Towards building up an m-World

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Abstract. The rapid development of mobile computing has dramatically changed the way users view and use computers. With mobile computing technologies, we can acquire, deliver and process information at every place. Appearing in many forms such as the PalmOS, Pocket PC and Mobile Phone with increasingly diverse functions, and equipped with advanced peripheral devices such as GPS, camera and wireless adapter, mobile devices is becoming a very powerful all-in-one Personal Digital Assistant (PDA). PDAs have increased the effectiveness, brought people closer and made people more dynamic and flexible. In this paper, we present our research on setting up an m-World with various activities on PDAs. Our research focuses on three categories: education activities (m-learning), commerce activities (m-commerce) and service activities (m-service). In the first category, we have built a PDA-based m-learning system which allows the students to access the learning resources and allows the students and lecturers to exchange ideas from anywhere and at any time. In the category of commerce activities, we have developed experimental system which allows the user to do his/her shopping with mobile phones. There are various of systems which we have developed in the category of service activities including tourist assistant and traffic jam warning system. Our initial results have shown that such an m-World we are looking forward to is not very far from real.

1 Introduction

The rapid development of mobile computing has dramatically changed the way users view and use computers [1]. With mobile computing technologies, we can acquire, deliver and process information at every place. Appearing in many forms such as the PalmOS, Pocket PC and Mobile Phone with increasingly diverse functions, and equipped with advanced peripheral devices such as GPS, camera and wireless adapter, mobile devices is becoming a very powerful all-in-one Personal Digital Assistant (PDA). PDAs have increased the effectiveness, brought people closer and made people more dynamic and flexible [2, 3].

In this paper, we present our research on setting up an m-World with various activities on PDAs. Our research focuses on three categories: education activities (m-learning), commerce activities (m-commerce) and service activities (m-service). In the first category, we have built a PDA-based m-learning system which allows the students to access the learning resources and allows the students and lecturers to exchange ideas

from anywhere and at any time. In the category of commerce activities, we have developed experimental system which allows the user to do his/her shopping with mobile phones. There are various of systems which we have developed in the category of service activities including traffic jam warning system and tourist assistant.

Section 2 presents our m-learning system, which exploits the advantages of mobile computing for education activities. A pilot project in m-commerce is then described in Section 3. Finally, two system in the category of service activities are presented in Section 4 and 5, which are traffic jam warning system and tourist assistant respectively.

2 M-learning system

In this research project, we focus on the construction of an e-learning system for hand-held devices through the communication over wireless network. This system brings the users the most advantage conditions to access e-learning resources and exchange knowledge at any time, anywhere.

The objectives of the system are:

- Creating a knowledge exchanging environment among users who join the system with hand-held devices and wireless network.
- Allowing users with hand-held devices to access learning contents on e-learning servers.
- Allowing users with hand-held devices to access online lectures broadcasted in real-time from classrooms as video streaming/video conference.

This is a pilot research project which investigates the possibility of implementing e-learning system on hand-held devices. Solutions are studied and implemented experimentally. As a result, this project provides an e-learning solution for hand-held devices, which can be deployed widely. The solution allows users at anytime, anywhere to access a variety of e-learning services from their hand-held devices such as Pocket PC, mobile phones, etc. The users can also exchange ideas and e-learning contents with each other and with their lecturers. Another important part of the project is the design and implementation of a video streaming/video conference system over wireless network for hand-held devices in order to cover real-time lecture broadcasting.

The main benefit behind the project is to provide a very flexible, very “mobile” e-learning solution. This eliminates any constrain of the physical location of the users, eliminates for the need for computer labs. Undoubtedly, the construction of computer labs for e-learning is expensive and inflexible. Moreover, computer labs are never enough for a large number of students. The idea of exchanging ideas and learning contents among people sitting in the computer labs is less meaningful than between hand-held devices. With the development of hand-held devices, especially the development of smart mobile phones at reasonable price, the solution provided in this project is becoming realistic in Vietnam, especially in the university environment.

