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Augmented reality smartphone environment orientation application: a case study of the Fu-Jen University mobile campus touring system

Te-Lien Chou [a] *, Lih-Juan ChanLin [b]

[a] *Graduate student, Department of Library and Information Science, Fu-Jen Catholic University, 510 Zhongzheng Rd., Xinzhuang Dist., New Taipei City,24205, Taiwan (R.O.C)*
[b] *Professor, Department of Library and Information Science, Fu-Jen Catholic University, 510 Zhongzheng Rd., Xinzhuang Dist., New Taipei City,24205, Taiwan (R.O.C)*

Abstract

Traditionally, environment orientations are given via signposts, tour guides, or through the web. However, these methods cannot construct a personal context-aware learning environment. With the advancement of augmented reality (AR) and smart phone devices containing a built-in camera, Internet connection, GPS technology and a compass device, mobile learning, or ubiquitous context-aware learning, becomes easy and boundary-free. AR technology creates a user-centered, visualized operation, and a real-time-feedback learning environment. For campus touring purposes, AR enhances users learning interest, and therefore reinforces learning. To explore how AR mobile learning can help visitors become familiar with an environment, a smart phone AR implementation tool, Layar, was used. A prototype campus touring system for Fu-Jen Catholic University was developed and reviewed by two focus groups (freshmen). Interview data were collected. The thoughts and reactions from these two focus groups were summarized. Findings of the research reveal that the smart phone AR campus touring system provides hidden information in a real environment, giving freshmen instant assistance if they have gotten lost, and is a good personal mobile learning tool. However, to make the smart phone AR touring more effective, suggestions are provided for further implementation.

Keywords: Campus touring system, Augmented reality, Context-aware learning, Mobile learning;

1. Introduction

As mobile technology becomes an essential in daily life, learners are no longer constrained by time and location. They can access and share information anytime and anywhere. With the advancement of smart phones embedded with GPS technology, compass devices, and cameras, visitors can quickly find their orientation and directions in a real life environment. When working with mobile applications, a user must consider some requirements: computation platform, display, tracking sensor to obtain information, and wearable input and interaction technologies. Currently, these requirements make the creation of a mobile augmented reality system a challenging task. (Höllerer & Feiner, 2004; Jaramillo et al, 2010).

* Te-Lien Chou. Tel.: +886-9-8999-3547
E-mail address: chou81@gmail.com

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Many universities are providing smart phone campus touring systems, and in this way allowing potential students, alumni, or visitors to familiarize themselves with the campus via self-guided devices. For self-learning and information-access purposes, mobile learning is less dependent on the location, and is more contextual, and pedagogically oriented to the constructivist and situated approaches (Boticki, Hoic-Bozic & Budiscak, 2009). By means of AR, the user can access hidden textual or graphical information, to see a picture of, for example, an partially hidden building or to obtain additional information about it. AR appears as a mixed reality environment, with one part being real and the other being virtual, with the real environment predominating. The specific characteristics of an augmented environment have provided this mode of visualization with various possibilities for human-computer interaction and for solving visualization and information access problems (Jaramillo et al, 2010). In this paper, a mobile campus touring system employing AR technology was developed at Fu-Jen Catholic University. Each year, about 5,500 freshmen enroll in this university. Most have to spend weeks to become familiar with this unknown environment. As strangers, a personal and portable location-based service can help them become familiar with their new environment and lead them to interesting sites.

2. Mobile campus tour

An effective and user centered touring system not only provides environment information to users, but also allow users to quickly utilize useful resources and enhance environment awareness (Educause, 2005). Traditionally, environment orientations are given via signposts, tour guides, or through the web. For individual touring purposes, construction of a personal context-awareness of the environment is necessary. In providing environment information, sites or buildings might contain history or context that requires a detailed description. Making the descriptive content available to individuals provides a richer experience in interacting with those places or buildings (Educause, 2005). This is especially true for new students who are still unfamiliar with current routines and practices in a university. They may also have trouble finding their way around campus. Under such circumstances, it is vital to have instant and personal information available (Asif & Krogstie, 2010). The use of AR is an innovative alternative for bringing experiential and location based learning to students.

3. Augmented Reality

Augmented Reality is a variation of Virtual Reality. VR technology completely immerses users within a synthetic environment where users cannot see the real world around him, whereas AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. AR supplements reality, rather than completely replacing it. (Azuma, 1997). Augmented reality was created in the early 1990s by Boeing researchers Caudell and Mizell (1992) who made a head-mounted video display designed to aid workers who were assembling electrical systems. AR extends the real world with a layer of virtual information. It is particularly well suited as a user interface for context-aware applications (Hollerer, et al, 1999).

