

Development of an Annotation-Based Classroom Activities Support Environment Using Digital Appliance, Mobile Device and PC

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Abstract. An annotation-based classroom activities support environment with home network technology is proposed. The environment includes digital appliances, mobile devices, and PCs to facilitate a face-to-face class. The resulting system enables the sharing and playing of learning contents among the teacher and students in the class. The teacher and students can annotate the learning contents without file operation to share. In addition, the system operates devices on a network to support a class and has a user management feature. The system design and the prototype under development are described.

Keywords: ubiquitous learning, home networking, pen-based interface, blended e-learning, face-to-face class.

1 Introduction

Information and communication technology (ICT) is rapidly progressing, and many educational researchers want to apply these various technologies in the learning space [1, 2]. In the learning environment, small-scale electronic equipment, such as mobile phones or handheld gaming devices, are used. The devices are taken outdoors or to facilities for learning, such as museums. However, with the downsizing of computer terminals, most ICT research focuses on ubiquitous computing for daily life and the everyday environment [3]. There have been few studies on achieving a ubiquitous learning environment.

With the progress of computer technology, digital appliances with network functions, such as VCRs, TVs, and digital cameras, have appeared. The network function of most digital appliances is implemented in relation to the Digital Living Network Alliance (DLNA) specification [4]. Digital appliances are not only easier to operate than PCs but also enable the user to collect, accumulate, and browse learning contents more easily than with a PC. For a learning system, the network function can connect several services and contents on PCs, mobile devices, and digital appliances. For example, by using the network function, a teacher can output contents recorded on a VCR through a projector or TV in a classroom by using a laptop in the

classroom. Moreover, students can use the service and the contents by using the network functions of their own devices.

We propose an annotation-based class activities support environment with home network technology. In the environment, users can use digital appliances, PCs, and mobile devices seamlessly through the home network specification. The environment uses the functions of digital appliances, e.g., collecting, recording, browsing, sending, and receiving of contents, via a network. In addition, for teachers and learners to handwrite comments and to share learning contents in real time, we developed a prototype on a PC.

In designing the prototype, we targeted PCs, digital appliances, and mobile devices. Therefore, we considered their compatibilities in trying to develop unique learning support functions. In addition, to consider ease of use, a pen-based user-interface was used to support learning activities, e.g., operating multimedia contents and making presentations in class.

2 Design of Learning Environment

2.1 Use of ICT in Classroom

In a face-to-face class, a teacher and students spend time in a classroom. The teacher explains the course content to students by using, for example, a blackboard, projector, or PC. In addition, to obtain student opinions and impressions, a teacher may put questions to the students. To gain a further understanding of the class, the teacher often offers group discussion or similar. To make class activities easy to understand for students, some teachers try to use ICT as a tool, e.g., a projector or PC.

Recently, some researchers have been focusing on a learning theory called active learning [5] by theorizing the use of ICT, e.g., mobile phones or PCs, for classroom teaching. Classes have tried to use ICT for active learning [6, 7]. In those classes, the shapes and the disposition of desks were designed to make ICT tools user-friendly. However, only the ICT tools themselves make learning activities easy for students to understand. Thus, we focus on improving an ordinary classroom with home network technology to facilitate the use of ICT tools.

Home network technology enables the teacher and students to use ICT tools more comfortably. Therefore, we propose an environment to facilitate using that technology in an ordinary classroom. To adopt a ubiquitous environment in a face-to-face class, we considered a teacher's actions in a class. We focused on the following actions to design functions to facilitate a face-to-face class.

- 1) **Teacher's explanation to students:** In a class, most teachers use a blackboard or PowerPoint presentation to give explanations. Handouts are often circulated to students in advance and are uploaded on a Web site. When using PowerPoint, teachers may use a laser pointer to highlight something and use the blackboard for a supplementary explanation.
- 2) **Feedback from students:** Teachers grasp the understanding of students from student behavior or from quizzes in class. In addition, teachers may incorporate the opinions of students as teaching material in the class.

- 3) **Discussion:** To complete the active learning in class, the teacher may set students a task for group discussion. Students may determine a definite topic in class, or the teacher may introduce the topic of group discussion in the class.
- 4) **Procedures for class:** Procedures include taking attendance, grouping students for group work, and operating equipment in class.