The widely deployment of this project will have several seeable impacts. The first one is the promotion of e-learning in order to partly replace the traditional education style. The second impact is the endorsement for the universities to become real ”digital universities”. The third impact is the reduction in cost for building e-learning computer

labs when the use of smart mobile phone is popular. Finally, users can exploit e-learning more efficiently, at anytime and anywhere.

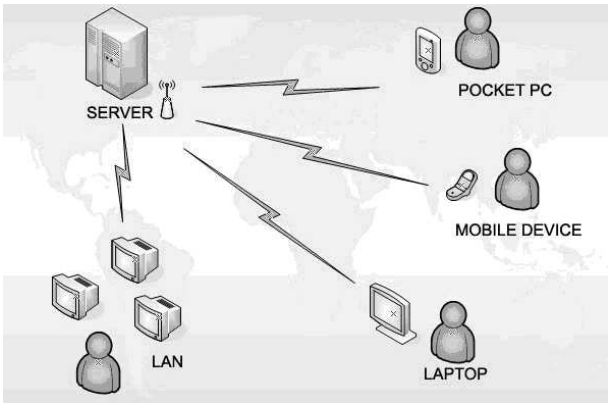

Fig. 1. E-Learning with hand-held devices.

An overview of our system can be seen in Figure 1. Our system was built based on the client/server model. The server plays the main role in all the communications and administrations. First of all, a user has to sign in to the system. The server verifies the user and let the user to join the system. The servers also remember the map between the user's ID and the user's IP address. After that, when any other user requested to communicate with this user, the server will pass the IP addresses so that they can communicate directly. Figure 2 shows the model of exchanging learning contents between users. Snapshots of our system can be seen in Figure 3.

The basic features of our system are:

- Learning content exchanging among clients:
  - Text data: This feature provides to a method for exchanging text data. It is similar to a simple chat system.
  - Drawing data: When joining an e-learning system, it is not enough for the user to use only text to exchange their ideas and learning contents. In our system, we provide a friendly tool to do so - a drawing table. This drawing table simulates the white board in the real life where some people can draw on to discuss their ideas and to exchange knowledge. This feature offers users a more flexible way to present their thought. Possible drawing methods are drawing line, circle, ellipse, rectangle, text-drawing, free-hand, etc.
  - Multiple-choice questions: Our system allows the users to exchange multiple choice questions. This feature allows the teachers to give a test for all the students. This feature also allows students to ask each other the answer of a specific multiple-choice question. The questions can be downloaded from the server, or sent from a client to another client.

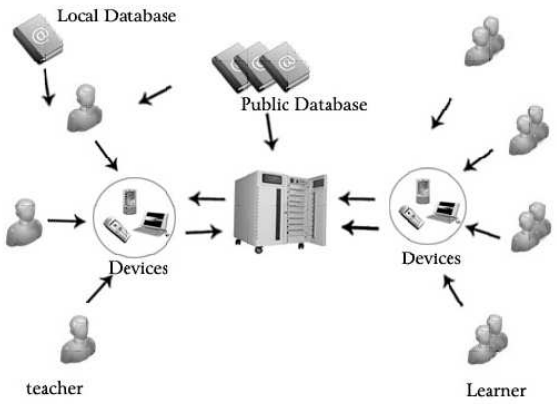

Fig. 2. The model of exchanging learning data between users.

Fig. 3. Snapshots of our m-learning system.

– Learning content accessing from the server: Similar to any normal e-learning system, learning contents are placed in the server so any client can access. Learning contents include lecture notes, tests, reading material, etc. These learning contents are converted into suitable forms in order to serve the hand-held devices.
– Video/audio streaming for Pocket PC: This feature was developed in order to cover the online lecture via video/audio streaming. The classroom is equipped with a digital camera in order to capture all the actions of the lecturer. The video/audio is broadcasted to the network. Desktop computers as well as hand-held devices can play this video/audio stream. In parallel with this feature, we also developed the

video conference application for hand-held devices. This allows the students and the lecturer to organize online tutorials. This feature, however, is still at its initial stage. It still needs more developments to operate efficiently.

