WebELS: A Web-Based E-Learning Platform

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Abstract—This paper introduces a web-based e-learning platform, called WebELS. WebELS is an on-line e-learning platform designed mainly for higher education focusing on powerful authoring and dissemination of contents as well as on-line Internet meeting as an all-in-one system, aiming to assist faculties to upload their learning materials on the web for on-line and on-demand asynchronous learning and presentation material-based Internet meeting for synchronous learning. WebELS features web-based authoring tools, portability on various platforms, and flexibility of XML-based storage allowing the learning materials to be delivered in many different ways. In the WebELS families, there are three members for different users: basic WebELS, advanced WebELS and WebELS Meeting. According to the requests, several e-learning systems are developed based on WebELS, such as e-learning system for the National Institute of Genetics of Japan, teaching and experiment platform for the Department of Automation, Tsinghua University of China. WebELS is distributed as an open source software. Services have been made available on the Internet and its functions are continuously extended to cover user’s requirements.

Index Terms—Distance learning, e-learning, higher education, web-based platform

I. INTRODUCTION

NOWADAYS, distance learning through Internet is regarded as one of the important ways to carry out education activities. With web-based learning, it is possible for the students to learn from anywhere, anytime, at their pace. Web-based learning brings unprecedented level of accessibility to courses in remote area, courses prohibited by budget constraints, courses updated to recently discovered knowledge, qualified instructors, instruction at any time, etc. [1]. However, the creation of quality didactic material for web-based distance learning and carrying out discussion or presentation through Internet remains a difficult task. The primary factor that prohibits the development of web-based course materials is the enormous cost associated with both the tools and the number of person-hours needed to produce a lesson [2]. So far a number of open and commercial systems for web-based learning have been proposed. WebCT [3] provides integrated e-learning systems for education. Macromedia Breeze delivers rich web experiences for distance learning, professional development, and collaboration [4].

In this paper, we propose a WebELS system to assist in the conversion of traditional learning materials into the format suitable for web-based distance learning, in addition to the Internet-based online meeting features by means of shared presentation materials such as power-point contents. Our research focuses on the on-line material authoring, presentation, and management for asynchronous learning as well as synchronous learning over the Internet [5]. The system is designed mainly for higher education, where major education materials are created by faculties for international conferences and symposiums and maintained on their own personal computers [6]. It should be noted that these materials are used for course lectures as well. In addition, meetings are one of important styles of higher education. On-line meeting over the Internet is an indispensable function to support distribution and internationalization of the education.

The system allows existing learning materials to be reused again on the web. These materials are stored on the server in a modern and flexible XML format which can be delivered to students in many different ways. Unlike WebCT, WebELS is intended to provide traditional instructors an easy way to create or store their learning materials with all the required authoring tools built-in. It has more powerful authoring tools than Breeze for editing learning materials. Hardware software requirements to the instructors are kept at minimal level. All necessary authoring tools are provided as Java applet and automatically downloaded from the server. The instructor needs to have only a Java-support browser.

II. WEBELS OVERVIEW

A. Objectives

Since WebELS is being developed for assisting the activities of higher education, the objectives of WebELS are including:

- WebELS is to be archive of learning materials, with ability to collect from authors and deliver to students.
- The course author and students can access to the system from any places with Internet.
- The multimedia learning materials are transformed into the contents of e-learning and stored in the server. They can be internationally managed and re-organized.
- The functions for on-line distance meeting are necessary to allow the presentation at the multiple sites of the world.
- WebELS is a user-friendly system for non-IT users. It is a software system with low requirement of hardware software supporting.

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B. System Features

The conceptual network diagram of the system is shown in Fig.1(a). The top page of WebELS is shown in Fig.1(b). The learning materials are kept and managed by the server. Authors and students can access via the provided Java-enhanced web-based interfaces. The author client computer contacts the server and downloads the necessary Java tools for editing the course materials. After the program is launched locally on the author machine, the material data is downloaded from the server and the author can edit it on his local machine. This reduces the impact of network delay on content editing. After editing is completed, author uploads the updated data back to the server. In building up the web server and interfaces, the ease-of-use and ease-of-access are the optimal goals. In designing the technical aspects of the system, we are paying more attentions in portability of the system, and reusability of the learning materials. In order to achieve minimal platform dependency, many tools in WebELS have been developed from ground up using Java programming language. This allows us to realize a portable foundation with rooms for future expansion. Therefore, the features of WebELS are as below.

