ARCHAEOLOGICAL SCAVENGER HUNT ON MOBILE DEVICES: FROM E-EDUCATION TO E-BUSINESS
A Triple Adaptive Mobile Application for Supporting Experts, Tourists and Children

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Abstract: This paper reports on the design and development of a mobile application to support archaeological education and to raise awareness for our cultural heritage by making use of the powerful notion of play. The application reads information from Quick-Response Codes (QR-Codes) on paper sheets, which can be placed directly at the points of interest. Users can now follow an archaeological scavenger hunt along those points of interest. They start at one point of interest and get hints on how to find the others. This makes use of collective intelligence, i.e. using the mobile devices amongst the group of users as social communicators in order to get specific information on the target; through these additional discussions both the one who states questions and the one who gets the answer can learn incidentally. Although this App has been developed for educational purposes, it can be used just for fun, e.g. for a children's birthday party: Hiding treasures in various spots in the garden and delivering information on QR-codes showing hints on how to find the spots. Moreover, the use of the ArchaeoApp in the Tourism modus, is a challenge for e-Business.

1 INTRODUCTION

A fundamental problem in urban archaeology is that objects found at archaeological excavations have been removed to a museum or depot and the site is built over and thus no longer visible: neither to experts nor to the interested public.

Consequently, it is of professional, educational and touristic interest to label such points of interests (POI) and to provide electronic information about the removed artefacts and their history in the context directly at the POI.

Due to the widespread and growing availability of Smart Phones (e.g. iPhone), the goal of this project was to make such information accessible by using ubiquitous/mobile devices (for example on iPhones, see Figure 1) and to address the specific interests, needs and demands of three different user groups: experts (students), tourists and children.

Figure 1: A view on the ArcheoApp (left: geo-location; right: the corresponding archaeological information.

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The ArcheoApp can be adapted to three different levels of expertise (Figure 2):

- Expert modus, for students of Archaeology;
- Tourist modus, for people interested in Archaeology and
- Children modus, to be used in a context of a scavenger hunt.

A scavenger hunt is a typical mobile activity that both adults and children can perform. In a scavenger hunt, participants are divided into teams and given a list of items, often unrelated and obscure. The first team to collect all the listed items within a given time limit wins the game. The essential elements of this play (timed task, teamwork, mobility) can be used for a mobile collaborative problem-solving approach.

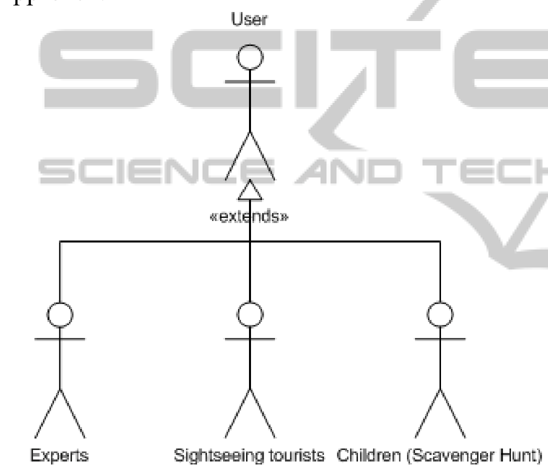

Figure 2: The triple mode of the ArcheoApp (for a better understanding look also on figures 5 and 6).

Such a scavenger hunt tool confronts users with a problem, which is usually more easily solved by the collective intelligence of the whole group (Massimi, Ganoe & Carroll, 2007). Collective Intelligence is currently of high interest among researchers, due to the fact that there are effects regarding the performance of individuals on a wide variety of cognitive tasks (Woolley et al., 2010). Recent research showed that different collaboration models, strategies, as well as atmospheres can greatly influence the performances of its members. In collaboration, each individual can have better learning effectiveness (Shih et al., 2010).

2 BACKGROUND

Originally, the idea of this project was to use radio frequency identification technology (RFID) for tagging archaeological objects and to make use of separate devices including Tablet-PC's (Holzinger et al., 2010c).

This was obviously due to the fact that we have past experience with the application of RFID based technologies and mobile devices (Holzinger et al., 2010a), (Holzinger, Schaupp & Eder-Halbedl, 2008b), (Holzinger et al., 2008a), (Weippl, Holzinger & Tjoa, 2006), (Holzinger, Schwaberger & Weitlaner, 2005), .

Based on the archaeological problem description in section 1 and the lecture of Urban Archaeology which consists of 13 points of interest (Figure 3), a concept for a mobile application has been created. A description of the 13 POIs from an Archaeological viewpoint can be found in (Holzinger et al., 2011).

Figure 3: The basis for ArcheoApp: 13 points of interest (indicated by red numbers) along an urban archaeological tour for students of Archaeology (M. Lehner, Graz).

