Position-Aware Active Learning Services Based on Connectionless Positioning in Indoor Environment✦

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Abstract- **A position-aware active learning system for indoor environment is developed in the paper. The system is implemented on Personal Digital Assistants (PDAs), and is aware of the position of the visitor through the infrared positioning devices. The standard IrDA is connection-oriented, and only one PDA is able to access the infrared positioning device at a time. In the paper, the infrared device is designed to provide the connectionless positioning service, and the number of PDAs that can access the infrared positioning device is unlimited. The system provides position-based learning services. As the visitor walks up to a specific exhibit, the system can retrieve the corresponding multimedia narration of that exhibit automatically.**

1. Introduction

Today, educational activities are no longer limited to the traditional classroom, and the learning could happen at every place [2]. People in modern life are quite good at enjoying their leisure time. Indoor knowledge-based trips, such as visiting to museums, galleries and exhibitions, are getting more popular. In the indoor environment, people can acquire knowledge of the exhibits through learning systems. As we can see in most of museums today, three learning systems are provided. The traditional learning system is done by narrators, another is the tape machine, and the other is the CD player. First, we may focus on how are these solutions doing.

Traditionally, the narrators can illustrate exhibits in a story-like way, and answer questions immediately. The interaction between visitors and narrators is straightforward. However, visitors must keep up with the expositor, and listen to the speech carefully. The tour trip is also restrained by the specified route and time. From the viewpoint of a museum runner, the training cost on novice or multilingual narrators would be long and expensive. Tape machines provide the convenient and personal learning apparatus for visitors. You can listen to the well-organized narration while stick your attention to the exhibit. However, a tape machine plays records sequentially, which means that there is no flexibility on the visiting route. A CD player has all benefits that a tape machine shows. Improvements are coming with the random access property, and hence visitors keep the freedom of moving. The use of tape machines and CD players seems to be cheaper, but they are both bounded by

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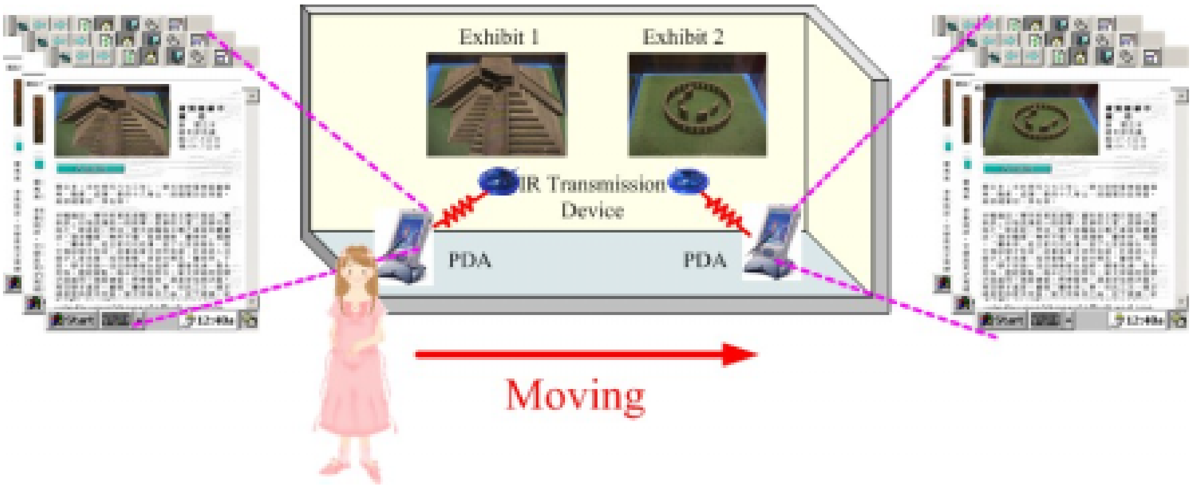


Figure 1. A position-aware active learning system

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 means lack of the ability of interaction.

