Preserving our Past with Toys of the Future

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This paper presents the initial outcomes of a key scoping study undertaken to explore the role of augmented reality and motion detecting technologies in the context of Intangible Cultural Heritage (ICH) for museums related environments. Initial prototypes are in the form of an interactive infrared camera based application for children to engage with an Aboriginal puppet. This scoping study is unique, as it tries to combine two extremes: the curation of historical intangible artifacts and their preservation through digital intervention. Heritage related intangible content is always restricted because of its non-physical nature and can never be fully embed in an environment like museums and related exhibitions. This paper explores alternative opportunities for knowledge transfer of ICH content that manifest with playfulness in order to elicit a deeper understanding of such intangible cultural artifacts. This study is complementary to multiple disciplines including heritage preservation, museum technologies and emerging interaction design.

Keywords: Heritage Preservation, Museum Technologies and Augmented/Mixed Reality

Introduction

The term heritage refers to things that are inherited from the past. It refers to tangible artifacts such as natural resources and man-made items or intangible artifacts such as customs and ancestral practices. Heritage also defines a culture through the identification of a community with their language, ecosystem, traditions, genetics and general way of life. Cultural heritage helps a community define its current and past identities for itself as well as others (Zhang, 2010). It has a tremendous power to elicit a sense of belonging in a community. Heritage and its preservation are also important for the local economy (Bowitz & Ibenholt, 2009). Heritage sites, museums and exhibitions generate employment opportunities and provide financial help for communities. Watson (2010) also acknowledges that songs are the most important carrier for cultural elements from one generation to the other. As songs are traditionally poorly documented when other communities colonized these

regions, the dominant culture cannot easily integrate the indigenous heritage and related oral culture with their own. Hence, the original oral traditions and local cultural creativity decline to sub-dominance as is seen in African and Caribbean regions.

Communities display their heritage through customs and objects from their past. The predominant forms of displaying such artifacts are museum spaces. The form of museum design has changed over time to protect and enhance intangible cultural heritage (ICH) and to provide diversified experiences from the user's point of view (Y. Shi, Hao, & Sun, 2008). New media and emerging technologies have the potential to move heritage preservation beyond static displays, capturing in cinematic or narrative forms and revitalize the intangible aspects (Yehuda, 2008). New and emerging technologies are utterly transforming two main activities central to the process of re-creating and understanding the past, (a) digital recording and analysis of scientific data and (b) the communication of new insights and understandings about the past to the widest possible audience through interactive applications (Silberman, N. 2004).

Augmented reality (AR) and gestural interaction are contemporary emerging technology that may breathe new life into museum displays through their bodily involvement and potential to preserve intangible content and educate future generations. This interesting use of technology in a museum motivates visitors to engage in challenging learning situations. Research has found that technology-mediated narrative and the interactive, situated, collaborative problem solving affordances of AR are highly engaging (Dunleavy, Dede, & Mitchell, 2008). In this regard, the concept of mixed reality based user interactions for heritage representation becomes one of the central interests for the design and evaluation of the future of museum exhibits.

There are two overarching factors that justify this scoping study:

a) Lack of interesting content related to ICH and its awareness for visitors to museums (Lee 2004);
b) Lack of purposefulness for the use of emerging technologies, especially AR, in order to engage and provide knowledge transfer opportunities to museum visitors.

In this article, we will present a scoping study in the context of ICH, museum exhibits and emerging technologies. We will discuss emerging user interactions, which involved a number of digital tools and methods to form cohesive, immersive and engaging interactions, which are essential for the design and evaluation of the future museum displays. In addition, a virtual AR prototype will be presented that leverages the kinesthetic value of the Xbox Kinect, "Aboriginal Dance for Kids", currently under development for examining the knowledge transfer, engagement and provision of authentic learning environments in relation to the curation of ICH in museums.

Background

One can enjoy the dances and music from the past, however, participation and learning from these performances are challenging in nature. Therefore, amazing festive events with dances and gatherings are choreographed in the museums; yet audiences are not interacting and most importantly learning from these events. In addition, producers of these tangible presentations in museums are only the transmitters of cultural information. They transform messages, stories and happenings from the past in a linear (non-interactive) fashion and do not provide freedom for the audience to interact with the content. Visitors to a museum, in these *one-way* scenarios, are the non-immersive, non-engaging players and cannot contribute; only acting as passive spectators.

