Requirement Analysis and Implementation of Palm-Based Multimedia Museum Guide Systems

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Abstract

A multimedia museum guide system is developed and presented in the paper. In contrast with conventional cassette audio tape exhibition tours, the presented museum guide system is implemented on Palm-based Personal Digital Assistants (PDAs), so as to provide a multimedia touring experience for visitors. Moreover, the museum guide system is capable of being aware of the current position of the visitor, and then automatically retrieves the related multimedia information of the exhibit that the visitor is gazing at. As the visitor walks up to another exhibit, without any clicks or operations, the screen on the PDA will be changed to the related multimedia information of that exhibit automatically. Basically, the developed museum guide system plays the role of a personal guide assistant, so as to construct the mobile learning environment in museums.

1. Introduction

As the power of storage, computation, and display technologies grow, handheld devices became more functional and suitable to play the role of mobile platforms for multimedia applications. E-learning, sometimes referred as e-education, is motivated by the assumption that information technology would be a tool in teaching and learning [1]. Educational activities were no longer limited to the traditional classroom. Now with the fast spreading carrier, the Internet, information was submitted, received and reacted virtually instantaneous. Its popularity also keeps us in touching with people all around the world. E-learning is material limited-less, it targets its subscriber to the whole society, and the learning could happen at every place [2].

E-learning is like a blossoming tree, stretching its branches and leaves to the very space. A research center named Learning Technology [3] in the National Central University, which is sponsored by the Minister of Education, has investigated projects on this issue. The Future Classrooms is the most high-tech related project. Ideas such as wireless networks, broadband networks, and m-learning are conducted here to form a learning environment in the future. With the use of ad-hoc networks and handheld devices and the efforts on analyzing teaching activities, we hope we can form a new learning schema and then improve learning efficiency. On one hand we would like to make the learning anywhere and anytime, and on the other hand we do not want to see the freedom of moving isolates people from each others. A studying group connected by the wireless network would be good in both quality and quantity on what they are study at.

2. Motivation and the Existing Services

People in modern life are quite good at enjoying their leisure time. Knowledge-based trips, such as visiting to museums, galleries and exhibitions, are getting more popular. People could simultaneously enjoy their holidays and learn new ideas that would not be noticed in the daily life. Walking in a gallery, a simple painting may tell you a history about Vikings. Playing in a science world, an operation on a bulb may give you the idea of how powerful the sun is. In such an occasion, a normal visitor without further help is no way to see exhibits more then what are said on the introduction tags. Therefore, a guiding system is used to fulfill these requirements.

* This research was supported by Excellence Project, Ministry of Education of the Republic of China under grant A-92-H-FA07-1-4.

Table 1. Comparisons between different museum guide systems

	Expositors	Tape Machines	CD Players	PDA
Setup time at the beginning	Long	Short	Short	Short
Costs spent to adapt whenever the display changes	High	Medium	Medium	Low
Long-term expense	High	Low	Low	Low
Content integrity	High	Low	Low	High
Freedom of moving	Low	Low	Low	High
The way to explain	Voice and body language	Sound	Sound	Texts, graphics, sound, and video clips
Available to blind	Yes	Yes	Yes	Yes
Available to deaf	No good	No	No	Yes
Multilingual	No good	Yes	Yes	Yes

As we can see in most of museums, three guide systems are provided at present. One is the legacy tour guide, the other is the tape machine, and another is the CD player. First, we may focus on how are these solutions doing.

All of solutions above bring out different troubles because of their natural defects. The legacy tour guide is like all those jobs done by manpower, suffering from the high expense on trainings and wages. The use of tape machines and CD players seems to be cheaper, but they are both bound by the storage capacity. People who have used it would also notice that they are too big and too heavy to carry around. Not to mention that these players lack of the ability of interaction. Therefore, this inconvenience gives the motivation to develop a museum guides system based on the modern wireless technologies and hand-held devices such as Personal Digital Assistant (PDA). We compared all those three tour guide systems and the fresh personal technology, PDA, looking for chances to overcome the old-fashion side effects. The result is favorable to the PDA, which we shall summarize in Table 1.