- Rich-Media Contents: Text, Audio, Video, contents with presentation pointer are supported.
- Real Authoring Tools: WebELS is not just a server for you to upload your pre-created contents. It provides you with all necessary tools for creating your content online: Full-feature HTML editor, audio recorder, cursor movement recorder for audio-synchronization, MS-Office document importers, etc.
- Platform-Independent Viewing Tools: WebELS provides viewing Java applet for all contents stored on WebELS. No more need to look for/pre-install AdobeReader, PPT Viewer, etc., for your platforms. (Except for Java VM)
- On-Line and On-Demand Learning Support: You can put your lecture on WebELS for students to review after class, or even carry out real-time classroom over the Internet with WebELS.
- On-Line Presentation with Audio and Whiteboard: WebELS comes with audio conference applet for doing multi-point real-time presentation (with synchronized slides, shared whiteboard, and pointer) over the Internet.
- Discussion Web-Board: Discussion web board is available to all contents created on WebELS.

III. WEBELS FUNCTIONS

A. Learning Mode

The learning mode in WebELS is for doing self-learning by students, as illustrated by Fig.2. The users of learning mode are classified into two types: guest and specific user. Guest users can access public contents without registration in the learning mode. Specific users can access non-public contents after logging into the learning mode. In the learning mode, contents are consisted of various types of courses. Each course is indicated by the title, author, updated time, category, media type, etc.

Each course can be displayed on the computer screen or printed out. The courses in WebELS can be one (or combination) of the following primitive content types:

- Formatted text with different typefaces, colors, languages;
- Still image in the following formats: JPG, GIF, and PNG;
- Still image in the following formats: JPG, GIF, and PNG;
- Animation such as GIF animation;
- Embedded and on-demand streaming sound;
- Embedded and on-demand streaming video clips.

In addition, there is a searching function to locate the course quickly.

Fig.2 WebELS learning mode

B. Editing Mode

The editing mode is to provide the tools for authors to edit their specific courses. In the editing mode, the created courses are indicated by the items adopted in the learning mode. In addition, each course has two entrance buttons. One is “Edit” and another is “Import”. The “Edit” button is to open WebELS editor to edit a course. The “Import” button is to download a course into the local computer from the server. Besides, there is an item called “Actions” with two buttons: “Delete” and “Hide”. If click “Delete” button, this course will be deleted from the course list. The “Hide” button is to hide the shown course in the learning mode.

C. Presentation Mode

Presentation mode defines how different content types: texts, images, video, etc., are presented to the students, and how they are relating to each other in the presentation. Usually on WebELS, contents can be presented to the students using one or combination of the following delivery modes:
- A single HTML page;
- Multi-page HTML for slideshow presentation. Each slide may correspond to a SECTION in the content;
- Video presentation;
- Multi-Modal-Synchronize video presentation with slides, side-by-side;
- PDF hardcopy;
- On-line Internet meeting.

For each presentation mode, an XSLT transformation file [7] is provided to convert the internal XML material into the format suitable for that presentation mode.

Concerning the on-line Internet meeting, it uses the function of client synchronization. That is, it allows teacher to make real-time presentation with group of students over Internet. As long as teacher and students open the same course saved in WebELS, the teacher can control slides which can be changed synchronized in the students’ computer. Teacher can also use a pointer to indicate the contents in the slide. This pointer can be synchronized appeared and moved in the students’ slide.

D. Custom Text Organization

On WebELS, if authors want to create a new course including part contents of a book, they can use the Custom Text Organization function instead of WebELS Editor. For example, there is a book forming a course in WebELS. It has several chapters. A teacher wants to make a new course which just includes some contents from different chapters of the book. By use of Custom Text Organization, the teacher finds out this book and selects the contents he needs. Then these contents can be freely combined into a new course.

E. User Management

In WebELS, it has the function for user management by administrator. When a new user wants to log into the WebELS, he/she should apply for an account by his registration and WebELS can automatically allocate an account for him/her. Based on the user’s requirement, this new user can be classified into different groups. That means this user can access the contents created by the members of this group.

IV. WEBELS IMPLEMENTATION

A. Web Server

WebELS server is responsible for both content management and content deliver, as illustrated by Fig.3. Content management includes providing data storage for all course materials (in XML format), supporting content retrieval and update for editing clients, managing user information, and verifying course dependency. The learning materials are divided into courses. Contents of the courses, in XML format, course information, and all user account information are maintained by SQL database server. The server also contains a customized HTTP server for handling web-based user interface with Java Servlet support, which is necessary for interacting with the Java tools on client, and for performing XML data transformation.

