation are among the missions of museums. Consequently there exist usually different kinds of resources and media that can be used to help the visitor approach the exposed object, a fact that would allow the Augmented Reality research community examine in depth the way different types of multimedia can be coupled with Augmented Reality applications.

This argument leads to the next one: Unlike other Augmented Reality applications, destined for the experienced in a specific domain user, museums are open to a wide public, of different ages and backgrounds, often with little or no knowledge in the use of computers. Consequently, if Augmented Reality is to revolutionize the way we interact with computers, with the surrounding environment and with each other and exploit in full the benefits regarding the potential social impact, museums seem to offer an ideal workspace for experimentations on that field. The design and implementation of a successful prototype could then easily be tailored to be used under similar circumstances. As we will see in the next session, museums have also good reasons to encourage experimentations with Augmented Reality in their premises.

1.4 Mobile Multimedia Guides in the Museum Setting

Mobile guides, considered as one of the last descendants of digital, sophisticated audio guides, are becoming more and more popular throughout the world. Proctor provides a list of 101 projects from 1997 to 2005 (Proctor, 2005). Mobile guides present numerous advantages as they stand in the cross section between multimedia and Information Technologies used in the museum setting and interpretation and communication means (Damala, 2007). All kind of media can be incorporated in mobile museum guides' applications in meaningful ways to guide the visitor throughout the full visit. In addition, mobile guides are able to be personalized and taking advantage of geolocalisation capabilities, deliver the right information on the right spot. Live streaming, bookmarking and communication possibilities are also key features of mobile guides. In addition, museum professional can use the logs of visitors' actions to get meaningful information about the attracting and holding power of exposed objects as well as about the way the multimedia resources are used. Despite the fact that evaluation (Damala and Kockelcorn, 2006) has proved these applications to be effective, some specific issues demand further attention:

1. The interaction surface is small and so selecting and manipulating objects might prove to be a difficult task especially for the elder or for visitors not acquainted with mobile technologies.

2. Geolocalisation is a very helpful feature but often proves to be not enough as it is not always easy for visitors to use floor plans of the exhibition space. In that case knowing the direction towards which the visitor is looking could be extremely helpful.

3. Creating links in between the real world and its digital counterpart is another challenge. Difficulties in associating a museum object with the available digital resources could perturb museum visitors that get easily frustrated when it comes to complex in use information and communication systems.

And though the above mentioned issues might constitute only a part of the challenges present in the domain of mobile multimedia guides used in the museum setting, they lie in the core of a successful integration of mobile guides in the museum setting and they are by no way trivial.

Figure 2: Augmenting the real world with digital overlays

Because of a long tradition and history in the domain of virtual worlds and humans (Bouville and Damala, 2006) and having participated in the past in two mobile museum guides projects (Brelot et al., 2005; Damala et al., 2005), our laboratory conceived the idea of a creation of a new mobile museum guide prototype, using Augmented Reality techniques. The fusion of the real with the virtual can transform in unexpected ways the available interaction surface and help create affinities between the commented objects and their digital counterparts. This task is very much helped by Augmented Reality as at every given moment, the system is aware not only of the geolocalisation of the visitor but also of his orientation.

Figure 3: An example of a wearable Augmented Reality display

2. COMBINING AUGMENTED AND NON AUGMENTED MOBILE MUSEUM GUIDE FUNCTIONS

2.1 Introduction

Mobile museum guides are dotted with a variety of functions in order to enable not only the visitor but also the museum staff and the curators to get the best out of their use in the museum setting. In the case of the Augmented Reality guide, it was obvious that apart a set of new functions, specifically made possible by the use of Augmented Reality techniques, other functions present in systems already implemented should be identified and included in the guide.

For this reason we created an inventory to which we added the Augmented Reality functions, that we thoroughly discussed with museum professionals so as to validate them. Some general remarks are that:

1. There are functions visible and invisible to the museum visitor. The actions activated by the visitor make part of the first category while functions such as logging visitors actions for use by museum curators and educators, or taking under account the number of terminals used in a specific space and the available bandwidth in order to optimize the visitor experience are present but not visible.

2. There exist a set of Augmented Reality functions. Their main impact to already tried out non Augmented Reality functions is that they have the potential to change the way of interaction as the "scene" on which the action takes place can move from a tiny computer screen to the full environment surrounding as, through, for example the use of Augmented Reality goggles (Figure 3). The same is true for the input and output devices that can be used to interact with the system.