An active learning system is thus motivated to be developed for the indoor environment, based on the modern positioning technologies, wireless technologies, and hand-held devices. Handheld devices, such as PDAs, have become more functional and suitable to play the role of mobile learning platforms for multimedia applications [1]. The system provides location-based learning services, according to the infrared positioning devices. As the visitor walks up to a specific exhibit, without any manual operations, the system can retrieve the corresponding multimedia narration of that exhibit automatically. Traditional infrared devices are connection-oriented, and only one PDA is able to access the device at a time. In the paper, the infrared device is designed to provide the connectionless positioning service, and the number of PDAs that can access the infrared positioning device simultaneously is unlimited. The project of the designed position-aware active learning system was formed since 1998.

2. System Architecture

The indoor active learning system in the paper is designed to be position-aware, and consists of the following parts:

- the hand-held platform, such as notebook, webpad, palm-size PC, hand-held PC, and PDA,
- a database server to store multimedia narration,
- learning functions,
- positioning technology,
- wireless communication networks.

Visitors use the learning functions, provided by the hand-held platforms, to acquire the knowledge stored in the narration database server, through the wireless communication networks, as shown in

Figure 1.

The amount of the multimedia narration will not be limited by the capacity of the hand-held platform, because the narration contents are stored in a database server and are on-demanded retrieved through wireless communication networks. The system uses HyperText Markup Language (HTML) documents to arrange explanatory contents, and the narration database is built on a SQL server. The wireless communication network adopted here is 802.11b wireless LAN with bandwidth 11 Mbps, for they are getting popular and the cost of establishment is not too expensive. The hand-held platform adopted in the paper is the WinCE-based PDA for their good multimedia supports.

3. Connectionless Positioning Mechanism

The positioning technology is adopted so that the appropriate narrations can be delivered to visitors automatically. There are many positioning technologies, such as GPS, GSM base stations, 802.11 series wireless access points, Bluetooth, and infrared. In the indoor environment, the GPS signal cannot be received. Besides, the position estimates from the signals the GSM base stations and 802.11 series wireless access points are not accurate enough. For the coverage of the infrared transmission is only several meters, the accuracy of the positioning is easy to be reached in the indoor environment. Thus the infrared technology is adopted in the paper. Each exhibit is equipped with an infrared positioning device, and the infrared positioning device broadcasts a unique ID number periodically for identification. As a visitor approaches to a specific exhibit, his PDA will recognize the ID number from the received infrared signal, and then automatically retrieves the corresponding narrations. Comparisons of various positioning technologies are given in Table 1.

Figure 2 shows the protocol stack of the standard IrDA (Infrared Data Association) [6]. The protocol stack is very complicated obviously. The standard IrDA is connection-oriented, and is designed for one-to-one communication. Thus only one visitor is able to communicate with the infrared transmission device at a time. However, the requirement of the position-aware learning application is broadcasting, not one-to-one communications, and thus the standard IrDA is not suitable

Table 1: Comparisons of various 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

