Fine-grained Recording and Streaming Lectures

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Abstract: There are several lecture recording systems (commercial and non-commercial) based on VOD technology. These systems record only slides or WWW images statically, so the fine-grained events are missed. For example, scrolling and/or mouse focusing are not recorded. We developed a fine-grained lecture recording system which records mouse movement during lectures, and also records lectures using Microsoft PowerPoint® and WWW.

Keywords: Lecture Recording, VOD, WWW, PowerPoint®

Introduction

Multimedia contents and Internet are widely used in lectures. Real time lecture recording and their libraries are realized in various situations. There are three styles for lecture recording:

Video On Demand (VOD) based system.

Based on the multimedia description languages such as SMIL (See SMIL).

Fine-grained lecture process recording using whiteboard.

The first style uses the script function of VOD systems, and synchronizes VOD contents and WWW pages. Synchronization commands are embedded within VOD stream, so it is difficult to edit the recorded contents, but customization of script functions is possible. The second style uses multimedia synchronization functions of multimedia description languages such as SMIL. The third style records the whiteboard writing process and uses special playback applications. Text and image data may be written beforehand on the whiteboard as background image. They use special data format, so it is difficult to play back with streaming style. They adopt fine-grained recording, so underlining and focusing action can be recorded.

Several lecture recording systems are developed and some software products are also provided, but there are the following problems when each teacher uses these tools in a variety of situations by themselves:

Fine-grained recording is needed. One page includes many concepts, so it is necessary to indicate which part is focusing at each time.

There are a variety of specific requirements, so the fixed given products do not satisfy the variety of users' needs.

Some software products have many functionalities, but they are expensive, so it is difficult for each user to use them in their own sites.

Users often want to edit recorded contents, but existing tools have no such function or usage is difficult.

Some tools developed in research projects also have many functionalities, but it is difficult for each user to use in a ubiquitous manner.

We have already developed and used a SMIL based lecture recording system (see Kenji), but it cannot record mouse events and WWW pages. According to the above problems, we acquired the following attributes, and developed the lecture recording system (FineRecordSystem) that satisfies all of the above requirements except the fourth. This system records lectures in which teachers use PowerPoint® or WWW pages for presentation, and stores them as streaming data:

Mouse event can be recorded and played back.

It is possible to customize usages according to each user's requirement.

It is easy for teachers to record lectures. Teachers need to do a little additional task to record lectures.

It is possible to play back in streaming manner.

We describe related researches in Chapter 2, our system in Chapter 3, and evaluation according to a few months' experiences in our laboratory in Chapter 4. We described the conclusions and the future works in Chapter 5.

Related Researches

We surveyed existing lecture recording systems and clarified their problems. There are several systems that use SMIL as the description language. SMIL itself has the multimedia control functions, but its granularity is not so fine. The WLAP system (Bousdira, 2001) records lectures as LectureObject (LO) using XML. Synchronization is described using Meta data, which is based on RDF (See RDF). These LO data cannot be directly played back, so if playback is requested, LO data is automatically transformed to some available data format, for example SMIL. WLAP is a very general system, so usages are not so easy. Hunter's system (See Little 2002) records lectures using SMIL, and separated post processing is needed to index the contents and to construct as SMIL data. Cast:stream (See Cast:stream) has many required functionalities, but it is a product and is not easy to use.

Dlb (Hilt, 2000), AOF (Hurst, 2001), AudioGraph (Jesshope, 2000), and WebLearner (See WebLearner) are lecture recording systems using a whiteboard. They need special playback tools. The objective of these systems is a little different from our system. CamtasiaStudio (See CamtasiaStudio) records any part of the windows screen, but synchronization with lecturers is not considered. The objective of Cornell Lecture Browser (Mukhopadhyay, 1999) is to record lectures in a ubiquitous manner. It uses special format, so streaming is not possible. The objective of Eclass (Graca, 2001) is also a ubiquitous electronic lecture room. Sync-O-Matic (See Sync-O-Matic) records slide based lectures. It generates RealVideo® based data. It is difficult to edit the recorded contents. ClipBoard-2000 (See ClipBoard-2000) also records slide based lectures. It uses the QuickTime® system.

RealPresenter (See RealPresenter) and Microsoft Producer are the presentation recording products and they can use PowerPoint® and WWW pages, but their objective is not real time recording.

Lecture Recording System

System Requirement

In our university, e-learning has already started and many teachers have prepared e-learning resources, but no support person is provided, so each teacher must use lecture recording systems in their own sites by themselves. Teachers also want to use several presentation styles, so we have adopted the following requirements for our lecture recording system:

It can record the mouse movement and scrolling.