AR provides a better solution for personal awareness of surrounding context, which might not be satisfied by traditional approaches such as radios, maps, and handheld displays. For providing more powerful display paradigms for interaction with contextual information embedded in the environment, Billinghurst, Kato, and Poupyrev (2001) from Washington University created Magic Book, which overlaid 3D virtual imagery onto real books. Shelton & Hedley (2002) used AR to teach undergraduate geography students earth-sun relationships to accommodate spatially related knowledge. Kauffman (2003) from Vienny University created Constrct3D, a spatial and geometry construction education tool for high school students. Li (2010) from New Mexico University's ARIS used Augmented Reality and Interactive Storytelling to let users to solve a fictional murder mystery in a physical environment. Augmented Reality has the capability to significantly change the way in which information can be delivered to individuals.

4. Related works

AR technology has been applied in various mobile devices as a self-guided tour. For example, at Columbia University, the mobile AR campus navigation system was started in 1996. The project, MARS (Mobile Augmented Reality Systems), allowed the user to walk around freely while having all necessary equipment mounted on his back (Columbia CGUI Lab, 1999). In 2010, Columbia University started the smart phone campus tour system, where visitors can simply use their own iPhones, iPhone touch, and Android phones to experience campus history (Columbia University, 2010). In UK, the University of Exeter created an AR dynamic landscape of flora and fauna. Using Augmented Reality, the campus was transformed into an accessible learning resource to support the formal and informal curriculum (University of Exeter, 2010). In Taiwan, National Taiwan University implemented an iPhone AR campus touring system (National Taiwan University, 2010). Users might use the personal mobile orientation alternative to discover the history of the campus.

In addition to commercial and customized smart phone campus touring systems, Freeware is available for creating AR experiences, including Layar (www.layar.com), Mixare (http://code.google.com/p/mixare/), Wikitude (http://www.wikitude.com/), and Junino (http://www.junaio.com/). Founded in 2009, Layar is widely used and supports iOS, Android, and Symbian platforms. Many universities adopt Layar to build their campus touring systems, including Purdue University (2009), University of Wisconsin - Madison division (n.d), West Virginia University (2010), Arizona State University (n.d), Georgia Tech Atlanta (2009), etc. In this study, Layar was used to develop the Fu-Jen University mobile campus touring system. The following is the design procedure and structure.

5. System Overview

The development of the mobile campus touring system applied the freeware tool Layar. In addition, Hoppala was used for the remote data server. Google Sketchup was used for the 3D icon creations, and photoshop was used for 2D photo modifications. Digital camera, recording devices, and a personal computer with Internet access were also tools for system implementation. Prior to building application, touring content was analyzed and planned. The procedure of implementing this system began by taking photos of the buildings and places in the campus, creating 3D icons representing the function of these building and places, and recording narratives for audio navigation (Figure 1). Then, these data were input into Hoppala by pinpointing each point of interest. The Hoppala overlay URL was inserted into the Layar API endpoint. Several 3D photos were used as touring system icons along with a brief introduction.

Fig. 1 FJU Mobile campus touring system design procedure

The structure of the Fu-Jen University mobile campus touring system follows the Layar's architecture. When starting the system, a user can set the search range between 0-5 meters, and select the types of buildings or places he or she wishes to visit, such as a certain library, a building, a restaurant, plays ground, or a dorm. A designated 3D

icon appears on the screen to indicate buildings or places in front of him or her. After identifying the destination, the user can see a textual introduction, listen to the audio touring narrative, or get directions (see Figure 2).

Based on the system structure, the system operation procedure of the mobile touring system is illustrated in figure 3, and a scenario is described as follows: A user heads to the main library with his smart phone. Starting from the main entrance, he sees through the campus via the built-in camera of the smart phone, in front of which shows him the library building was built in 1998 according to the textual intro. He selects the recording button to listen to the history of the building. He finally selects direction guidance to walk him to the final destination.