Fig.3 Structure of WebELS server

B. Web Interface

As the above introduction, there are many web interfaces for different modes. In the learning page, the user can choose whether to view the course material either in HTML or PDF.
format by clicking on the corresponding hyperlink. The server then applies appropriate XSLT transformation to present the material in requested form. The table-of-content is also generated automatically by XSLT transformation. In the editing mode, presentation mode and other functions, the tools work on platforms on which browser and Java applet are supported such as Microsoft Windows with Internet Explorer and Sun Java J2RE, and Mac OS X with Safari Browser.

C. XML Representation of Learning Materials

Learning material for each course is stored in XML format with hierarchical structure on the server. The hierarchy subdivides a course into chapters, sections, subsections, etc. In order to manage the course structure, a course hierarchy editor allowing the author to move, delete, or copy any parts of the course easily is also provided. The author can select only one part for editing and the client program will download only that part. UTF-8 [8] character set is mainly used in order to support multi-lingual contents. There are some of supporting tags used for defining the course structure, formatting text and embedding multimedia contents.

D. XML Transformation

The learning material in XML format can be transformed into several presentation files formats depending on the purpose of use. There are a number of XSLT transformation files corresponding to different transformation paths. For example,

- Fo.xsl: This transformation is applied to the XML document in order to generate an appearance-specific XSL-FO (XSL Formatting Objects) [9] document that can be rendered into PDF by FOP (Formatting Objects Processor) [10].
- Content.xsl: This transformation is used to generate a HTML file suitable for a generic WWW browser. Predefined applet tags are also included in the output file in order to launch Java Applets to render the dynamic presentation modes.
- Toc.xsl: is used together with content.xsl to generate the table-of-content part of the HTML document. The output of toc.xsl is merged with that of content.xsl before presented to the user.
- Source.xsl: This transformation generates a WebELS editor-compatible data representation of the course content. It’s basically the XML document customized for the specific user platform.
- Xref.xsl: This transformation file is used to extract cross-reference anchors. In WebELS system, an author may create multiple courses, each of which may contain links to different sections among them. Each section in each course can be referred by a unique ID number generated by Gen-id.xsl below.
- Gen-id.xsl: This transformation attaches globally-unique section IDs to the newly edited course before storing it in the system XML course database.

E. Meeting Server

Meeting server acts as a proxy passing messages from teacher to the attending on-line students. As multiple courses may take place concurrently, the messages are grouped and circulated only within the participants of the same course. Both command message for switching slide, placing pointers, etc., and multimedia messages for transmitting voice/audio are supported. In order to make it able to propagate through the network firewall in deploying environment, the communication protocol is custom made, based on the traditional TCP socket.

Beside relaying messages among the participants, meeting server is also equipped with moderator controlling the operating mode of the session.

- Single moderator mode: Only a single participant is allowed to send commanding message, and audio. This is useful for a classroom scenario where only the teacher make presentation most of the time. Teacher can allow a specific student to change the slide or speak if needed.
- No moderator mode: Anybody in the session can speak, and change slide at anytime. The commands from any participants are broadcasted to everybody. Multiple voice streams are mixed at the server, before broadcasted to everybody. So that every participant can hear whatever others say.

F. Viewer Client Program

Viewer client program is a set of Java programs used for rendering the dynamic or interactive presentation modes on the student’s browser screen. As the content can be multimedia, the client uses a modular design allowing rendering modules for each material type to be installed separately. This design makes it possible for a new module for corresponding to a new material type to be installed in the future. The web browser is used to present static text and still images, while modules are used to render slide-presentation, video, and audio streams. These Java-based rendering modules are launched by the Viewer Client Applet.

G. Authoring Tools

Similar to the viewer client program, the course author also needs a set of tools for preparing the course materials. In this case, the whole editor program is also a Java applet running inside the browser on the author computer. It just needs to be able to render and edit the same set of material types. Importantly, it must be able to import existing materials (in Microsoft Word .DOC or PowerPoint .PPT formats) from the user local computer. Thus, the applet is signed so that such an access is granted.

Basically the editor can edit a basic HTML content which includes formatted texts and still images. Sections and subsections can also be assigned. Multimedia materials and special presentation modes are defined and edited by additional modules for that particular type. The WebELS editor features basic tools for formatting texts, and paragraph alignment, as well as importing external document, such as MS-Word, PowerPoint, PDF files, etc. Content transfer using Cut & Paste mechanism with other native applications on local machine is also supported for texts and still images. After the user finishes editing the content, the “Save” button sends the content, converted to XML format, directly to the WebELS server bypassing the web browser program. Existing materials
in .DOC, .PPT, .PDF, etc., can be imported by clicking on icons respectively. HTML materials can be copied from Internet Explorer screen and pasted into the editor.