3 Mobile book shop

With the growing number of people who spend their time with mobile phones as one integral part of their life, m-commerce is definitely having a place in nowadays age. M-commerce is an emerging area of research and development which promises to blossom in the near future. The advantages of m-commerce over traditional commerce are ubiquitousness and reachability - the reach to customers at any time, any place.

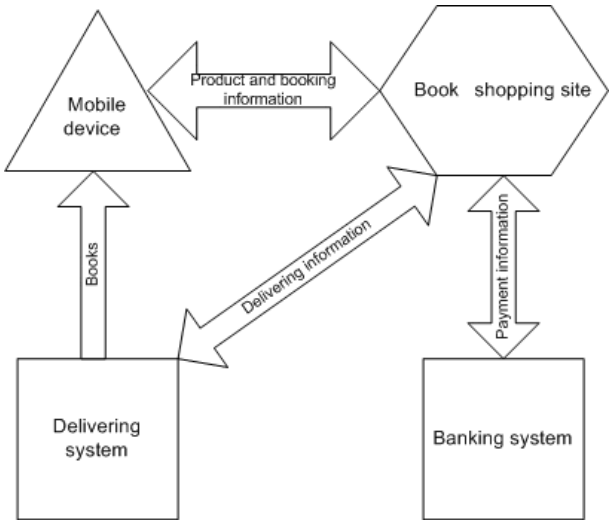

Fig. 4. Mobile book shop conceptual model.

We contribute an small effort in the process of m-commerce development by building an experimental system, the mobile book shop, which applies the m-commerce model of business to sell books over the wireless network. The mobile book shop is one of our pilot systems which does not try to solve all the problems of mobile business, but to have an image of a system that gives customers the ability to get what they wants with their mobile phones. A mobile shopping system can fulfill the need of customers the right time and instantaneously, given that the business model provides customers with a good delivery system. The objective of our system is to exploit the ubiquitousness and reachability of m-commerce to satisfy user needs and to be able to work out in the specific market of Vietnam. The general model of mobile book shop is illustrated in Figure 4.

As shown in Figure 4, the system comprises several elements, which are: book shopping site, mobile device, banking system, and delivery system.

- The book shopping site includes a database and a mobile web site, which is the front end of the system and provides graphical user interface to interact with the system. It presents a mobile shopper with products, helps the shopper to retrieve product catalog and product details, and processes any required transaction. The front end of the system allows customers to browse for books and book details. Book info are sufficient so that a customer can have an overview of the book. Summarized contents and comments of a book are provided for customers to easily make choice. Searching options assist customers in finding the relevant books. Processing booking function is the last step to go to get the book the customer wants.
- The mobile device represents a mobile customer. It uses Internet connection to access the book shopping site with a mini-browser. A customer can access the system through a cellular network or a wireless LAN.
- The banking system assists the payment process conducted between the customer and the merchant. The aim of the banking system is to securely process payment information, namely the credit card number entered by a customer, and any transaction between a bank and its customer - the mobile book seller in particular.
- The delivery system carries out the delivery task. Delivery information is exchanged between the book shopping site and the delivery system. Then books are being physically delivered to the customers after the completion of the payment process. The customers may have ordered books delivered to him instantly by a delivery man driving a motorcycle. Cash payment is possible for a mobile customer and it can be done directly with the delivery man in the exchange of books. With this model, books reach the customer at anywhere and at anytime.

Figure 5 shows a snapshot of our mobile book shop system. As can be seen in the figure, the summarized information about a book fits in the display of the mobile, which is convenient for the user to browse books. Our mobile book shop has shown the potential to the book retail market. However, it is still a pilot project with limited functionalities. Our system can still be further expanded with other features of m-commerce such as personalization - the ability to adapt to individual's need, and dissemination - the ability to distribute book information to a large consumer population.