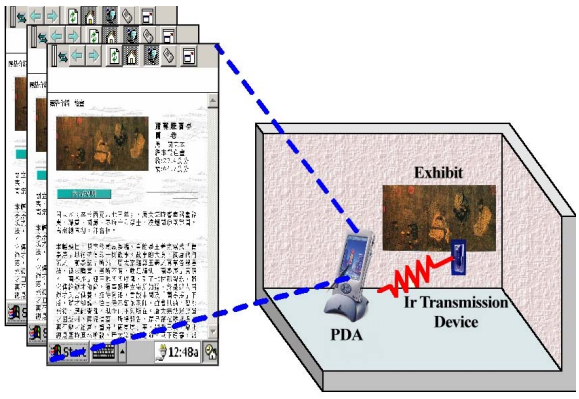

Figure 1. The concept of the museum tour guide systems

3. Requirement analysis

As proposed, the museum guide systems is an active exhibit information teller. As shown in Figure 1, once a visitor approaches the exhibit, his PDA will display the expositive information of the exhibit automatically, according to the received infrared signal from the exhibit. That is, the visitor is able to learn deeply or just browse the expositive information by himself, based on his knowledge on the exhibit. Knowledge is passed to visitors through the interaction with the museum environment, and the problem on limited tape capacity no longer exists. Besides, the visitor can roam and look around in the museum at his pleasure, and does not need to stay close to the expositor.

A typical introduction on the screen would include some texts or graphics. But with the power of modern PDAs, fancy stuff like video clips and music playbacks are used to give users more visual impacts and the fun of learning. Multimedia based context display itself is a revolution on tour guide. Nevertheless the vision of museum guide is beyond this innovation. It takes advantage of the multi-function ability on each PDA, making it more than a digital context displayer. Combining with positioning technology and well-designed touring trip, it not only shows where you are, but also be a pilot leading you walking on different interesting roads.

As visitors walking around the museum, the PDA they

Table 2. Comparisons on different positioning technologies

	Infrared	IEEE 802.11 series	GPS	Bluetooth
Best apply to	Pico area	Micro area	Wide area	Micro area
Positioning accuracy	High	Low	Low	Low
Directional Signaling	Yes	No	Yes	No
Indoor signal error rate	Low	Medium	High	Low
Power consuming in user-end	Low	High	High	High
Cost to make every exhibit locate-able	Low	High	Low	High
Background knowledge required to maintain	Little	Much	Little	Much
Practical utilization	High	Low	Low	Low

carry with will receive the signals emitted from the Ir Transmission Devices at every exhibit. By reading the signal, the guide program on the PDA will refresh the display page to the exhibit in front of you. Since now we have the positioning mechanism, visitors may enjoy their tour freely. They do not have to follow the pace and the route of an expositor, nor do they need to worry about how little information they can only gain if they are visiting on their own. No matter where the visitors are, the museum guide systems can locate their positions correctly, and show them data about the one they are watching. All these process are certainly automatic done without any manual operation.

All the PDA we can see in stores are equipped with an infrared port, so PDAs would run this mechanism without additional equipment. Whenever the core program is noticed receiving an identification signal from the infrared port, it would either search the exhibit database or fetch data about the exhibit through a wireless local area network (WLAN).

3.1 Positioning technique

The automatic exhibit information display is the key to be the museum guide system. The best part of the museum guide systems is that it tells you automatically at which exhibit you are. This means the PDA need to know where it is. To reach this effect, the system must involve an accurate positioning mechanism. Basically this job should be done by a wireless signal whether the signal tells you the coordinates of your position or just the name of that exhibit. Hence we surveyed several wireless signaling techniques including infrared transmission, IEEE 802.11 series [4][5][6], the Global Position System (GPS) [7], and Bluetooth [8]. The comparison is done based on our needs, which are shown in table 2.

The first requirement should be the accuracy. In most museums, there are always some exhibits put close to each other. Using the IEEE 802.11 series and Bluetooth technology to position have a great risk on long error distance. In our early days experiments shown that wide signaling emitting range of these two techniques make the display page keep jumping between two adjacent exhibits. GPS is a widely employed technique to locate one's position on the globe. But it has a great error probability up to 100 meters horizontal and 156 meters vertical. In the accuracy issue, the infrared transmission technique shows its virtues. The advantages of infrared are not only the short error probability but also the controllable emitting direction.

Considering about the power consuming on PDA, all of the four techniques except the infrared transmission require add-on equipment to receive signals. External equipment consumes additional power. Besides, the infrared receiving port is a passive element to PDAs which is also good to power saving.

In our design plane, the background knowledge of a manager needs to learn should be cut down to minimum. While using the infrared transmission technique to position the manager only has to mark each exhibits with a unique identifier. But the IEEE 802.11 series and Bluetooth are not so simple because the idea to make these two techniques be able to position is to put access points (AP) at every exhibit and let the PDA recognize from which AP the signal is coming. This not only brings up the high cost on planting APs to every exhibit but makes the job tough because managers have to find out the unique number embedded in every AP first.

To summarize all, the infrared transmission technology is good to fit in our design comes to several important

specialties it has. First, the error probability is short and the emitting direction is controllable. Second, the cost to make every exhibit be locatable is low. Finally, it is quite simple to maintain.