It was felt, however, that a consistent taxonomy that could be used to better classify the set of identified functions was missing. This led to a process of a more abstract functions' classification composed of four categories: Contextualization, communication, personalization and museum data management. It is not in the scope of this article to present the full set of functions we have identified but rather to give pertinent and adequate examples to establish the proposed taxonomy.

2.2 Contextualization

Contextualization is a term initially used in biblical studies but steadily adopted from the 70s onwards in cultural studies and archaeology. It is in this spirit that the term was chosen for our taxonomy, in order to express all functions that help a visitor situate a museum object in its original context. The visualization of images, slideshows, 3d models, animations and avatars used as virtual guides belong in this category as well as the audio function, the speech to text or text to speech function or the video function. Granting to more initiated visitors access to the museum data base and providing hyperlinks also belongs in this category as well as all functions allowing the manipulation of digital artifacts or 3d models.

2.3 Communication

Another distinct set of functions is related with the issue of communication. Communication functions can assist different kind of communication needs, between the museum and the visitors, the visitors with the museum, the visitors with other co-visitors and eventually address the need of communicating parts or the full visit for later consultation, linking thus the pre, during and post visit experience for some visitors and strengthening the bonds of the museum with its public. The implementation of a function, that would allow visitors to spatially comment exhibits could enhance the public dialogue and engage more the public in the exhibition. Another example of function is the sending out of alerts regarding closing hours, or special events taking place in the museum.

2.4 Personalization

Personalization is another great advantage of the use of mobile guides in the museum setting and can be said to be a function of its own, composed by different sub functions. In this report we use the term personalization with its general meaning, including as well configuration, and without strictly drawing a line between customization or adaptability, thought to be triggered by the user itself, and personalization or adaptivity, which lets the system induce the visitors preferences (Bowen and Filippini-Fantoni, 2004; Proctor, 2004).

There are many criteria upon which personalization can occur, like age groups, learning styles (Damala, 2007), disabilities (Proctor, 2004), level of visitors initiation, available time for the visit (Damala et al., 2005), thematic tours, bookmarking, different visitors communities. In a more technical level personalization can also occur according to the terminal chosen and the available bandwidth.

2.5 Museum Data Management

Finally, there is a fourth category, completely invisible to the visitor that plays however a major role in the way the visitor will live the experience. A common point among all these functions is that they deal with data, either this is provided or comes from the surrounding environment or the use of the devoted visitor's terminal and is directed to the server, or data that comes as a response from the server to the dedicated terminal. It is for this reason that we chose to name this

category "Museum data management", with the term management embracing the storage, transmission and processing of data. Registration of visitors terminals, that allows museum staff be aware of the number of visitors in each room as well as logs of visitors actions belongs in this category, as well as geolocalisation, orientation and live streaming. Modules for content creation, content management and content update can also fall under this category.

Figure 4: An example of an Augmented Reality mobile museum guide

3. AN AR MOBILE MUSEUM GUIDE: USE CASE SCENARIO

3.1 Registration

The visitor enters the museum and heads for the kiosk where the guides are distributed. He registers together with his companions. This process will later enable him to communicate with co-visitors and know their exact position in the exhibition space. It is also required for storing the path visited so as to later provide the visitor with a unique and completely personal "souvenir". This very same information of visitor's path is also useful for the museum personnel. At this point the visitor is provided with information regarding the use of the terminal.

Different kind of terminals could be available like Tablet PCs, UMPCs (ultra mobile personal computers) and PDAs without excluding a future use of the visitors' self owned terminals, e.g. smartphones. Whatever the choice of the platform, it should include a camera which will capture in real time the scene the visitor is looking at so as to augment the viewed scene with meaningful information. The visitor's terminal is also equipped with single or double headphones and maybe a special pair of Augmented Reality see through glasses through which the visitor will observe the exhibits and the digital overlays instead of looking them through the screen display.

3.2 During the Visit

The visitor enters the exhibitions and points his device towards a painting or simply observes the exposed object through his glasses. The image is captured by the camera and processed by a special module of the application where the pose estimation is effectuated. Once this done, it is possible to correctly place the available information around the observed object in terms of images, menus, buttons or widgets that activated by the visitor will present him a wealth of multimedia information. The interaction device would depend on the terminal used and could be a stylus or the index. In the case of using special Augmented Reality glasses, it could be also very interesting to attempt to combine them with a "hand smart" solution, where the visitor's one palm is transformer in a virtual keyboard (Antoniac et al., 2001). During the visit, the visitor can communicate with his co-visitors or other visitors and leave spatial comments regarding exhibits that can be viewed by his co-visitors and/or other visitors. The museum can also communicate messages to the visitors during the guided visit. Personalization helps the adaptation of the content to the visitor's profile and specific interests.