4 Traffic warning system

Mobile phones can serve people with instantaneous information. Bearing this in mind, we have built a streaming system on mobile phone called traffic warning system. Its main purpose is to provide travellers with the current traffic information of Hanoi city. A traveller enters the system and listens to the streaming audio that update the current traffic situation in the city.

There are several advantages of this system:

- Instantaneous access and information: a traveller can collect traffic information when travelling.

Fig. 5. A book in our Mobile books shop.

- Multiple usage of mobile phone: it is important for a driver to be able to use his/her mobile phone to run this application; no addition equipment is required.
- Overcoming the limitation of mobile device: streaming applications are even fitter for mobile devices because they usually do not have large storage space to store multimedia files and users can not wait long before an application starts.

The high-level architecture of our traffic warning streaming system over an IP-based mobile network is shown in Figure 6. As in the figure, our system consists of three main components: the server, the mobile network, and the mobile streaming client. The server comprises two subcomponents: the streaming server and the database server which handles traffic information for the system. At the moment, traffic updates are manually entered into the database. Audio content is created at the user request and customized according to client query. When the client requests, streaming server creates audio content and sends its back to the client. The mobile network carries audio streaming traffic between the server and the client. As soon as the client receives audio packets from the server, it starts playing. Mobile streaming client keeps a connection with the mobile network and exchanges data with the server. The mobile client can roam but it retains under the coverage of the mobile network to guarantee the service. The mobile client must be able to play multimedia data, which is audio data in our system.

We have built four main functions in our traffic warning streaming system. The first function is called “General traffic report”, which reports the overall traffic situation in the city - all places currently in a traffic jam or possibly in a near future. The second function, called “Traffic report by places”, reports the traffic state of a road or a cross-road based on the client query. The third function, called “Traffic report by districts”, gives information about traffic currently happening in a particular district of the city. The last function so far, called “Yesterday statistical report”, summarizes the traffic situation of the city one day before.

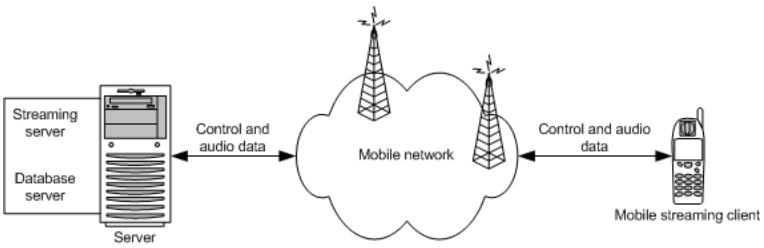

Fig. 6. The high-level architecture of the traffic warning streaming system.

The client application of our traffic warning system is written for Java-supported mobile devices, the snapshots of which are presented in Figure 7.

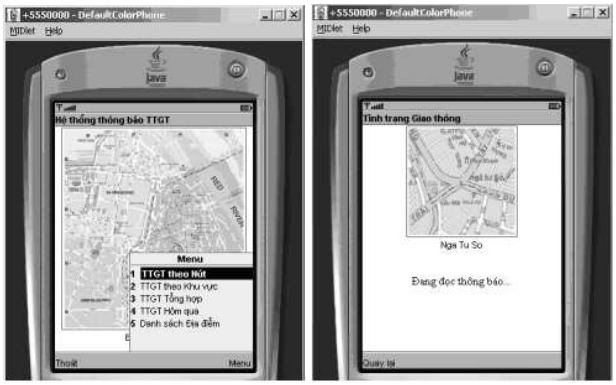

Fig. 7. The client application for the traffic warning system.