The use of simulation games produces real-life situations with a deeper understanding of the subject matter (Boocock & Schild 1968), (Pan, et al 2006), (Huang, Rauch, & Liaw 2010). Embodied and gestural based game devices with AR, have the potential to breathe new life into museum. The use of these technologies in the context of ICH not only provides tremendous showcasing opportunities but also guarantees the spontaneous, undirected learning experiences for people of all ages (Tanenbaum & Bizzocchi, 2009).

However, there are some challenges facing these exhibits. While new technologies have complemented museum related installations and representations of the past they are somewhat limited in showcasing objects with their related processes and contexts (Kalay, 2008). Visitors are experiencing the ubiquitous use of new technologies in museums around the world however this approach has created a challenging situation where more objects and artifacts are seen rather than examined in historical context (Lee, 2004).

In today's museums, visitors experience both linear and non-linear interactions. Linear interactions are ones where visitors receive information and they do not have choices to stop, start and skip the information. In contrast, non-linear interfaces are those where visitors have full autonomy to select, run and execute the information. While linear displays attract users with the extravagance of visuals and multimedia, non-linear interaction, such as touch screens and interactive displays, invite them to challenge their mental abilities and to retrieve information. The ultimate goal is to allow users to understand the application content and goals in an easy and natural manner (Ganotto, Mainetti, & Paolini, 2008).

While tangible historical objects such as artworks, photographs and items from archaeological digs have always made up the majority of museum exhibits, the presentation of intangible content has been limited and restricted to two dimensional art depictions and/or animations and video. Kinaesthetic interaction with intangible content such as music and performances including dance is essential for knowledge transfer, future dissemination and the passing on of such *wisdom* to others. Without these opportunities, traditions and customs of cultural significance vanish. This is evident from the limited knowledge of the intangible heritage of lost civilizations such as ancient Greek music (West, 1994) and the Chinese indigenous musical performance named "kunqu" (Wong, 2009).

Types of ICH

There are numerous manifestations of ICH. In this section, we will discuss some significant types that could better be preserved through emerging technologies.

Oral Traditions, Expressions and Language
When a society makes a certain major decision to segregate themselves from another society, a distinctiveness of a certain culture is formed (Arizpe, 2004). Oral tradition, community's expression and particular language are built based on differences and uniqueness.

Memories
Memories plays an important role in the development of human culture and inter related socio-interactions. (Gandhi & Gandhi 2009) relates how memories can heal the bitter past and bring various ethnic group together.

Music and Performing Arts
Like organized ideas transform into arts and design, organized sound turns into music. Music is important in human civilization and playing a pivotal role in categorizing communities. The evolution of music over the period of time could help to categorize and study human as well as animals of some breeds (FITCH, 2005)

Practices, Rituals and Festive Events
Clavir (2002), who study Aboriginal and non-Aboriginal culture argues that cultural preservation can only be achieved through maintenance and perpetuation of the values, beliefs, and related activities of a culture. Preservation of context and associated activities are also important (Simpson 2009).

Traditional Craftsmanship
Various ritualized actions from different cultures and ethnicities were responsible of giving form to associate or related objects. A strong relationship between rituals to its physical spaces could easily be noticed (Conan 2009). For example, a Chinese garden and Chinese theatrical performance 'kanqu' where the wealthy people build a stage near the water pound in the garden. This structure for performers is necessity and is later converted to a design element of the garden.

Emerging Museums

A more engaging and immersive experience for museum visitors is critical (Marianna Adams, Jessica Luke, & Theano Moussouri, 2004). When visitors have control over the exploration of ideas and concepts, their experiences become more meaningful. Interactive components within the museum's installation provide these kinds of experiences. Clarity of purpose, design factors, social engagement and learning are some of the key factors important in acquiring this experience. For that reason, the changing paradigm in heritage related asset representation is rapidly shifting from tangible to intangible; from visible to invisible.