3.2 Subjective tours

Being a whole new touring guide fashion, the last thing we would like to do is to throw the advantages of old fashion away. Therefore, the museum guide system is designed with subjective tours. Exhibits are with various properties. Authorities are used to put exhibits in the same hall because they have one common property such as their age, style, or even size. But an author may have productions with several styles, which means those works will be put in different exhibition halls. This would be troublesome if one would like to have "a glance over Leonard da Vinci" instead of "paintings in the Renaissance century."

A subjective tour collects exhibits with the same properties all over the museum, making them an identical trip by a well-designed visiting route. Those tours provide visitors having systematic trips on different subjects instead of wandering in exhibit halls without a direction. Users may pick up a subjective tour in the map page, then the system would start the trip from where they are, pointing out the direction to the next exhibit one by one. Once it combines with the knowledge from museum experts, a subjective route may be set up according to various artistic topics, visiting time, and user groups to be a virtual touring leader.

4. Implementation and evaluation

The museum guide systems can be viewed as two parts. We shall exam both parts one by one.

4.1 Palm-based museum guide system

To be a personal guiding system, the first consideration goes to the size and the weight of that equipment. Thinking that people tent to ramble gently in a gallery or concentrating on interacting with a robot in a science world, it would be impossible for them to carry heavy or big equipment around. Not to mention sometimes visitors would be too young to carry them. A good touring equipment should be in a pocket-size and it would vanish as a part of your clothes whenever you do not need its help. Just like the trend of technology, making things smaller is for easy carry and do not want them to be cumbersome. That is why we came to use the PDA as a user-end tour guide system.

The handheld PDA here is used to present the museum virtually with context that contains its own set of representations, identities, and relationship with the others. As an assistant to e-learning, we were not afraid to make the virtual exhibit more attractive than the real one. In the

(a) (b)

Figure 2. Services provided by the museum guide system

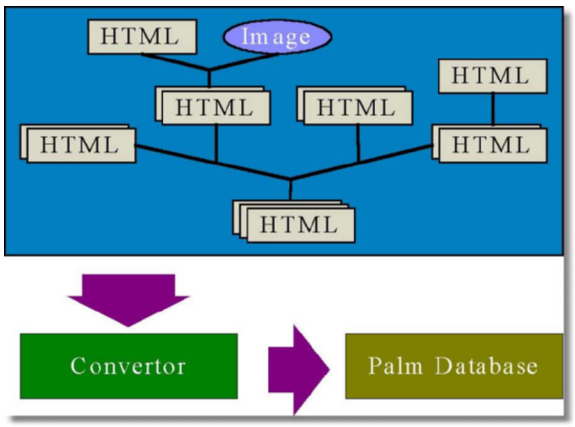

Figure 3. HTML to Palm database converter

Figure 4. The Infrared Transmission Device

early stage, the Taipei Astronomical Museum had been a cooperative partner to this system. With their help, we had the opportunity to experience the touring activities present and knowledge needed to build a virtual museum on PDAs.

The Palm OS was the most popular PDA operating system. Our approach to implement this system was no doubt being it. The hardware resources of a Palm PDA were quite few [9] which was a challenge to build virtual museum on hand. Representation can only be in 256 colors and no multimedia playback supported. Tough work it was, the client-end system still had been done as a sample demonstration. Figure 2 shows how it was on our development platform, Palm IIIc. Graphics and texts are used to be an illustration in this version. Visitors may view next page via walking to the next exhibit and let the PDA get the new signal or just tap the next page button indicated with circle A, the page should change to Figure 2(b) then. Circle B is an arrow mark, telling visitors which direction should go in a subjective tour guide.

A Palm PDA has no file systems like what we used to on PC [10]. It tends to use a block of memory to stack all your data up together instead of giving each of them a unique identifier. Using a file name and an extension to mark each data from mess up with others is not a Palm style. Hence, we also had to implement converting mechanism for transforming those graphics and texts into the Palm database format. This is shown on Figure 3. Our design making use of the feature of Hyper Text Markup Language (HTML), combining texts and graphics together, to be the input of the converter.

4.2 Infrared transmission device

The infrared transmission technique we want is a connectionless data communication protocol. Its mission is to constantly send out the exhibit ID no matter if there are any PDA going to receive that signal. Because no commercial products that match for our design are available, we decided to design the infrared transmission device by ourselves. Figure 4 shows the device. Using an 8051 microprocessor [11] to be the controller of the infrared transmitter, it keeps emitting an identifier of the exhibit into the air. Once a PDA gets the identifier, the museum guide system on PDA should switch the exhibit page to the correct one.

5. Conclusions

In behalf of providing a simple way to absorb new knowledge for every visitor in museums, this paper brings up the idea of making the PDA be a professional tour guide and implements this system on Palm OS. Combining with the convenience human interface on each PDA, our work makes every exhibit vivid via comprehensive descriptions and multimedia display. We believe that the establishment of on-hand virtual museum would give people the inspiration to learn knowledge that less noticed in daily life.

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