Basically, our system is feasible with almost all network infrastructures. Mobile networks, such as GSM, offer higher bit rate for packet-switched data transmission, which is crucial for multimedia applications. 2.5G networks, such as HSCSD (High-Speed

Circuit-Switched Data), GPRS (General Packet Radio Service) and EDGE (Enhanced Data rates for GSM Evolution), allow bit rates up to 64, 171.2, 473.6 kbps, respectively. These networks are able to carry low and medium bit rate multimedia traffic that is the prerequisite for our system that offers voice streaming to users. 3G networks offer even higher bit rates, up to 2Mbps. With better compression technology, that reduces bandwidth usage, multimedia application will play an important part of city life.

However, there are several multimedia communication problems with the network we have to deal with. First of all, in order to deal with varying end-to-end delay caused by the network, or with jitter phenomenon, we have implemented some mechanisms, which are typical measures to remove network jitter. They are:

- Prefacing each packet with a sequence number. The server increases the sequence number after each packet has been sent.
- Prefacing each packet with a timestamp
  - Delaying play out of packets at the client. In our implementation, we simply use the fixed-delay strategy, in which the client plays each packet exactly t milliseconds after the packet is generated.

Secondly, packet loss has impacted on the quality of multimedia applications in the Internet and even more severely in a mobile network environment. The high error bit rates can be caused in a mobile network by a weak radio signal or because of handover due to the movement of the client from one cell to another cell. In order to reduce the impairment of the streaming media, we employ a loss recovery scheme, called Media-independent error correction described in [4], to preserve acceptable audio quality in the presence of packet loss.

5 Traveling Assistant Agent system

For the problem of traveling assistant, our perspective is to focus on what the user needs more than what technologies can provide [5]. Keeping our perspective, we have design our system so that it can maximally assist the user while still following the technical requirements. Figure 8 shows the overall model of our system. Figure 9 shows the context where our Traveling Assistant Agent is useful.

Our system consists of three modules: the language assistant module, the map assistant module and the place assistant module. Figure 10 shows snapshots of our assistant agent

The Language Assistant Module

This module helps the traveler to speak common sentences in the local language in order to bridge the gap of language barrier. This is a talking sentence-based dictionary which contains common sentences within common categories such as everyday conversations, shopping or local transportation. One solution for this module is use Text To Speech system for each language. The advantage of this approach is that there no effort needed when adding more sentences in the same language. However, its disadvantages overshadow its advantages to be selected for this modules. The disadvantages are: the

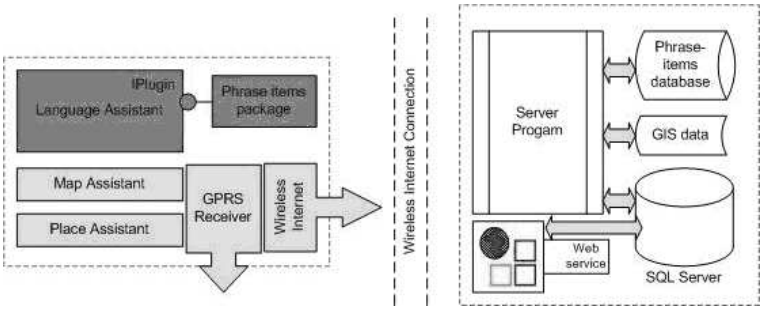

Fig. 8. Model of a PDA-based Traveling Assistant Agent system.

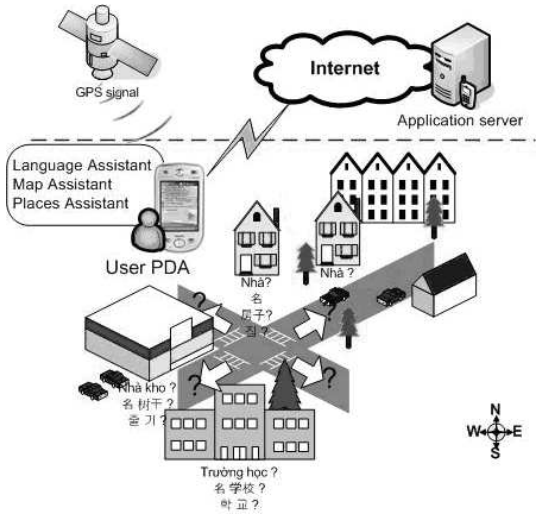

Fig. 9. The application of our Traveling Assistant Agent.

