Collaborative learning system based on Wireless Mobile equipments

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Abstract

With the popularization of Wireless Mobile equipments, the long distance education based on Wireless Mobile equipments, such as PDA, attracts increasing attention. However, how to transform currently used web pages into pages that can be displayed correctly in PDA, and how to deal with long distance discussion between peoples using PDAs and peoples using PCs become two problems we are facing with. In order to resolve the above-mentioned problems, we have developed a Mobile Learning System, which are composed of a Collaborative Learning model and a Network Agent Service model. The system can be deployed over a heterogeneous network of mobile wireless devices and wired devices, ranging from PDAs to desktop PCs. The Collaborative Learning system, based on traditional C/S architecture, includes some basic discussion tools such as whiteboard, words chat, share images, slide show, member management etc. The client side is implemented in the form of an applet, which can communicate with the server side located on the web server. By using this system, teachers and students can discuss with each other through web page browser of PDAs or PCs. The Network Agent Service model, which acted as a HTTP agency, can transform the text and images in HTML page into appropriate size and format that can be displayed by the browser of PDA , according to the size of PDA's screen. In this paper, the architecture and framework of the Mobile Learning System, which includes the Collaborative Learning model, the Network Agent Service model and some key technologies such as the realization of image conversion, are introduced. At last we demonstrate the usage and effect of the system in the context of long distance education.

1. Introduction

Today many learners are equipped with mobile device such as PDA. How to use this kind of mobile device in distance education attracts more interest in recent years. Much work has been done in the field such as the Online Feedback System[2] based on hand-held device developed by University of Mannheim and the Stanford Interactive Workspace project [3] which represents an example for a learning scenario with mobile device. Differently from above mentioned work, we pay more attention to the synchronous collaboration, the so-called WYSIWIS (What You See Is What I See) technique [1], between desktop PC and PDA for the purpose of distance discussion. We have developed a Prototype of Mobile Learning System which can provide the following services:

Shared Whiteboard: one of the most important issues for distance discussion is that a teacher can share his/her screen with students. Though the size of screen of PDA is quite different from the size of screen of PC, users can share same drawings and pictures.

Online Presentation: another powerful tool for distance education is on-line presentation, through which a lecturer and students can share same slides for discussion. These slides can be PowerPoint slides saved in HTML format, or a sequence of images[4].We implemented the online presentation by using a group of images. Every Applet client can get a slide as the format of a GIF image from the server. Because of the differences in screen size and resolution, the images must be transformed, so that they can be displayed in the client side correctly.

User Management: There are two kinds of users, teacher and students. A teacher can create a session by entering user name and password. If a student wants to enter the session, a request is sent to the teacher for permission. By default, the teacher owns all authorities of operation, and students only have the authority to watch and send messages.

HTTP Agency: Most of our existing education resources are in the form of web page, which can be displayed correctly on devices with a resolution of 800x600. The resolution of PDA, however, is much lower than this value. The HTTP agency can change

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the web page into a new format which can be displayed by PDA correctly.

Our prototype runs under 802.11b WLAN. PDA that we are using is Compaq iPAQ. In order to run Applet, Java Virtual Machine should be installed on PDA. The Virtual Machine we adopt is Jeode Runtime, which is a fully-certified implementation of Sun's PersonalJava 1.2 specification.

2. Usage Scenarios

One use of the prototype is to make a presentation in multi-play environment. In on-line presentation, a teacher and his/her students may use different devices. Typically, the teacher may use a desktop PC or a laptop and students may use laptops or PDAs. It would be convenient for each student, whatever device he uses, to be able to independently point out areas of a slide or make signs on a slide. Some related work has been done in this field such as the Smart Presenter in iRoom[5] and Pebbles project[6]. The Smart Presenter implements the online presentation by moving the content of the web to multiple display and students can't make any sign on slides. Pebbles project takes PDA as a remote commander control and slides can't be showed in the PDA. Differently from above work, the online presentation in our prototype can show slides on the screen of PDA and on the screen of PC. PDA users can also manipulate the presentation and make signs on the slides under the authority of the presenter. Moreover, the presenter can save the modified slide into image file to the server where the Applet comes from.