One example is the collection of stories at the Amsterdam Historical Museum and the accompanying exhibition "East" (Alivizatou 2004). The oral histories exhibited represent the first virtual objects in the collection of the museum. Similar goals to preserve ICH and the sufficient portraying of theatrical events have seen museums record theatrical performances to include them as part of their collection (Alivizatou 2004). Moreover, museum exhibits are also transforming content and displays from non-interactive to interactive and linear to non-linear (Leinhardt & Crowley 2002). As museums are seriously challenged by the increasing number of available online information they must adopt more interactive information retrieval systems on their premises. For example, *Pockets Full of Memories* which was exhibited on the main floor of the Centre Pompidou National Museum of Modern Art, Paris (Legrady, 2002), was an interactive installation in which visitors could contribute visual and descriptive information to the digital archive about a particular object in their possession. This information is embodied within an interactive kiosk and the relevant information is made available online after their visit.

Diminishing indigenous songs and languages from all cultures of the world are just some of the existing challenges for preservationists. The use of emerging technologies could successfully provide meaningful, entertaining and endless leaning opportunities. For example, the top 10 languages (of approximately 6,700) are spoken by 40% of the earth's population, and the top 20 are spoken by half of the people on Earth. 96% of the human population speaks just 4%. According to Dalby, a language dies every two weeks (Dalby 2002). Marett and Barwick (2003), in this context, also talk about the endangerment of indigenous Australian songs and languages and mention the active collaboration among the experts, performers and relevant communities is required to revitalization and awareness of music, which is a deeply valued part of Australian cultural heritage. While putting emphasis on the preservation of indigenous songs and language, their article also mentions the current localized existence of indigenous and endangered musical culture in Australia. Today, due to historic and other reasons, such oral history fails to be passed down to the next generation. It requires an urgent need protection. However, with the modernization of the society, ethnic traditional cultural has suffered a severe impact with fewer and fewer festivals and folk song/lore events being held by ethnic groups each year. In Australia, some of the events have closed due to the retirement of elders and lacking of younger successors (Hong & Ling, n.d) Just because such ICH is registered with the Australian National Intangible Cultural Heritage List doesn't mean the details, context and nuances of such performances are retained for future generations. Diminishing indigenous songs and languages are some existing challenges for preservationists. Just as today's kinesthetic interactive computer games on the motion sensitive Xbox Kinect, Nintendo Wii and Playstation Move are recording, preserving and providing virtual game-based learning activities for today's contemporary hip-hop and break dancing, the strategic use of these same technologies may provide and essential tool for conserving traditional customs, dance, music and language that could not otherwise be fully appreciated unless bodily experienced.

Augmented Reality (AR) together with emerging technologies may provide the mechanism to revitalize ICH within museums. To date, there has been little research performed investigating the need for the purposeful use of new media specifically in museum exhibits. However, as related research shows benefits in the uses of AR in teaching, learning and collaborative settings with findings relating psychomotor skills with wearable AR (Jayfus D, 2008), it's a natural progression to apply this pedagogy, referred to as *Augmented Learning*, to ICH. Furthermore, mobile AR systems are increasingly being tested in rich content environments, as they can enable visualization of 'unseen' valuable and complex 3D content as well as provide added edutainment-value in today's cultural heritage sites (Papagiannakis, Singh & Magnenat 2008).

Augmented Learning

Augmented Learning (AL) is a pedagogy whereby the real world is adapted with props and contextual information to provide an immersive and authentic learning environment for students while sustaining student-student and teacher-student social interaction. Where once props were as simple as paper, pencil and costumes, today the renewed domain is tightly coupled with technology due to the endless possibilities emerging media provide to adapt learning situations to student needs. Although an emerging issue for education, action research is needed to ensure optimal use of AL in a variety of contexts. Augmented Learning environments provide unique, hitherto impossible, opportunities to change the nature of learning and teaching experiences. First, AL environments enhance interactivity with content and processes through simulations and role plays (Oblinger, 2004). Moreover, they support interpersonal interactivity (with individuals or groups of individuals) while immersed within another activity (Rosenbloom, 2004). Second, AL environments are able to deliver rich conceptual resources for reasoning about and thoughtfully acting in playful spaces, and thus can more easily

become highly engaged in the subject matter (Roschelle & Pea, 2002). Third, AL environments facilitate students to build their own activity and experiences and to take control of their own learning (Meiguins, de Souza Junior, de Brito Garcia, & Gonclaves, 2004). In this way AL, much more than 'traditional' learning environments (digital non-augmented learning environments included) and could support individual differences in students' learning styles, physical abilities, intelligence levels, and background knowledge.