text to speech system is complicated and not very suitable for PDAs, especially, developing PDA-based text to speech for each language is not easy and effective; the quality of the speech synthesized by text to speech systems is not very high, especially PDA-based systems. Our approach for this modules is to store the wave files of sentences in the dictionary. This approach produces high quality of the voices recorded by real people. Moreover, adding the database for a new language is as simple as recording the sentences in that language. Because the dictionary contains only common sentences, it would not suffer from storage problem. However, we still need an effective speech compression implementation.

The Map Assistant Module

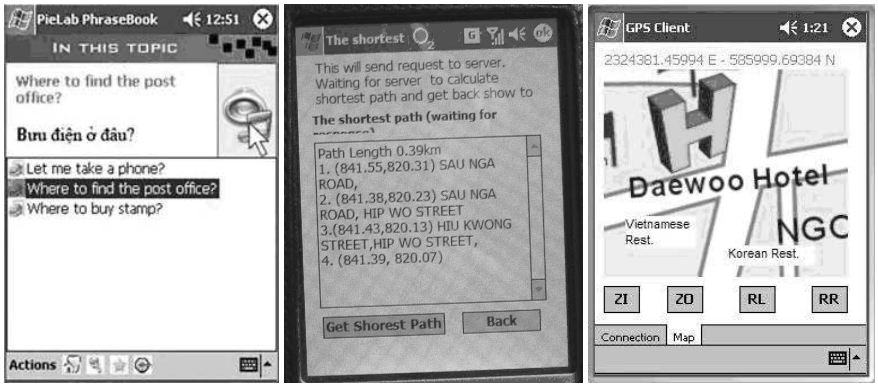

Fig. 10. Snapshots of our Traveling Assistant Agent.

This module helps the traveler find the way to travel from place to place. Using GIS data of the local area, this module allows the traveler to find out the way in a more dynamic way such as searching places and finding the shortest path from place to place. This is extremely helpful especially in big cities with many streets, buildings and places. Different from other systems, we not only search for direct shortest path on the normal map but also search for shortest path when traveling by bus or underground. This potentially increases very much the utility of this module. Moreover, in order to maximize the utility of this module, unlike other existing digital map system, we concentrate on the way to present the shortest path to the user. Instead of showing only the shortest path in the digital maps, we also show the shortest path as a list of immediate points in text form. This can be a list of intersections of streets, e.g. (Hue street, Dai Co Viet street), or a list of bus stops if traveling by bus is suggested. Again, this is more useful for the traveler. When the traveler walks, showing the list of intersections of streets would help him to navigate faster and more accurately; when the traveler hires a taxi, it is easy for the driver to navigate with the list of intersections when the driver does not know the way to the destination; when the traveler uses bus, train or underground, the list of bus stops, train stops or underground stops would be extremely useful for him to get to the destination.

The Places Assistant Module

This module helps the traveler find interesting places around his current position. By combining both GPS information and GIS data, this module determines precisely where the traveler is and what are available around him. The information is in the form of position in a digital map with additional text information. Again, this module is very useful for the traveler when he is in the middle of the street and need to know restaurants, shops or bus stations nearby.

6 Conclusion

In this paper, we have presented our research on setting up an m-World with various activities on PDAs. With three categories to focus on, which are: education activities (m-learning), commerce activities (m-commerce) and service activities (m-service), we have built several pilot systems. In the first category, we have built a PDA-based m-learning system. In the category of commerce activities, we have developed experimental system which allows the user to do his/her shopping with mobile phones. Two applications in the category of service activities have been presented. Our initial results have shown that such an m-World we are looking forward to is not very far from real.

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