IMPROVING USER EXPERIENCE IN THE MUSEUM

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ABSTRACT

Today ICT can benefit any environment, including the safeguarding, preservation and empowerment of cultural heritage. Pervasive technologies such as mobile devices (smart phones and tablets), sensors and RFID (Radio-frequency identification) are flooding the real world, enabling new intelligent and easy-to-use services for everyone, including the differently-abled. RFID technology enables automatic identification of objects and has been successfully applied in museums to improve the museumgoer's experience or to increase the efficiency of a physical inventory. In this paper we discuss using RFID passive technology to identify artifacts in the museum and deliver content description in the most appropriate form through various sensorial channels, according to the user's abilities. Specifically, we describe the initial steps of a project aimed at creating mobile apps to facilitate the usability of museum visits for differently-abled and special-needs users.

KEYWORDS

Museum, RFID, user experience, accessibility, usability, users with special needs

1. INTRODUCTION

In the last two decades the Internet has changed our society profoundly. The World Wide Web with its simple user interface and link mechanism has brought the user into the net, providing transparent access to the enormous amount of data available worldwide in servers and databases. ICT technology has revolutionized the way products and services are provided; eGovernment, eLearning, eCommerce, eHealth, etc., are the new paradigms made possible by the Web, in some cases allowing the simplification of processes and procedures, but mainly creating new ways of interaction aimed at generating a more satisfying user experience.

Today, RFID and sensor technologies embedded in everyday objects promise to further revolutionize our society. In the near future, everyday objects would be able to provide information related to their characteristics or usage. All this information, transmitted via network, may trigger intelligent services available everywhere and under any conditions, so RFID has become one of the potential key technologies for enabling "object-based" services. One advantage of RFID compared to other technologies such as QR codes (Quick Response Code) or barcode, is that it does not require sight, enabling its use for blind persons as well. RFID technology has two components, readers and tags. Tags store object identification information that readers can retrieve. Tags can be battery powered, but the most interesting are passive tags that take advantage of the energy induced by the reader and are small, cheap and long-lasting.

In order to provide a more satisfying user experience for museum visitors, including differently-abled persons, flexible adaptive services should be provided to dynamically convert content to a more suitable format, or one preferred by the user. In fact, as argued by Kelly et al., in the eLearning field rather than provide universal access for the same resource, the equivalence of the content provided using different sensory channels (i.e., touch, sight, or hearing) is important. The idea behind the 'Museum for All' (M4A) project is to deliver information about artifacts during a visit to the museum in an accessible way. RFID technology provides personalized content considering the diversity of needs of all users, not only the differently-abled; for instance, to make the experience more usable, interactive paths could be provided for children: learning by experimenting and gaming may enhance learning.

Special attention will be given to the design of content delivery; if a person has reduced perception or other disabilities, the pervasiveness of technologies may create barriers if information and services are not designed according to accessibility and usability principles. Universal access refers to the possibility of delivering content and services to everyone, including differently-abled people. Since disabilities embrace a wide range -- perceptual, motor, learning and cognitive -- the Museum for all project aims to offer information on artifacts through various channels: visual, auditory, vibro-tactile, etc. Furthermore, children should access different levels of information according their developmental age. Thus, the information is organized by levels of increasing difficulty managed by the system adaptation features. Providing any type of information through mobile devices and applications can be a valuable way to differentiate content according to the users' characteristics. Recently, mobile devices and applications have been also become accessible to people with special needs, such the blind and the visually-impaired (e.g., iPad, iphone Apple devices enhanced with Siri synthesis, Google Talkback app, for Android devices). In addition, certain special devices designed especially for blind users (http://www.bones.ch/bones/pages/eng/products/milestone312.html) are able to read RFID tag contents without a specific application.

The paper is organized as follows: after presenting related work in the field, the museum domain is introduced to apply our proposal, which will be described next. Conclusions end the paper.

2. RELATED WORK

In the last decade pervasive computing and localization technologies have been increasingly applied in several areas, including cultural heritage. Recently multimodal mobile environments and vibrotactile devices with touchscreens have advanced human-computer interaction, improving the user experience through more natural interaction. Many museum applications have been developed and we only report some of them here, selecting studies most similar to our work. RFID (Radio-Frequency Identifier) technology has been successfully applied in museums in order to improve visitors' experience. Based on HF (high frequency) readers/tags, Hsi et al. developed the eXspot system, which enables visitors to capture information about exhibits they visit and to take souvenir photographs during their visit to the museum. Furthermore, they can access the exhibit information on personalized Web pages (His et al., 2005).

Santoro et al. developed a multimodal museum guide offering various accessibility options to users, fitting and supporting the needs and preferences of different users, including the visually impaired. An initial empirical evaluation showed overall good acceptance among users, but the use of HF forced users to stand in very close proximity to the artworks, which is not very natural in the museum environment. The authors fixed the problem using active RFID tags, which can reach a longer range and at the same time provide a localization of the current user position without forcing them to stand in close proximity to the artwork (Santoro et al., 2007). However, they used active tags that are expensive and require maintenance (battery powered) while we selected passive UHF tags since that are small, cheap and with a potentially infinite life.

Hall and al. (Hall and al., 2002) developed an application for children to combine replicas of antique toys, accessing multimedia information about the artifacts and playing different music according to different levels of content, depending on the object combinations.

Recently Near Field Communication (NFC), a radio-frequency based wireless technology, has been incorporated into modern smart phones such as Android and ios devices, offering new interaction opportunities. Ceipidor et al. investigate the use of NFC technologies to enhance user experience by retrieving additional contents and accessing social activities using a smart phone (Ceipidor et al., 2013). Participatory Design (PD) techniques are a key factors in the design process since they enable the production of artifacts and services fully usable by users. (Cober et al., 2012) applied PD techniques to simplify interaction for the blind user and improve his/her experience in the museum.