AR combines real and virtual, interactivity in real-time and operates in three dimensions. In other words, it is a promising field developed on the basis of Virtual Reality (VR), which superimposes computer generated virtual information onto the surrounding real environments to augment user's perception in real-time and interactively (Su, Kang, & Tang, 2008). Figure 1 shows the use of AR and related technologies such as Head Mounted Displays (HMD) to superimpose multiple layers of information. In addition to virtual objects, more information related to touch, smell and taste could also be embedded or augmented to produce richer experiences (Yu, Jin, Luo, Lai, & Huang, 2010).

Figure 1: User wears a head mounted device (HMD) and views the 3D version of the story while exploring the contents of the story by unfolding the magic cube (Pan, Cheok, H. Yang, Zhu, & J. Shi, 2006).

Augmented Learning in todays Museums

There are many research-oriented efforts to bring augmented reality learning to its fullest intervention in the context of cultural heritage. For example, the ARCHEOGUIDE systems (Gleue & Dähne, 2001, Vlahakis et al., 2001) that provides on-sight personalized cultural guides. These guides, based on position and orientation in the cultural site, help visitors as a virtual assistant and provide AR based reconstructions of ancient ruins. Figure 2 shows ARCHEOGUIDE systems and user's point of view together with the augmented view of the Hera temple in ancient Greece.

Figure 2: Mobile unit's main module in backpack and ARCHEOGUID system.

There are also many tourism based AR applications for example the augmented binocular (Fritz, Susperregui, & Linaza, 2005). This is a coin operated binocular system found on hills and tourist palaces. This AR based binocular offers an overview over the buildings and streets of an area, natural and cultural sites as well as the chance to zoom tourist assets close to the spectator. Other systems, which use mobile devices together integrate with freely available Google 3D models to augment the vision by placing virtual objects with historical

significance in situ over live vision of the real world (Honkamaa, Siltanen, Jäppinen, Woodward, & Korkalo, 2007).

AR improves existing static and non-interactive real-world artifacts and multimedia presentations, by heightening visitors' understanding and appreciation of cultural heritage. Many museums have already integrated AR into their educational offerings. While handheld devices are flooding the market, AR related applications are available for consumers to emerge themself into augmented realism. Figure 3 shows an iPhone application (Streetmuseum, 2010) developed for the Museum of London to see the old London (Zhang, 2010). The application uses GPS coordinates system and lets you see about 200 historical images from different parts of London.

Figur3: An augmented reality based iPhone application created by the Museum of London that allows users to browse historical photographs in various parts of the city.

Unfortunately while there are numerous AR installations in museums they do not focus on ICH and offer little interactive learning experiences in addition to requiring time passive user involvement. These systems, for cultural presentations, do not offer the full potential of AL through immersive and engaging experiences. Furthermore, these installations continue to rely on conventional methods of presenting tangible heritage related representations from the past (East County Magazine, 4 April 2011). Systems like ARCHEOGUIDE reconstruct the physical past reality however ICH is not addressed.

A Prototype Immersive ICH Application for Children

For our own research, based on the importance of ICH in the Australian Aboriginal culture, including body paints, dance movements and sound, we have created a prototype application "Aboriginal Dance for Kids". The application targets children in a heritage related environment in order to create awareness about indigenous dance movements and body paints. Figure 4 shows a child synchronized and playing with an Aboriginal puppet. The application is based on the infrared camera embedded in Microsoft Kinect device and various patches on Quartz Composer. Quartz Composer (QC) is a node-based visual programming language provided as part of the Xcode development environment on Mac OS X for processing and rendering graphical data. A screen based Aboriginal puppet appears and moves accordingly as person moves in front of the camera. The background plate behind the puppet is not live footage; it is also an animated images based on a QC patch. The application calibrates the user in front of the camera together with the skeleton and the puppet. Afterward, the user can control and move the puppet around. An aboriginal song is also accompanied during the calibrated period of the application.