Another use of the prototype is online discussion. For distance education, a teacher needs to make online discussion with students by means of whiteboard. Students with PDA can use whiteboard to communicate with the teacher and other students with PC or PDA anytime and anywhere.

3. Architecture and Implementation

3.1 Architecture

The prototype of mobile learning system consists of two components: a collaborative learning model and a HTTP agent service model. The collaborative learning model is based on C/S mode and the HTTP agent runs at the gateway of wireless network as showed in figure 1.

Clients are implemented in the form of Applet, and the client of PDA and the client of PC are different in view. The application server runs on a HTTP server which sends the HTML page with Applet to the PDA client or PC client. The physical heterogeneity coming

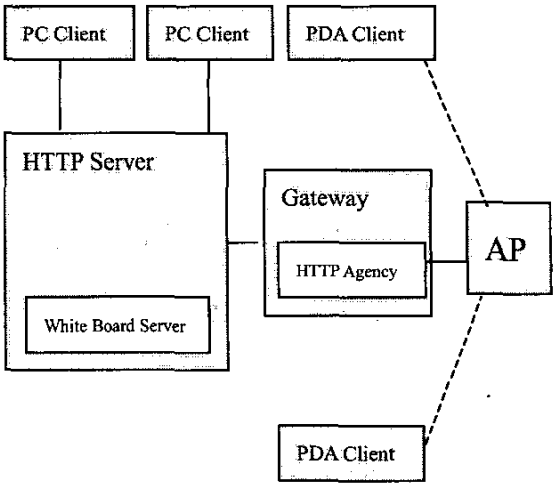

Figure 1. Prototype architecture

from PDA and PC manifests itself in CPU speed, memory, display capabilities, and network bandwidth, with the last two having the most prominent discrepancies [7]. So the main issue we should address here is proper display of view on different clients. We will discuss this issue in details later.

Because there are different clients in this prototype, the usage of the prototype is a little different from traditional whiteboard. Let's take online presentation for example. First the presenter opens a HTML page where the Applet client for PC is embedded (the HTTP server maybe on the presenter's laptop or other places somewhere). Then the listeners with laptops can open the same page and download the Applet client for PC, while the listeners with PDAs can open a HTML page where the Applet client for PDA is embedded. The presenter can choose a slide from all slides, and the corresponding event was sent to other PDA or PC client which can acquire the proper slide from the HTTP server.

3.2 Implementation

The prototype of collaborative learning system composes of Server-side and Client-side. The task of server-side is to maintain the sockets connected with client and to pass information between clients. Meanwhile Server can also address some issues such

as Event Collision and user management.

The prototype takes advantage of the separation between logic model and display model, in order to simplify the task of developing the client-side of heterogeneous devices. A class named Cwhiteboard performs the task of display on pc client. Correspondingly a class named CPDAboard performs the task of display on pc client.

The method we adopt here is 2D translation and scaling in order to implement the so-called WYSIWIS technology. The basic structure for 2D transforming is like this X'=MX, where M is a transformation matrix. Such transformation matrix can be represented by a 3 row and 3 column matrix with an implied last row of [0 0 1]. That is

$$\begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} = \begin{bmatrix} m00 & m01 & dx \\ m10 & m11 & dy \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} m00x + m01y + dx \\ m10x + m11y + dy \\ 1 \end{bmatrix}$$

This matrix transforms source coordinates (x, y) into destination coordinates(x', y') by multiplying the coordinate vector by the matrix. The left top 2×2 sub-matrix of the transformation matrix are rotations and scales matrix and dx, dy are translation values, used for translation.