To support these four actions in a face-to-face class, we designed the following functions: to share learning contents, annotate learning contents, use a pen-based interface, and manage attendance and groups.

2.2 Sharing Learning Contents

This function enables learning contents to be shared electronically instead of by paper. Terminals that are compatible with the home network, e.g., PCs, mobile devices, and TVs, can handle multimedia contents, e.g., music, pictures, and movies. The interfaces of most home network clients show the contents sorted according to the media type.

The learning contents in a class consist of learning materials of several media types. Therefore, the prototype treats all learning materials in class without classification by the media type by a unit of a class. The media is compliant as HTML documents and pictures and movies. HTML documents are prepared by using a conversion program on documents created by a word processing tool. HTML documents are also prepared for learning by using HTML documents from Web sites. Pictures are prepared by using a conversion program to create picture files from PowerPoint files. Movies are prepared for using video clips to give explanations accompanied by animated visuals.

2.3 Annotation and Sharing

Annotation of learning contents is a function for drawing on the currently displayed learning content. The user can make annotations using not only a mouse but also a pen with a tablet. Annotations can be made on movie files that are being played with the written time of the contents. The annotations are shared with other students and the teacher as files via the network. The annotation file contains the annotation history, such as user, group, color of annotation, and time of annotation (when made on the video media), and so on. The system aims to display the learner's thinking process through the annotation file.

2.4 Pen-Based Interface

The interface is designed to be easy to use with a pen with a tablet PC or a tablet device. The user can select the learning content to annotate and can annotate the learning contents while they are played. Other devices can be controlled with the network function and infrared remote control via the network by user operations on the screen.

2.5 User Management

By the user registering before using the system, the system can take attendance in conjunction with the network function or other devices. In addition, it can manage group work by grouping the students.

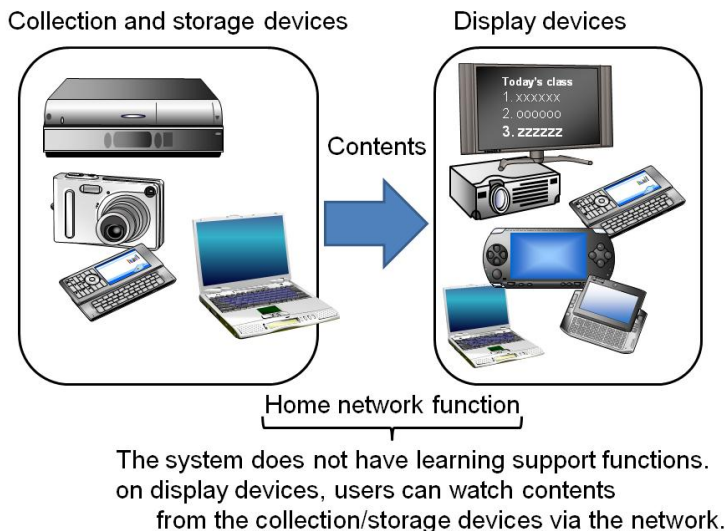


Fig. 1. Overview of the home network and learning function

3 System Overview

3.1 Adding Class Support Function

The mechanism of the home network specification is shown in Fig. 1. The mechanism enables the contents in storage devices to be shown on display devices via the network. Devices are digital appliances, mobile devices, or PCs. Regardless of the location of the storage device, the environment provides contents without complications, such as copying the contents, via the network. For example, pictures taken by a digital camera can be shared with other devices via the network in this environment.

However, the home network is hard to use because the contents are classified by media type, e.g., picture, music, or video, in the home network player. Moreover, functions for facilitating education are not available, e.g., ability to annotate contents. Therefore, we added functions to support a face-to-face class, as shown as Fig. 2. The added functions are as follows.

- 1) **Sharing teaching materials:** This is a function for sharing contents in the class among the teacher and students. For example, the contents taken by a digital camera can be shared in class in real time.
- 2) **Annotation:** This function enables annotations to be made on playing contents. It can record the history of annotations. Students can present the

results of student discussion with annotations. The annotations recorded with the teaching materials can be shared with the teacher and other students. Therefore, not only can students view the annotations of other groups, but the teacher can get feedback from the results.

- 3) **Pen-based interface:** The system uses a pen-based interface that tablet PCs or some mobile devices have for easy operation. For example, the user can make annotations by hand and can change the status of devices connected by the network.
- 4) **Managing attendance and grouping:** This function takes attendance. It can also manage the grouping of students.