Our first field tests in summer 2010 with a group of 8 students of archaeology on the archaeological route of 13 points of interests revealed that more than one device is awkward and difficult to handle – for both the students and the teacher; most of all the users reported that the tablet size (even the iPad) is still too large and too heavy for outdoor activities.

Based on these experiences, we decided to use smaller devices (e.g. iPhones, which are increasingly available amongst students) and Quick-Response (QR-Codes) as these have the advantages of being optical readable, i.e. functioning with any handheld with a camera.

3 RELATED WORK

Although there is some related work on the use of tagging POIs with QR-Tags, there is to date no such work within archaeological education.

Osawa et al. (2007) developed a support system for outdoor learning using exploratory observation and conducted an experiment to use their system in the observation of nature. Their system used both RFID tags and QR-Tags to locate positions on a horticultural farm and its surrounding forests. They used a handheld computer along with a reader to detect the tags where the students got a description and an educational hint. Additionally, they used a mobile phone with a camera along with QR-Codes. Their evaluation showed that both RFID and QR-Tags were regarded as useful for outdoor learning by the students. The comparison of the two tag systems showed that the QR-Code was preferred due to the easy handling with lightweight mobile phones (Osawa et al., 2007).

A further work was presented by Chang et al. (2007) and describes a novel way-finding system aimed at increasing the independence of cognitive-impaired people (e.g. mental retardation etc.) in their daily lives. They used geo-coded QR-codes, which embed the coordinate (x, y, floor) along with a social computing approach to shorten the learning curve of the end user. For this purpose, they attached geo-coded QR-codes, which can be imagined as a new kind of traffic sign system to selected positions on routes. The navigational photos are delivered on demand to the end user who uses the built-in handheld camera to read-in the QR-code when it is within range and line of sight. A tracking function is integrated to timestamp the visited positions and issue alerts in case of anomalies. They found QR-codes to be a cheap, easy and a useful alternative tracking system in comparison to RFID sensor networks. They were also found to increase the sense of security and lowers the acceptance level for the assistive technology (Chang et al., 2007).

A general approach to tagging objects can be found in (Goh et al., 2007). Moreover there are examples of cultural mobile guides that put the end user and their need for mobility in the focus of attention (e.g. (Augello et al., 2006); (Pilato et al., 2006)) and there is some previous work which has been done on augmenting the learning experience in museums (e.g. (Hall et al., 2006), (Hall & Bannon, 2006). To date, no work on the implementation of an archaeological scavenger hunt has been reported, although there are a few museums mentioning their usefulness for education (see e.g. the American Museum of Natural History, who also provides a so called directionApp, http://www.amnh.org/apps).

Massimi et al (2007) point out that mobile computing enables a group to accomplish, in teams, efficient fieldwork that would have required several trips if performed by individuals, or may not have been accomplished at all.

Field researchers can deduce new information from findings they make while in the field, and apply it immediately to the situation at hand. This is especially important in fields where the time or resources to conduct several studies isn’t available. This domain can be termed mobile collaborative problem-solving (Massimi et al., 2007).

4 SYSTEM ARCHITECTURE

In the beginning, we carefully considered on which platform the application should be developed. Primarily due to the robust hardware, the choice was on the iPhone - or rather on the iOS platform. There are several reasons for selecting the iPhone for this application (Want, 2010). Moreover, there are some reasons which clearly affect e-Business (Want, 2010). The iPhone has an integrated high resolution auto focus camera for an easy and precise capture of the used QR codes.

Furthermore, the built-in GPS and the compass are also ideal for geo-location and thus suitable for navigation in the field.

In the current version, the app was implemented as a tab bar application in Objective-C, based on the iOS SDK 4.1.

Figure 4 shows the structure of the software, which is very simple, since we only need the provided "UIKit framework" and our own few classes for the application. The reason why we need so few own classes is simply because the frameworks can cover most of the required functions.

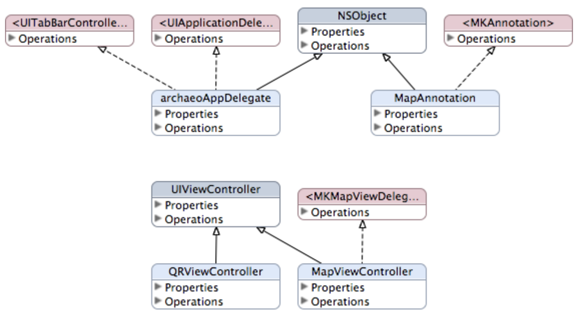

Figure 4: Class overview of the ArchaeoApp.

The following figure 5 shows the use case for tourists/experts; and figure 6 shows the use case for the scavenger hunt modus.

We fully implemented a running prototype; as our test device, we used an iPhone 4 with the current operating system iOS 4.1. The application also runs well on all models of iPhone 3GS series with the latest iOS versions.