Another branch of research focuses on enriching and adapting user experience, also benefitting from social activities. Karimi et al. (2012) investigated recommender systems for museums, by "sniffing" the surrounding environment using the RFID technology. Similarly, Mody et al. 2009 exploited RFID and adapted recommender systems for personalizing platforms for the museum. However, to observe user activities may pose privacy and security issues that must be carefully analyzed.

Concerning social activities, sharing creates interest: attracting people to the exhibition, and allowing people who miss the visit to still enjoy it. Kostoska et al. (2013) investigate how to promote the sharing of memories, after a visit to a museum or exhibition, by performing surveys and trials. Results indicated that users can significantly enhance this sharing when they have simple and easy-to-use tools for building a collection of photos of their visit, supporting their storytelling.

3. THE MUSEUM FOR ALL

The Museum for All (M4A) is a project aimed at organizing content description of artifacts present in a museum. The idea is to provide accessible information according to user ability in order to offer a level of knowledge suited to each individual. The RFID tag applied to an artifact enables the delivery of the description of the characteristics and historical details associated with it, according to the personalization of the content configured via web (before the visit). When the user is in proximity to the artifact, the content can be delivered automatically or on-demand, depending on user preference. The content is delivered through one or more channels (visual, auditory, haptic, etc.) according to rules described in the next subsection. A simple user profile is selected before or when starting the visit. According to the selected profile, different amounts of information are presented in a fully usable way with different sensory modalities. For instance, when the children's profile is selected, the language used for providing content is simplified and the description shortened. A sort of game may be proposed, making the child receive an image of the artifact that can be zoomed, highlighting details and putting the artifact into its historic-artistic context. Serious games are a new and active research topic that investigates the potential of games for learning and stimulating brain activities.

3.1 Designing the Content

The information related to the museum collections is usually stored in a database. Recently artifact descriptions have been made available via wireless networks to visitors using mobile guides (Ghiani et al., 2008). However, little attention has been devoted to personalizing user experience according to different user abilities. Systems able to adapt the content as well as the user interfaces may be a possible solution for providing suitable information to any type of user. This type of methodology has characterized our design approach.

Adaptive systems may operate statically, reading configuration files, and/or be dynamically based on user behavior and feedback. In the context of our project, the configuration is mainly static but the rhythm of the delivered content can be adapted according to the rapidity of the user's interaction (i.e., clicking a button, making gestures, etc.) while the other adaptations are performed reading configuration files.

When conventional museums are arranged to become accessible for all, these design principles for delivering content related to artifacts should be followed as much as possible. Furthermore, to enrich user experience, multimedia interaction with the artifact should be provided, possibly simulating the real experience with an augmented virtual environment interaction provided through electronic mobile devices such as a tablet, which with its touchscreen interface offers more natural and intuitive interaction.

A museum designed for children should be different from conventional museums, offering large spaces where children can run, and artifacts -- or virtual copies of them – that can be touched and experimented with, offering a multisensory experience that enables the child to learn by experience (Dindler et al., 2010). Offering performances with actors can immerse the child in a typical historical scenario. In addition, a user interface designed for a child will be very different from those targeting visually-impaired users (e.g., with fewer graphical objects and more textual content).

Table 1 shows the content adaptation rules that drive the content delivery.

Table 1. Adaptation Rules for Driving the Content Delivery

Reduced/ missing ability	Content	Delivery channels
Visual	Add a detailed description of the article, provide tactile user interaction (gesture) and vibrotactile feedback	Auditory, vibrotactile
Hearing	Simplified language	Visual
Motor	Modified User Interfaces (UIs)	Visual, auditory
Cognitive	Content by levels, Simplified language	Visual, auditory
Learning	Content by levels	Visual, auditory
Children	Content by levels, Simplified language, Modified UI	Visual, auditory, tactile

3.2 System Architecture

The database of information related to a museum's collections will be enlarged with the additional information necessary for delivery via different channels, for instance adding the description related to visual content and structuring it in at least two different levels of information (one simplified version and a complete one). Different users profiles according to Table 1 will be created and stored. A web application will allow users to register themselves and choose a suitable user profile, specifying the user preferences. A profile manager will select and organize the information according to user preferences. A key feature of the usability of the M4A system is its portability. Thus, the user should be provided with a mobile phone or tablet touchscreen equipped with an RFID reader operating at high frequency. When the RFID reader reads an artifact tag, the M4A web application will provide the information according to the user's preferences, allowing interaction through the touchscreen devices. We have selected the Web architecture because it is multiplatform and device-independent.

We are developing our prototype on the Android platform, which offers an open development environment and can also lead to potential improvements suggested by the international developer community. In order to better design for content that will be presented to different users, a participatory design approach involving people with disabilities will be undertaken from the early phase of the design.

4. CONCLUSIONS AND FUTURE WORK

Museums are places of culture where people expand their knowledge. Everyone should have the opportunity to benefit from them. Developing content that is fully accessible and usable for all remains a challenge, but the careful development of new systems and services for special needs users is possible.

The advantage of the "Museum for All" (M4A) system is that it provides everyone with accessible and suitable content related to museum artifacts. Its design approach could be followed and utilized in other application contexts to take into account the needs of differently-abled persons.

Access to cultural heritage is a right for all, and simple and feasible ways to facilitate this should be explored. In this paper we have presented the idea of the "Museum for All" project and we introduced its main basic architectural characteristics. The idea proposed herein could be integrated into online systems for reservation/purchase of Museum tickets, providing a more satisfying user experience for all.

Future work will address the implementation of a prototype designed applying the principles of participatory design, to be tested with differently abled users.

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