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ARCHIE: Disclosing a Museum by a Socially-aware Mobile Guide

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Abstract

We present ARCHIE, a research project which aims to discover how handheld guides can be used as powerful instruments to enhance the visitor's learning experience. Although mobile devices are becoming a common aid to support a museum visit, they often lead to an individualized experience. However, most people do not visit a museum alone, and recent research has pointed out that social interaction is a prerequisite for an intensified and improved learning process. To accommodate the shortcomings in many of the current solutions, we are designing a platform that enables us to create a socially-aware handheld guide that stimulates interaction between group members. They can communicate with each other either directly (by voice) or indirectly (by collaborative games) by means of their mobile guides.

Besides the aforementioned communication possibilities, handheld guides can also provide a way to present personalized content. By using a personal profile, it is possible to adapt the interface and tailor the information to the needs and interests of every visitor.

The combination of personalized content and interfaces, communication channels between visitors in the same group and support for localization might lead to an innovative mobile guide that integrates with the museum as well as with other visitors. Our platform enables social, and, in many cases, playful interactions with other visitors in the same group. At the same time the context-awareness (proximity and personalization) increases the involvement of the visitor with the content presented in the museum.

1. Introduction

In this paper we describe ARCHIE, an interdisciplinary research project of the Expertise Centre for Digital Media (Hasselt University) and the Gallo-Roman Museum (Province of Limburg). This museum is located in Tongeren, Belgium's oldest city, and tells the story of the region from prehistory up to and including the Merovingian period. The museum's visitor approach focusing on temporary exhibitions, exploring fascinating themes and a professionally-run educational programme has proved very successful. Annual visitor numbers rocketed from 20.000 to 150.000 in just ten years. The restrictions of the existing museum building and new trends in museum presentation explain the extensive expansion project of the museum. The new museum is due to open its doors in 2008.

As part of this expansion, the Gallo-Roman museum has rephrased its mission and aims. The main objective became to create an optimal learning experience for different visitor groups. The museum wants to provide information in the future exhibition in such a way, that any person can make his visit a personally meaningful one. Furthermore, the museum wants to develop a tool to encourage and steer social learning. Families are a good example of a group where so-

cial learning takes place: a mix of different age groups with different interests can share their interests and opinions.

The current trend to introduce PDA-based mobile guides to enrich the visiting experience of a museum [PT03, Fis05, Exp05], has led us to investigate how such guides can support the social processes that are fundamental for learning in a museum. The challenge in the ARCHIE project is the combination of a personalized mobile guide that is still part of a group of cooperating guides. While information can be tailored to the needs and interests of individuals in a group, there has to be a way for these individuals to interact with each other and exchange knowledge and interpretations during the visit.

The development of our ARCHIE Mobile Guide System is done by an interdisciplinary team. The team consists out of people with different backgrounds: historians, educationalists, computer scientists and graphic designers. The content of what is presented on the mobile guide is defined with great care and in close collaboration with the museum team.

In this paper we give an overview of the Mobile Guide System that supports the key missions of the museum such as social learning and personalization. Section 2 delves deeper into the context in which we developed the mobile guide: section 2.1 identifies the expectations of the (potential) museum visitors, section 2.2 shows the importance of social interaction and section 2.3 concludes with our objectives. The objectives are translated into a concrete mobile guide in section 3, where we focus on group communication (section 3.1), personalization (section 3.2) and location-awareness (section 3.3). We conclude the paper with a framework overview in section 4 that shows how the different parts are integrated in one complete system and make some conclusions.

2. Defining the context

2.1. Know your visitors

In order to accomplish the realization of the new objective, the Gallo-Roman Museum needed to get better acquainted with its public. For this reason the museum conducted an extensive investigation among visitors and potential visitors, to find out what prompted them to visit the museum, what their interests are, and in which way they would want to learn about the museum collection [PGR05].

Concerning visit expectations, 61% of the (potential) visitors indicate they want to learn something, look at/admire objects (53%) and experience something, relax (33%). Questions about visit behaviour reveal they also prefer a social museum visit: 56 % wants to talk to family or friends about what there is to see. These results correlate with recent studies about visit motivations; Falk and Dierking argue in their leading reference work *Learning from museums* [FD00] that "dozens of studies document that the primary reason most people attend museums, whether for themselves or for their children, is in order to learn". The second most cited motivation is entertainment: most visitors mention they go to museums in their free time to have fun and/or to see new interesting things in a relaxing and aesthetically pleasing environment. Museum-going is also commonly viewed as a social event. Visiting a museum is widely perceived as a 'day out' for the whole family, a special social experience, a chance for family members or friends to enjoy themselves separately and together.