Figure 4: "Aboriginal Dance for Kids" an application for the awareness of Aboriginal's dance, body paints and their inseparable association with the environment.

The first purpose of this scoping study was to acquire knowledge about ICH and emerging haptic/motion-detecting technologies. Second, as museums should be attracting young minds, our goal was to integrate the above two variants together and develop a playful application for children. The initial impact of this application is favorable and shows promising results, particularly on the motivational level for the young. At this initial stage, the primary objectives of this prototype are: a) to determine the overall effectiveness of the prototype with children in the context of ICH; and b) to identify important perceptual and technical additions/adds-on that will help in providing recommendations for the development of a concluding application. Subsequently, during the design finalization phase, we will be able to evaluate the qualitative and quantitative learning outcomes for the visitors at a cultural sight or museum.

To date, we have trialed the interface with 15 children between the ages of 6 and 12 (9 female, 6 male). The prototype was placed in a heritage related environment in Qatar and the children encouraged interacting with it. Qualitative observations were gathered with respect to the children's engagement and playfulness while using the system. It was noted that the majority of the children felt comfortable using the prototype and found the content enjoyable. During the testing it was discovered that the puppet's range of movement is too limited as it is currently a 2D object and only responds to up/down and left/right movements. Children became frustrated when they were expecting to see the puppet rotating but could not. Future versions of the prototype will require a 3D avatar to be integrated in order to extend functionality to the full range of human motion.

Sound, visuals and active physical involvement/interaction constantly engage with the participants providing a considerable amount of emersion into the augmented realism. Consequently, with the assistance of the final application, we will be able to collect some empirical data related to children's motivational engagement and learning outcomes in the context of this type of presentation of ICH.

Summary

Although there have been many technological based representations of cultural assets in museums, these installations only represent and visualize the physical objects and environments. It seems the representation of a culture has been transformed into elements of a showcase. The challenge therefore is to construct immersive and meaningful experiences by leveraging current emerging gaming technologies. It is quite possible that the ubiquitous natures of these devices could provide a wide range of heritage representations in a unique and impactful manner. Our study has identified the use of augmented learning in the preservation of ICH as a gap in the research, adaption and deployment of such technology. In 2007, AR was listed as one of the ten most exciting emerging technologies, which are most likely to alter industries and the fields of applied research (Jonietz 2007). Moreover, in 2010, it is also listed as a key educational technology with a time-to-adoption in the next four to five years (Johnson et al 2010). Therefore, it is imperative to create mind-engaging applications and challenging pedagogical contents in heritage related exhibitions so they not only expose users to the past but also enjoy the limited time they spend inside the museum. These interventions may help in culminating new patterns of curation and understanding of ICH and might have the potential to revitalize, and preserve the culture in ways not yet realized.

Cultural tourism is an important and fast developing industry. There are over 40,000 museums worldwide; it is a major segment of cultural tourism market (Hsieh, 2011). While museums are multiplying in numbers, they are also facing challenges such as active participatory learning opportunities for youngster. Visitors inside the museum should not only be entertained but also learn the importance of intangible cultural heritage at conscious and sub-conscious levels. Since AL and AR are not currently being used for best possible pedagogical purpose in museums, visitors inside the museum are not engaging with the subject matter. Furthermore, emerging technologies such as haptic and motion detecting technologies are not widely used to enhance the impact of ICH related learning opportunities due to the lack of technical skills and an understanding of their conceivable benefits by museums and heritage preservation organizations.

It is assumed this study and the resulting prototype will be a point of departure for the meaningful and playful activities for future visitors to museums. The application is attracting interest from children and demonstrating that the emerging interactive technologies and ICH content is crucial for today's museum. The application provides physical participation and entertaining feedback that immerses museum visitors within the ICH content in a truly unique way. The puppet inside our prototype, which shows Aboriginal body paints also, helps in creating awareness about the indigenous body arts providing an authentic learning environment.

It is expected that engaging visitors with emerging technologies inside a museum will have meaningful results to engage the mind and body in subject matter that has been traditionally two dimensional and passive.

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