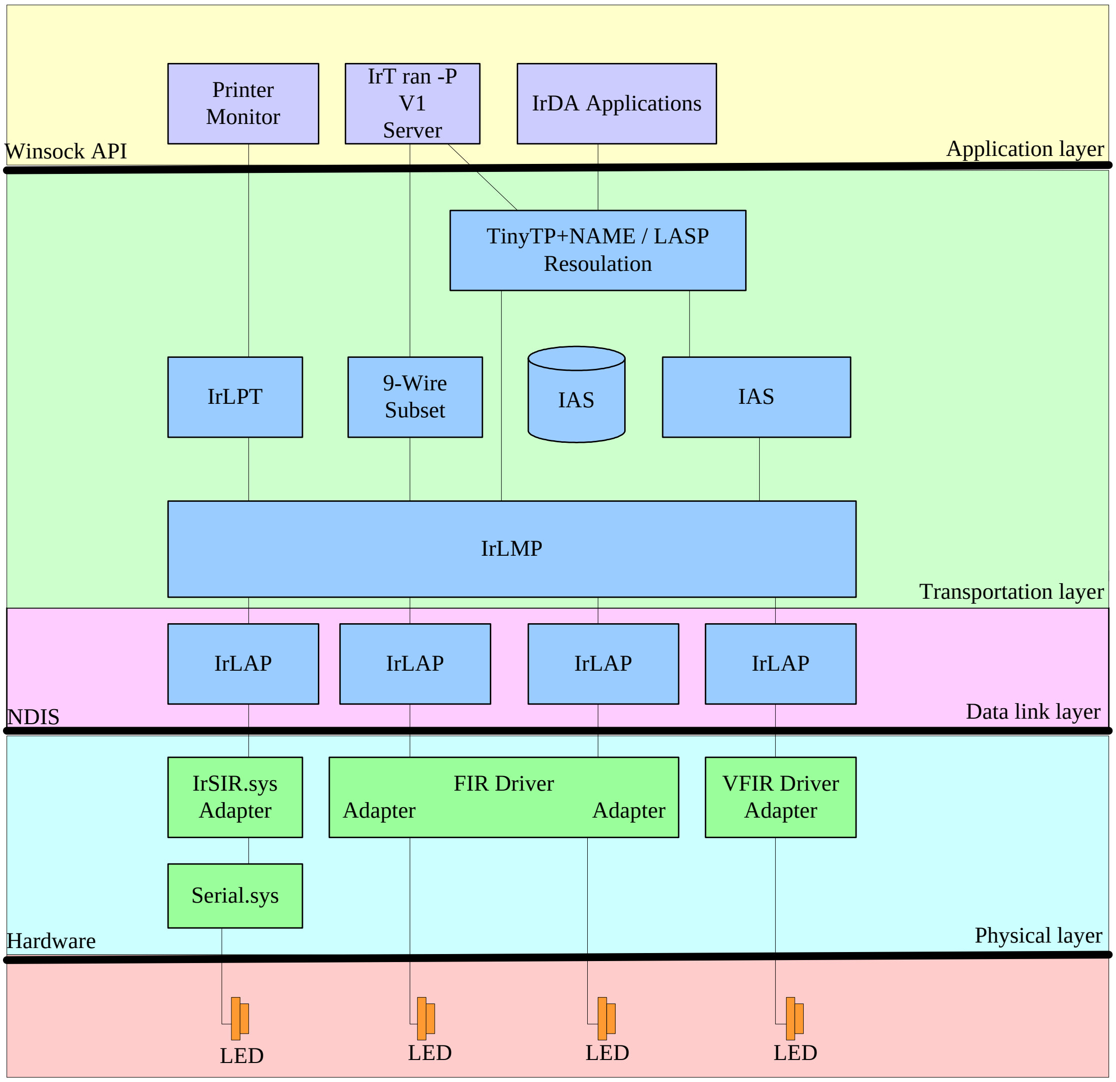
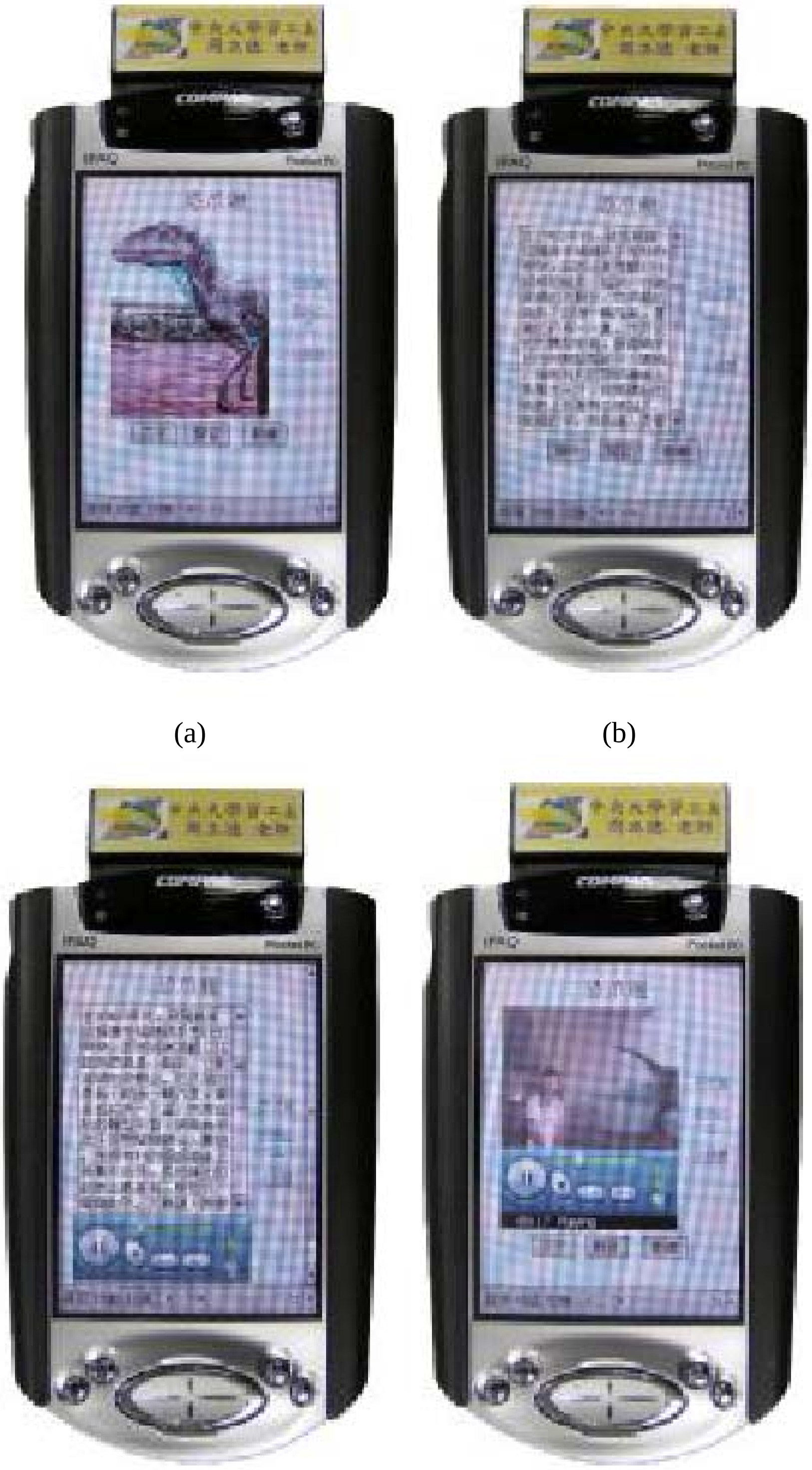


Fig. 2 IrDA protocol stack

in the indoor learning environment. In the paper, the IrDA protocol stack is simplified to reduce the cost of implementation. The infrared positioning device is designed for providing connectionless services, and thus is capable of serving unlimited number of visitors simultaneously.

4. Learning Functions

A typical introduction on the screen would include texts and 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. Moreover, the system should provide additional location-based learning functions. The learning functions provided in the paper include the text narrations, voice narrations, video narrations, subjective tours, context retrievals, multilingual narrations, and unequal explanations. The snapshots of the learning functions are shown in Figure 3.



(a) (b)

(c) (d)

Figure 3. Snapshots of the learning functions (a) exhibit portal, (b) text narration, (c) voice narration, (d) video playback

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. 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 artistic topics, visiting time, and user groups.

5. Conclusions

In the paper, the museum can be treated as a virtual classroom, and a professional tour guide is implemented on WinCE-based PDAs. Combining with the convenience human interface on each PDA, our work makes every exhibit vivid via comprehensive descriptions and multimedia display. We adopt the connectionless communication model to design the infrared positioning device, and thus the number of visitors that can access the device is no longer limited. The learning functions are also implemented so that the multimedia narration is supported.

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