2.2. The importance of social interaction

Starting from a social-constructivist approach, Falk and Dierking came to emphasize the role of the social group in the way visitors construct meaning in their contextual model of learning. In this model, three overlapping contexts contribute to and influence the consequent learning and meaning-making: the personal context (visitor profile and learning style), the physical context (museum environment) and the socio-cultural context (social interaction).

Following this model, social interaction does not only promote, but is a prerequisite for intellectual, social, personal and cultural development [Mor02]. Recent studies with children also recognize the important role of social interaction: "the potential of the learning environment and its objects largely depends on the social atmosphere generated and the support young children receive through positive, reciprocal interactions. [...] The successful learning setting functions as a community of learners, where all individuals are respected, their learning is supported, and opportunities for collaboration are provided." [PW02] However, the social aspect of a museum visit is often neglected, especially when using new media. Audio-tours for example generate the unintended side effect that it is a quite individual, isolated experience: it can put individual visitors in a bubble, making it difficult for them to keep track of companions or family members, let alone chat about what they have seen [Ang06]. In spite of the many opportunities and benefits a PDA-tour can offer, recent research on the visitors' use of the first PDA-tours in museums does share the same conclusion [VH05]: "the PDA makes it difficult for visitors to talk and engage in discussion." Main reason is that the hardware and content of the current solutions are designed and structured for retrieval by one person rather than by multiple persons.

2.3. Objectives

One of the main objectives of the project is to deal with the (possible) negative side effects and therefore to encourage and stimulate interaction between visitors and the museum by use of the PDA. This can be done by providing opportunities to communicate with each other directly (using Voice-over-IP) and indirectly (by collaborative games) (see 3.1).

The inquiry of the museum also reveals that visitors have different preferences concerning the way they want to learn in a museum. Some visitors have a strong need for hands-on and minds-on activities and want to 'experience' the museum (38%), while other prefer a rather reflective discovery and space for abstract conceptualization (27%). There are also differences in visit behaviour, preferred profundity and nature of information, favourite type of media, object display and interior design. Not to mention different levels of knowledge, ages, types of groups, and personal interests. While traditional mobile museum guides often offer a uniform tour and presentation, the ARCHIE project wants to discover the opportunities and benefits of a personalized approach while exploiting the social relationships between the visitors.

3. The ARCHIE Mobile Guide System

The ARCHIE Mobile Guide System provides a basis to develop customized mobile guides, that can differ in presentation (visualization), structure, behaviour and style but still communicate the same content to the visitors. This is accomplished by a unified framework that can load an arbitrary *interface shell*. Independent of the interface shell, the framework also offers other components such as a person-to-person communication component and localization component, two services that enable a more immersive visitor experience when using a PDA to visit a museum.

3.1. Group-Based Communication

Our Mobile Guide System provides different types of communication through the mobile device. A server application keeps track of the different groups of visitors. During the visit, the system allows visitors to communicate with other visitors in the same group in two different ways:

- a *direct communication* style that is voice-based and uses Voice-over-IP (VOIP). This allows a visitor to address the other members of the same group directly and to talk with each other regardless their locations. An audio forwarder on the server handles the communication traffic. First user tests pointed out that there is a little noise on the communication channel when nobody is talking; such noise should be filtered out. A short delay on the messages is not experienced as annoying.
- an *indirect communication* style that allows people to exchange other types of data related with the interface shell. This style of communication does not require the visitor to address the other visitors of the same group directly, rather it is used by collaborative games to share game (shell) related data. The synchronization between different clients involved in a collaborative game depends on the game and should be taken care of by the shell developer.

Because the wireless network is deployed in the complete museum, visitors can communicate with each other no matter their location in the museum. The combination of both types of communication opens up several possibilities to implement collaborative applications such as games that need to be played in group (e.g. by families, schools, ...).