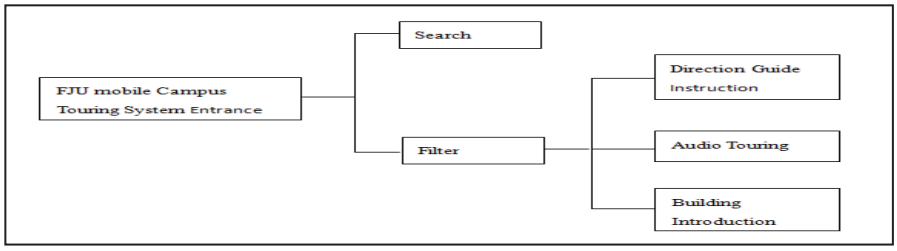

Fig. 2 FJU Mobile campus touring system structure

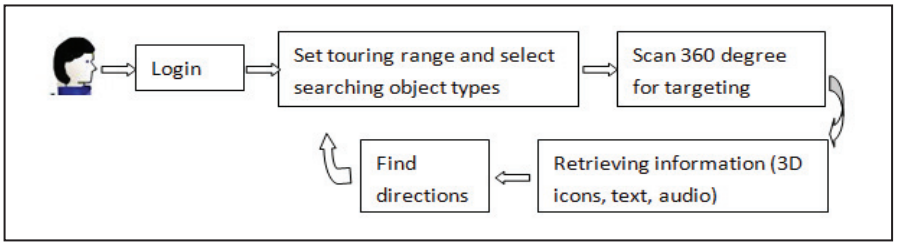

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Fig. 3 User instruction

6. User feedback

The prototype of the Fu-Jen mobile touring system was designed and developed in 2010. To provide formative information, pilot testing was conducted among the small groups of students. Subjects volunteering for pilot testing were college freshmen at Fu-Jen Catholic University. They were encouraged to reflect on their experiences in using the system. Interviews were used to obtain thoughts and reactions from the two focus groups. User feedback was summarized as followed.

6.1. Positive feedback:

6.1.1. Smart phones give a personal navigation experience

Participants recalled their experience with the first campus orientation was performed quickly. They had no prior directions about where to go, however, with the smart phone touring system, they could check out information anytime and anywhere.

> "I remember it was after the welcome party, the seniors took us for a walk around the campus, but it ended quickly. They expected we would explore the campus ourselves sooner or later."

> "There was one time we got lost in Taipei city. By using the GPS system from the iPhone, we were able to find our way shortly after. Therefore, I consider the GPS system (mobile campus touring system with GPS technology) useful when we are lost in the campus."

6.1.2. AR information presentation provides context-awareness learning

With 3D icons appearing on top of the physical environment, all participants were able to instantly obtain contextual information about specific buildings or places. Textual introduction also give them quick information about their destination, for example, they can stay 5 meters away and see the opening hour of the libraries without walking into the library to ask.

> "For example, if I want to know the opening hours of the library when I am busy, I don't have to walk all the way to the library, or try to find the phone number and make a phone call, or even use a computer to go to the library's website. I can simply take out my smart phone, point to the library from a distance, and the opening hours are displayed on my screen."

6.1.3. Instant directions give users convenient assistance

With an 86-acre campus, newcomers quite easily get lost amid all the buildings. With instant direction guide, a freshman does not have to worry about spending too much time on finding the location for the next class. Students also responded to the need of AR applications for daily activities from their new environments.

> "It was about the 1st or 2nd week when I first came to the school, and I was still unfamiliar with this environment. I got lost in the campus twice. One time was in the day, and the other was at night. I was so frightened at that moment"
> "If you simply look at the building, you would never know when it was built, and what it is for. With AR information, you will see its attributes. For example, you will know what is served in this restaurant. The augmented information brings added convenience to my school life."

6.2. Suggestions:

6.2.1. Social networking connection

Social media brings people closer. Many participants suggested the mobile campus touring should incorporate social networking tools like FaceBook or Plurk, so visitors could share their ideas with others while exploring the campus.

> "It took me a couple weeks to get familiar with the campus, by then I might not need this mobile touring system anymore. However, if I could add text onto it, or check out others' messages, I would definitely continue to use this system."

6.2.2. Hot spot coverage

Hot spot coverage is an important issue when using the mobile campus touring system in Fu-Jen Catholic University. Since the 3G-signal service charge is still considered high for many individual students, free WIFI signal services provided by the school is the primary source of going online. Unsuccessful transmission or broken signals might decrease the mobility and accuracy of the mobile touring system.

"I once used the WIFI services on the campus of National Taiwan University, and its WIFI signals were very strong, pretty much covering all the campus. However, it is another story at our campus."

7. Conclusion

In this study, using AR technology with smart phone capability, a prototype mobile campus touring system was developed and evaluated. It was intended to allow all visitors to familiarize themselves with Fu-Jen campus using a self-guided device. Based on the pilot testing, all users provided positive feedback about the mobile touring experience, and they would like to use it and would recommend others to use it in the future. Currently, some fine-tuning is still being carried out.

Based on users' suggestions, integration of the social network function into the mobile touring system is also needed. Although the social function of the mobile touring system was not planned as intended for direction and orientation, it might be a new design trend to reflect the need of users' social networks. Therefore, adding FaceBook functionality will be included as a new feature in the Fu-Jen mobile touring system.

In conclusion, AR technology surely shines a new light on user-centered, visualized operations, and the real-time-feedback learning environment. It has the capability to significantly change the way in which information can be delivered to individual in daily activities. As smart phone users rapidly increase, and with open source tools commonly available, the AR mobile technology will undoubtedly be widely adopted in every aspect of the living environment. It is hoped the findings of this study might provide a reference for future development of AR mobile touring systems.

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