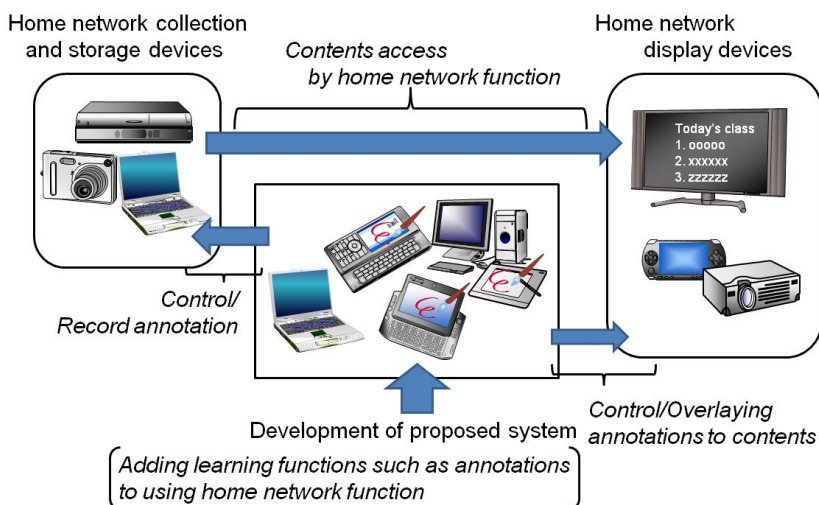


Fig. 2. Development area of proposed system

3.2 Adding Class Support Function

The system flow is shown in Fig. 3. For using the system, a wireless LAN is put in the classroom. According to need, a projector, PC, digital camera, and so on are put in place. The flow is as follows.

- 1) **Creating and uploading learning contents:** The teacher creates teaching materials for a class and uploads them to the system.
- 2) **Preparing the classroom:** The wireless LAN router is put in a class before the class starts. The teacher connects the teacher's PC to the wireless LAN. In addition, the teacher prepares to use devices in the class.
- 3) **Starting the teacher's system:** The teacher starts his or her system.
- 4) **Connecting student devices to network:** Students connect their devices to the wireless LAN.
- 5) **Using in the class:** The teacher gives classes by using the system.

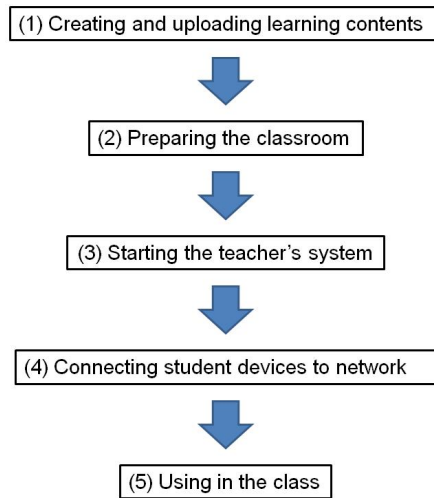


Fig. 3. System flow

4 Example of Usage

The purpose of the system is to improve the use of learning contents in class and to gain some feedbacks from students. A teacher can use the system for a presentation tool. In addition, to gain a further understanding of the class, students can actually operate the learning contents by annotation and so on.

For example, if a teacher gives an explanation of motion of equipment, the teacher may use a video clip. This system can annotate on playing the video clip for the use. In addition, the annotation and the video clip can be shared. Therefore, students can verify the video and the annotation.

In group work, the system facilitates to arrange the students' through over a finite period of time because the students can draw on the HTML documents and can share with the teacher. Therefore, the result can be used as a feedback in the class.

5 Implementation

5.1 System Architecture

The prototype was developed using Java on Windows. The system uses CyberLink for Java and uses Java Media Framework (JMF) and Communication API as libraries.

The prototype consists of three parts: the system controller, the annotation editor, and the user manager. The controller can get and set device statuses. In addition, it controls external devices. The editor can make annotations and share learning contents from storage devices on the network. The user manager provides management of user attendance and grouping of students.

5.2 Structure of System

Devices used in the system consist of three parts: (1) an interface for users, (2) an application to provide services to other devices on the network, (3) and a network function (Fig. 4). For example, a TV that does not have storage consists of a content player, display, and controller. A VCR consists of only a contents server.