3.2. Personalization and visualization

In section 2 we mentioned the importance of a personalized approach to enhance the visitor's museum experience. The most visible part of the personalization component embedded in our Mobile Guide System are the different interface shells that can be loaded. Figure 1 shows two possible interface shells: 1(a) shows the interface shell that is more suitable for kids and 1(b) is an interface shell that is typically used for adult visitors. The multimedia tour for kids is an animation movie with their buddy Orf who guides them through the virtual world of the Neanderthal man. By clicking on the animated skull, an edugame can be started. Adults receive a more formal presentation using realistic images and accompanying short texts. By clicking on the picture more information can be retrieved. These two different presentations (or visualizations) of the same content, explaining the Neanderthal skeleton, are deployed on top of the same Mobile Guide System. Since an interface shell is used to support a rather large group of users, further personalization is required to increase the personal involvement and interaction with the museum.

In order to create a more personalized museum visit, a user profile has to be composed. This can be done in advance or dynamically during the museum visit. Entering a user profile may not require much effort and time from the visitor and therefore should be limited. When no profile is entered, a default profile is provided. At each moment, the user profile can be (manually) changed by the user. Notice the creation of a user profile does not necessary exclude any information for the visitor, it can also be used to highlight information or change the presentation of the information according to the user interests and preferences. If identical information is available in different media types, one can prefer e.g. an animation to a documentary movie.

Based on the user's interactions with the device, the profile can be automatically adapted. Similar adaptations are also investigated in the PEACH project [KBGB*05]. The way the visitor uses the digital content gives us a clue about his preferences: stopping an explanation prematurely may indicate a lack of interest, whereas asking for more, or bookmarking it, suggests a genuine interest. We use a weighted algorithm to adapt the user profile: the user profile will evolve slowly and does not change constantly, in order to avoid confusion. According to the action the user takes, the weights assigned to the different parts of the user profile will be changed. The following non-exhaustive list shows actions that can change the weights, they are listed in order of importance (actions at the top will have a greater influence than the actions at the bottom):

(a) (b)

Figure 1: *Interface shells for children and adults.*

- Explicit questions about appreciation of what is currently on screen;
- Bookmarking a current screen for later retrieval;
- Information retrieval actions (the user shows more interests in items he clicks on for more information);
- Time spent at a certain position (the user might want to learn more about the displayed objects at that position).

Notice the time spent at a certain location can have very different reasons, so only when a certain threshold is reached will this action be taken into account (e.g. a minimum amount of time spent at a location while the user is actively retrieving more information about an artefact in the vicinity). We are currently experimenting with this kind of automatic adaptation of user profiles in order to avoid forcing the visitor to go through a extensive questionnaire before starting a visit. Preliminary tests have shown that this approach is feasible.

3.3. Localization

Part of making the environment more immersive is done by adding an indoor localization system. In most traditional settings, an electronic mobile guide requires the user to manually input the location by entering a number or scanning a tag. Other rudimentary localization systems use IR-based localization techniques (e.g. Portable Cicero [CP03]). A more advanced technology makes use of object recognition based on an artefact's photograph taken by the visitor [BBZB05]. Current networking technologies allow us to use the wireless network to give an estimate of the location of the user or the proximity of the user to an artefact [BCLN05]. We use this as an interaction modality: the user can interact with the system by just moving around and changing her/his location. Additional reasons why we currently use a WiFi-based localization technique are: the infrastructure will be available in the museum, it provides a cheap way to support localization and it offers us the required granularity.

Although there are several commercial solutions for indoor location detection available, we started with creating a customized location detection system based on the signal strengths of the various wireless access points in the vicinity of the user. Implementing a usable WiFi-based localization system turned out to be a challenging task: there are still several ongoing research projects that try to accomplish this [HFL*04, YA05, CCC*06]. The first drawback of using WiFi signals is that they tend to be quite erratic. Simply calculating the distance to the access point based upon the strength of its received signals will give back anomalous results. Consequently, trilateration of those results will not produce any accurate locations. We introduced a learning phase where we collect fingerprints (a set of signal strengths per access point per location) in the areas we need the localization algorithm to be more reliable. From this data we can derive the probable signal strength on a whole set of locations. Afterwards we can use the set of measured signal strengths per access point and search for the closest match

with the recorded signal strength of each access point to determine the location. In order to cut down on the processing cost, only the best signals are used, since they tend to be the most reliable. With this approach we find the location with the highest probability.

While this approach gives good results in estimating the location of the visitor in a static environment, in museum settings with clusters of moving visitors the precision in locating visitors decreases. Though this may seem to result in a system that is less usable, in an exploratory environment such as a museum this could lead to a more enjoyable user experience. Careful design of the application and its user interface can turn the lack of granularity into an asset that motivates the visitor to explore its environment, looking around for information. Observations and interviews with children who were exploring a museum by means of a PDA even indicated that they really liked to search for an artefact.