3.3 After the Visit

In at least one mobile museum guide project personalized souvenirs were proposed to the visitor (Sauer et al., 2004). As all visitors actions are logged, useful data regarding the sessions can be retrieved and help in redesigning or better adapt to visitors' needs the guide. But there is also another possibility, already explored and published by the Cite des Sciences et d' Industrie in Paris (Topalian, 2005). As the visitor returns the terminal, he receives a postcard onto which there is a url printed. The visitor can access the content of the web pages once in front of a PC and visualize the objects he visited and the path he followed whilst in the museum premises. In that way the visit is extended beyond the museum and the visitor is given the chance to examine further specific objects or aspects of the exhibition.

Figure 5: Augmenting the painting with a detail

4. IMPLEMENTATION ASPECTS

As the scene that the visitor perceives is the real or the video scene of the surrounding environment augmented with digital objects, it is very important to cater for a proper alignment and registration of these last to the real world. Unfortunately and unlike virtual reality, in Augmented Reality even small errors are easily perceived by the human visual system. Another very important factor is the combined latency, else called transport delay, meaning the delay form the time the measurements are taken to the time the images appear in Augmented Reality display (Azuma, 1993).

Both of these factors are crucial to the acceptance and success of the system but unfortunately no existing approach completely satisfies these requirements. A possible solution would be to combine marker tracking with sensor (inertial, ultrasonic, or radio ranging) and 3d model data. However for the time being

the marker based approach is the most robust and reliable and that is the reason for which it was chosen for the first implementation. In any case, the challenge is to adopt the most appropriate solution in the more discrete and less obtrusive way for the museum visitor.

Opting for the marker based approach, the type of museum objects had to be defined. A decision was taken to proceed with three different types of museum objects. The first one is paintings. Apart from being one if the most usual museum objects, because of their two dimensional and rectangular forms they can be used as 2d markers, detectable by the Augmented Reality guide. The second type of objects resides behind museum transparent showcases. Though the cooperating museum agreed upon the inclusion of discreet markers in the showcases, in this case too it could be probable to use the objects geometry for registration and tracking. However that would require proper lighting conditions and a minimum of reflection on the transparent glass showcases. Finally a third case study will be provided by quadruped stands with a marker on each side, onto which the possibility of commenting pottery or statuettes will be explored. In this way the marker base experimentations will anticipate future improvements in estimation of camera position and orientation as well as in novel ways of interacting with Augmented Reality.

This is why the goal of our implementation is not the creation of a fully fledged Augmented Reality prototype but rather the creation of numerous Augmented Reality demonstrators first, to assist museum professionals better comprehend the potential of the new approach and then adapt it to their specific needs and secondly to actively involve visitors in Augmented Reality assisted tasks. Evaluation will eventually prompt interesting issues regarding the use of mobile guides in the museum setting, the use of AR for interaction, entertainment and learning.

5. DISCUSSION OF THE AUGMENTED REALITY APPROACH

5.1 Current limitations of the Augmented Reality approach

Despite the innovative and promising character of Augmented Reality applications there are still lots of barriers to overcome in order to ensure consistency and efficacy of the Augmented Reality approach when it comes to mobile museum guides.

The lack of dedicated authoring tools renders the full chain of content creation, authoring, implementation and presentation a difficult task that can not be carried by museum professionals alone. The innovative character of the approach is often making bewildering the expression of the needs of museum curators, as they are not really aware of what to expect and consequently having a difficulty to express their needs. Technical constraints related with tracking and correct display as well as the lack of accurate, powerful and inexpensive equipment is another very important issue. Therefore, prototype applications are much more common than viable, ready to be commercialized applications. It is for the same reason that many Augmented Reality applications lack a "bottom-up" approach. Consequently, the process of development is often technology driven instead of user driven.

5.2 Conclusions

Because of the aforementioned limitations, trying to make abstraction of the technological constraints is of paramount importance for the development of Augmented Reality applications destined for the "museum sphere".

It is also important to remember that museums could provide an exciting environment for experimentations with Augmented Reality and one that could help the Augmented Reality community build in experience that could later be embedded in other Augmented Reality applications, especially because museums are extremely rich in content and socially inclusive as environments.

As technological progress will finally address the need for light and reliable equipment, robust Augmented Reality algorithms and dedicated, easy to use authoring tools, Augmented Reality might provide a valid, intuitive and playful approach towards the appreciation and comprehensions of tangible and intangible cultural heritage, opening up the way for other learning or entertainment Augmented Reality applications.

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