In our prototype, the coordinate of the left-top point of PC client's whiteboard is(200, 70) and the size of the whiteboard area is 600 × 450. The coordinate of start point of PDA client's whiteboard is(0, 100) and the size of the whiteboard area is 240 ×180. The scaling of two whiteboard's size is 2:5, so transformation matrix is

$$\begin{bmatrix} 0.4 & 0 & -50 \\ 0 & 0.4 & 72 \\ 0 & 0 & 1 \end{bmatrix}$$

A drawing event composes of color value (RGB value), start point coordinate, end point coordinate and an identifier which can identify which kind of device the event comes from. When a client, such as a PDA client, receives a drawing event from another client, it will check the identifier. The PDA client will draw according to the values it receives directly, if the event is sent by another PDA client. If the event is sent by a PC client, the PDA client will draw according the coordinate values obtained by above transformation matrix.

In online presentation, PDA and PC clients can share same slide with different size. There are some necessary buttons for presentation, such as forward, backward, jump, begin, end on the control panel at the bottom of the whiteboard. The slides are kept as a group of Images. There are two groups of images in JPEG or GIF format on the HTTP server. The two groups of images are different in size, one for PC while another for PDA. During presentation, when presenter presses a button, such as forward, the corresponding image is fetched from HTTP server by other clients.

HTTP agent changes the format of original web page so that it can be displayed by PDA browser. Some tags are disposed to adapt the resolution of PDA before they are sent to PDA client. Our prototype adopts the following methods to change the tags:

1. Image: If the width and height of an image is less than 240*320, the image will be displayed directly. Otherwise <img > tag will be changed into <a href= > tag, and user can click the link to look on the image.

2. Tables: Usually, a web page composes of many tables, and the width attribute of a table can be initially set in pixels or percentages. If the width attribute of a <table> or a <td> tag is set in pixels, it will be changed into a relative value in percentages.

3. ActiveX: By now, Internet Explorer for Windows CE does not support ActiveX, and the agent replaces the ActiveX with some words. Users know there is an ActiveX through the words.

4. Prototype Effect

A test of the prototype system has been carried out in the context of distance education. Figure2 shows the user interface of a PC client during an on-line presentation, and figure3 shows the interface of a PDA client which is synchronizing with the PC

client. The figures demonstrate that the slides are the same in content but different in size, which is like the following two red marks.

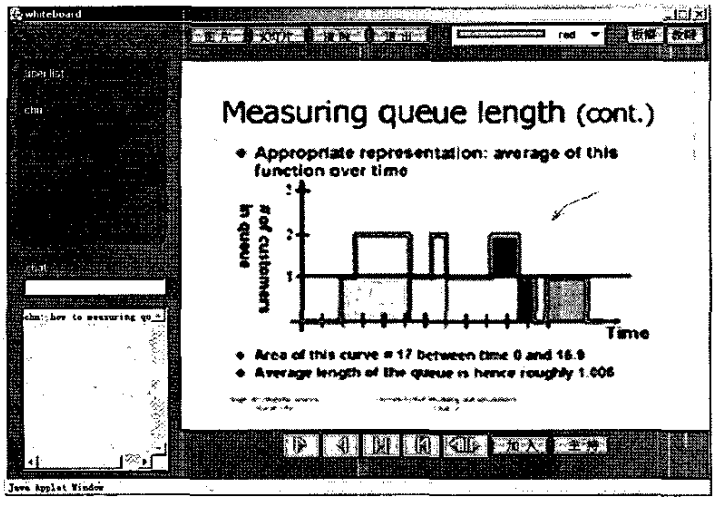

figure2. PC client for online presentation with resolution of 800*600

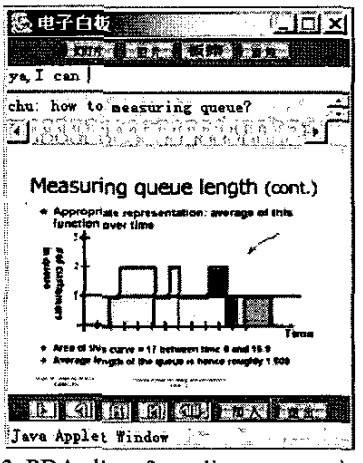

figure3. PDA client for online presentation with resolution of 240*320

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