4. Framework Overview

The different core components presented in section 3 are integrated in one framework. The shell developer can make use of this framework to create a new shell that uses personalization, localization and communication. Figure 2 gives an overview of the framework and shows the core services that are available through the framework interface. The core services are in fact proxies that communicate with a central server that keeps a database with visitor profiles, visitor groups, artefact locations etc. This is completely transparent for the shell developer.

Figure 2 shows the framework interface is structured as an event bus: a user interface shell can subscribe to events originating from one of the services, and process these events according to the shell. The event bus can also include direct user interaction events (e.g. tapping on the screen), so both direct and indirect interaction with the interface shell can be easily supported. This approach results in a flexible mobile guide system rather than one particular mobile guide: various shells that behave differently can be deployed on top of this framework. By using the communication service a shell will be able to engage in a collaborative game.

One example that we developed using the localization service are the 'artefact notification messages'. These type of messages will notify the visitor when she/he approaches a particular artefact. This is accomplished as follows: the shell developer registers for events from the localization service and events from the personalization service. The personalization service can be queried for artefacts that are of high interest to the visitor according to its profile. The proximity of the visitor with regard to these artefacts is available through the localization service. An interface shell can use this data to emphasize information in the user interface. Figure 1(a) shows the skull in the presentation is highlighted: this is caused by the visitor approaching a skull object in the museum. If the shell also uses the communication service, it is possible to start a conversation with another visitor, all triggered by the event of the visitor approaching an artefact.

We are currently developing this framework and defining its interface. Only the three core services presented in this paper are currently used by the shells we developed, but one can imagine other core services being included. Their functionality is still subject to changes and evolves according to the requirements of the interface shells we are building on top of the framework. However, the architecture of the framework is created to be extensible and allows us to include other core services without changing the architecture. Also creating new interface shells does not require a new software structure since there is no hard binding between the interface shells and the core services because of the event bus interface.

5. Conclusions

Starting from the new objective of the museum *to create an optimal learning experience for different visitor groups*, and the project objective *to discover the opportunities and benefits of a personalized approach while exploiting the social relationships of the visitors*, we created a framework to build customized mobile guides that meet these desires. In contrast to many existing systems that work similar to a portable information kiosk, the ARCHIE Mobile Guide System stimulates interaction among visitors while offering a personalized interface and enhancing the immersive feeling of the visitor in the museum environment. Three core services were developed and integrated into one unified system to accommodate this: a group communication facility, automatic personalization and localization detection. An event based framework integrates these core services, so different interface shells may use these services and can co-exist. Collaborative applications can be built using these services and the framework.

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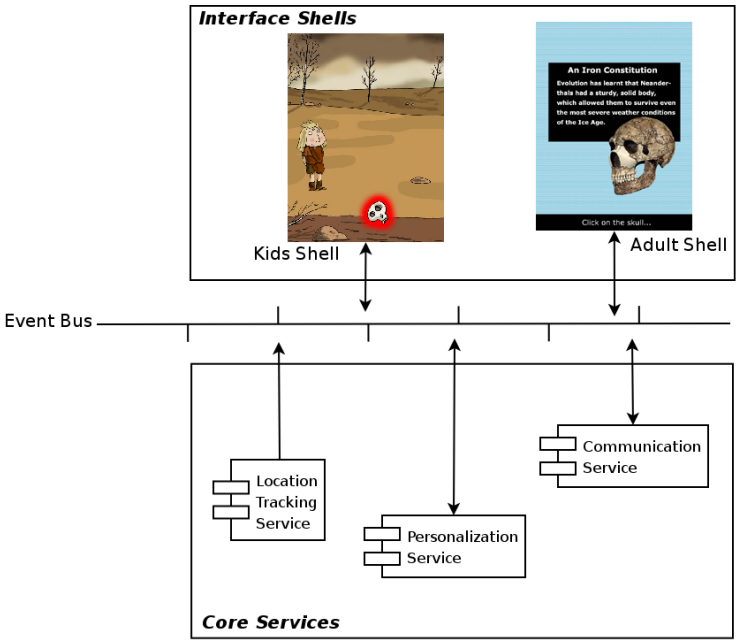

Figure 2: *Framework overview*

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