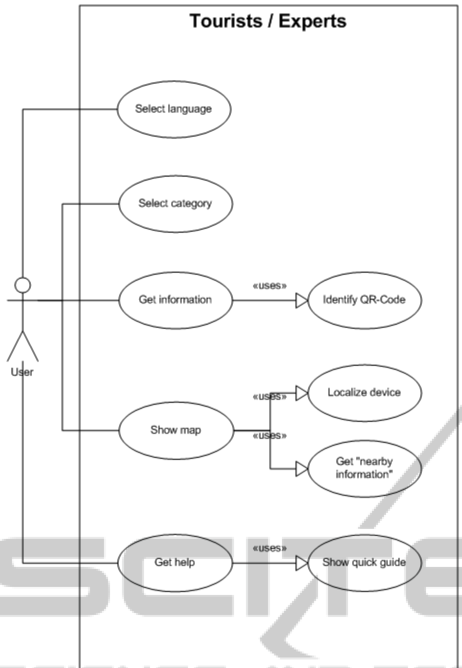

Figure 5: Typical Tourist and Expert Use Case of ArcheoApp.

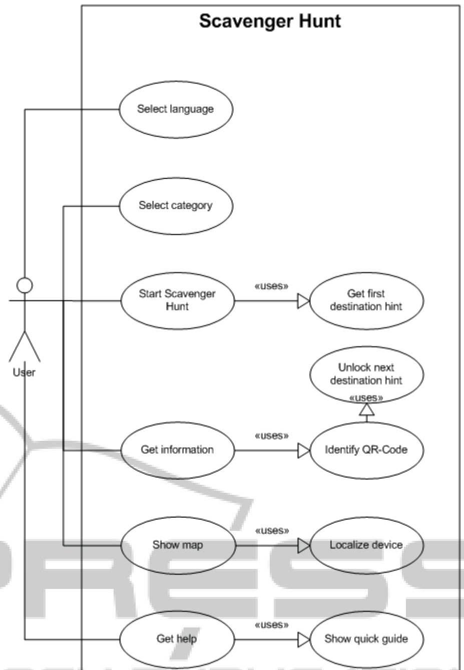

Figure 6: The Scavenger Hunt Use Case of ArcheoApp.

For the implementation of the software we made use of existing frameworks and for the recognition/processing of the QR codes we used the Open Source Encoder ObjQREncoder (Verkoeyen, 2011).

For the geo-location and map view we used the already integrated framework "CoreLocation" (Kuehn & Sieck, 2009), and "MapKit" (Mark & LaMarche, 2009).

These two frameworks are not only for the retrieval of up-to-date maps, we are also able to determine the position of the device on the map, i.e. the ArchaeoApp can also be used for navigational purposes – which is also a relevant feature in the work of archaeologists.

The archaeological information described in section 1 is displayed in a so-called "Web View".

In this view, you can easily embed web content in the application. In our case, this is done by using HTML code, which has the big advantage that the content can be edited without much programming knowledge.

5 E-EDUCATION & E-BUSINESS

Whereas the primary intention of ArcheoApp was e-Education, it can also bring some other benefits:

On a Business-to-Consumer level (B2C) there is a mass market in tourist areas on a personal level, where interested people can download ArchaeoApp for a small fee.

On a Business-to-Business level (B2B) ArcheoApp can be interesting for a mass market in large towns with a historic background (e.g. Rome). This is also interesting for smaller towns, open-air museums or archaeological finding places (e.g. Flavia Solva (formerly in the Roman province of Noricum, now Styria (Austria), or Carnuntum (formely in the Roman province of Pannonia (now Lower Austria (Austria), etc.). It is proven that customer interactions can create opportunities for positive experiences that can lead to long-term relationship building (Rose, Hair & Clark, 2011). This can be especially relevant for tourism.

Moreover, by using ArchaeoApp as an attractive customer benefit, the circle is closed by offering the big advantage of raising awareness for our cultural heritage – thus combining both aspects: e-education and e-business.

6 CONCLUSION AND FUTURE WORK

Mobile computing, along with new concepts including Web 2.0 in Archaeology is generally very promising (Holzinger et al., 2009).

ArcheoApp shows some interesting possibilities on various levels, including:

1) Enabling a group of archaeological students to accomplish efficient fieldwork – once performed individually – in teams even over distance. This enables us to make use of some promising concepts, e.g.

a) Mobile collaborative problem-solving generally has a big potential for learning (Massimi et al., 2007) and makes use of collective intelligence.

b) The game-based approach can be very powerful (c.f. with (Ebner & Holzinger, 2007)), in order to raise awareness for our cultural heritage, which is of raising importance of our society, even – or especially – amongst younger children.

2) The archaeological scavenger hunt shown in this paper is similar to a geocaching experience, which is of growing popularity (O'Hara, 2008).

To date, no work on the implementation of an archaeological scavenger hunt has been reported.

However, future work must address issues of privacy, security and data protection (Holzinger et al., 2010b) and a large scale study on the effects of using the concepts presented in this paper must follow.

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