The architecture of the annotation editor is in Fig. 5. This architecture is part of the architecture in Fig. 4 and has functions to support a face-to-face class.

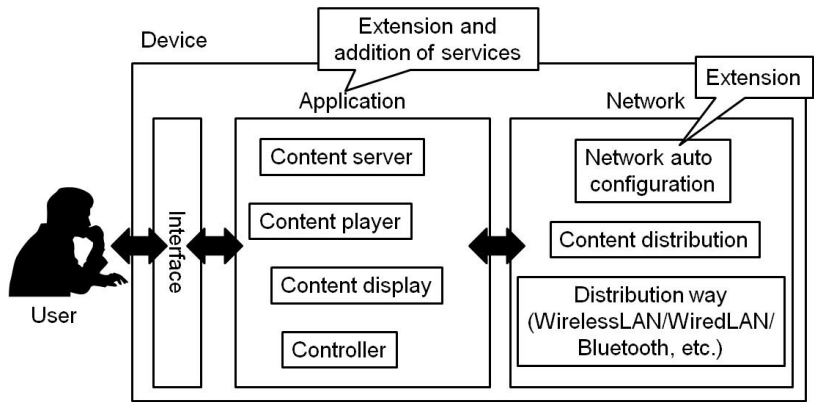


Fig. 4. Architecture of ordinary device

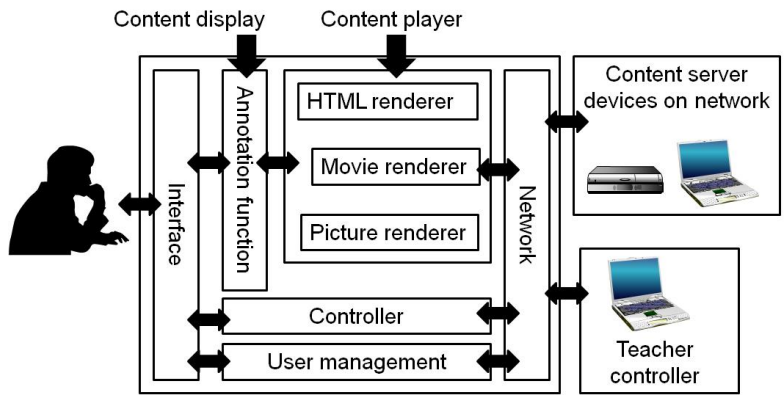


Fig. 5. System structure of proposed system

5.3 Structure of System

A snapshot of the prototype interface is presented in Fig. 6. The system enables the sharing and annotating of learning contents in class. The interface has a content player for annotation and a user management function.

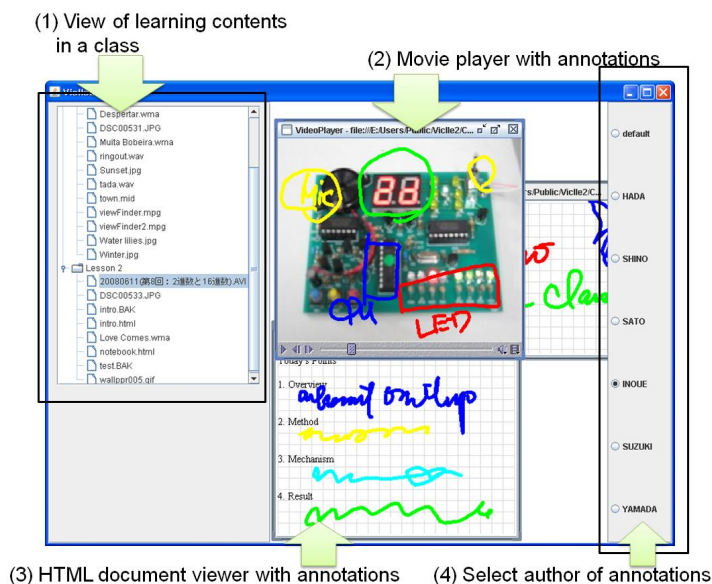


Fig. 6. Snapshot of system interface

6 Concluding Remarks

We proposed a system that supports activities in face-to-face classes with home network technology to provide ubiquitous learning. We will next adjust the system design to further develop the prototype. In addition, we will consider evaluating the use of the prototype in an actual face-to-face class.

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