H. Installation System

Since WebELS is an open source system, a WebELS installation system has been developed and opened at the WebELS website. The WebELS installation system includes source codes of WebELS and the command for installation. When users download the installation system into their servers, they only need to run the command for installation, WebELS will be automatically installed into the server. In addition, at the WebELS website, a detail installation manual has been given to assist users. According to the installation manual, users should set up basic server system for WebELS before installing WebELS, such as Linux OS, Java Platform, Tomcat, Ant, Apache, MySQL database, etc. With the developing of WebELS, the installation system will be also updated for users.

V. WEBELS FAMILIES

An experimental system has been launched at Internet URL http://weblsx.ex.nii.ac.jp/. It is hosted by a Linux-based PC, with apache web server, Tomcat servlet container, Java 1.4.1, and MySQL database engine. It is being used regularly by a group of test staffs at our institute, adopted with Skype [11] for online interview and made demonstrations in the academic conferences. The WebELS families have three members which include different functions according to the user’s requests: Basic WebELS, Advanced WebELS and WebELS Meeting.

A. Basic WebELS

Basic WebELS is a beginner’s version with essential functions of WebELS. The functions of Basic WebELS includes learning mode, file management (import, view, delete, etc.), user management, whiteboard, BBS, etc. By use of Basic WebELS, teachers can uploaded their documents into the WebELS and students can view them easily. In addition, users can adopt it for online discussion. In a word, through Basic WebELS, the purpose of e-learning can be realized, i.e., it is possible for the students to learn by themselves from anywhere, anytime, at their pace. Students only need to log into the learning mode of WebELS and select the course they want to learn. Then the course can be shown by HTML or PDF format. The course can be also printed out. Besides, the contents given in the courses can be shared among users of WebELS. WebELS can be regarded as an on-line library. It is therefore possible to do group learning.

B. Advanced WebELS

Advanced WebELS is a full version of WebELS. Except the essential functions given in the Basic WebELS, other advanced functions has also been included in the Advanced WebELS, such as editing mode (WebELS Editor), Custom Text Organization, online meeting system, etc. Since it is a full version of WebELS, its web interface is more complicated then other versions of WebELS. From this version, full functions of WebELS can be implemented. In addition, new specific version of WebELS can be easily developed according to the users’ requests. New developed functions for WebELS are always added into this version firstly.

C. WebELS Meeting

WebELS Meeting is an online meeting system. Since WebELS provides strong functions for on-line presentation through Internet, Internet meeting can be held at anywhere. When using WebELS to hold an Internet meeting, members of meeting can be staying at different place. The presenter is the teacher and others are students. His voice can transfer to other members through the audio function of WebELS. An actual interview between Japan and Thai using WebELS has been made. Several professors are in Japan and a student is in Thailand, who is applying for the graduate program in Japanese university. This student makes his presentation by WebELS and other professors listen to his presentation in Japan. They can also ask him questions at the same time.

VI. E-LEARNING SYSTEMS DEVELOPED BASED ON WEBELS

According to user’s requests, several specific e-learning systems are developed based on WebELS, such as e-learning system for the National Institute of Genetics of Japan, teaching and experiment platform for the Department of Automation, Tsinghua University of China. They not only have the different interfaces, but also add some special functions for their situations.

For example, the teaching and experiment platform for the Department of Automation, Tsinghua University of China, is an online system. It is developed based on the Basic WebELS and WebELS Meeting, and mainly used on the teaching and experiment. In order to satisfy the special requests from teachers and students, as one of most important points, this new system should match the features of academic education or discussion in the Department of Automation. Therefore, some new modules have been added. For example, a module for experiment is added in this system. With this module, teachers can upload the demonstration of experiment. In addition, students can understand the conditions of laboratory and select their scheduling for taking experiment. Besides, this platform is made in Chinese. It can deal with various contents of learning with Chinese format. Like WebELS, it also can synchronously operate learning materials, has a whiteboard via Internet as well as synchronously play video, etc. In the near future we want to extend its usage for other departments of Tsinghua University. The top page of this platform is showed in Fig.4.
VII. CONCLUSIONS

This paper introduces the WebELS system for higher education. WebELS achieves portability on multiple platforms by implementing Java-based authoring tools. It provides import filters for major applications to allow material reuse. The system is extensible as flexible software architecture and XML is used to store the material content. Internet on-line meeting strengthens the e-learning functions. WebELS families have three members. Based on user’s requests, several specific e-learning systems were developed based on WebELS.

REFERENCES