Recorded contents can be viewed using streaming techniques.

It can record the presentation using WWW pages and Microsoft PowerPoint® slides.

It is free.

It is easy to use.

It is customizable.

According to the above requirements, we determined to use Microsoft Media Technology. In Microsoft Media Technology, the SDK and custom scripts are available, so it is possible to customize prepared tools (encoders and players) and to insert customized scripts in order to record various actions while teachers make lectures.

VOD Script Function

Ordinary VOD systems have script functions. When recording, some predetermined script commands can be inserted within video objects. When playing back, players recognize these script commands and implement actions according to the command functions. Synchronizing with video objects, for example, Microsoft MediaPlayer can recognize URL access scripts, so MediaPlayer plays back video objects synchronously with WWW pages.

MediaPlayer can recognize only limited scripts, but using the SDK, MediaEncoder can insert customized scripts into video objects. If we extend MediaPlayer using the SDK so that it can recognize these customized scripts, then it becomes possible to record and to play back more sophisticated action during lectures. This is called a custom script. In order to use custom scripts, corresponding events, for example mouse movement, must be recognized and the playback function for these events needs to be realized.

System Overview

Our system consists of the following two tools:

Lecture Recording Tool

Our system can record PowerPoint® based lectures and WWW based lectures. In the case of PowerPoint®, each slide must be transformed into image data. This tool transforms each slide and inserts a custom script invoking these slides into video objects. This tool also recognizes the mouse event and inserts a custom script, which replays this event, into video objects. It uses MediaEncoder as a component.

Lecture Playback Tool

This is a special playback tool. MediaPlayer cannot understand custom scripts, so we extend MediaPlayer using the MediaPlayer SDK so that MediaPlayer understands custom scripts.

System Usages and Evaluations

System Usages

FineRecordSystem is a real time recording system, so users must follow these two procedures:

Initialize the recording tool

Users must determine the following conditions: 1) lecture resource (WWW page or PowerPoint® slide); 2) encoding condition. Encoding rate and input/output media must be determined. This information may be saved, so in ordinary cases, this saved information can be reused and the initialization process becomes easy. Users only need to select lecture resources and predetermined recording conditions.

Start the recording tool and conduct a lecture

In the case of WWW pages, users must use a specialized browser in order to record mouse movement and URL transition, but there is no special action needed except for the action which starts/stops recording the mouse event: In a WWW based presentation, there exist many mouse events, except for focusing purpose, and recording all of these events needlessly increases scripts. As a result the burden of players increases, so we have selected a manual approach (Figure 1). In the case of PowerPoint® slides, there is no need for users to use a special tool, so there is no special action needed and an ordinary slide show in PowerPoint® can be used. When users stop the lecture (in WWW case, push the stop button and in PowerPoint® case, stop the slide show) recorded data will be saved automatically.

Recorded data are stored using Windows Media Video format (WMV). In the case of PowerPoint® slides, transformed slide image files are added to WMV files. In the case of WWW pages, online html data will be used, so if these html data are changed, synchronization will be missed.

FineRecordSystem uses customized scripts, so a custom made player (Figure 2) is needed. In order to play back the recorded lecture, users start this playback tool and identify the recorded resources. URL and local files are possible. In order to play back using streaming mode, these data must be stored in a streaming video server. In a WWW based presentation, only user selected mouse events are recorded and will be played back, so focusing becomes clear.

System requirements for FineRecordSystem are as follows:

PC with video camera (over 256MB main memory, over 500MHz clock, video camera).

IE (**FineRecordSystem** uses IE component).

Media Encoder 9.0, or later version.

PowerPoint® 2000, or later version.

Evaluations

We have used FineRecordSystem in some seminars. All seminars are recorded successfully, and all seminar presenters can use FineRecordSystem with a few minutes explanation. From the several experiments it becomes clear that scripts may be omitted during transmission. If the omitted script is a URL script, then the corresponding WWW page is not presented. This omission was caused by non-ACK transmission, so the resolution for this problem is 1) to narrow the encode bit rate, or 2) to widen the transmission line. We applied the first solution.

Conclusions and Future Works

We realized the fine-grained lecture recording system (**FineRecordSystem**) which has the following characteristics:

Both WWW pages and PowerPoint® slides can be used.

FineRecordSystem records the mouse movement.

It is simple, so it is easy to use.

It records lectures in real time.

In order to realize finer grained recording, the following functions become necessary:

The scrolling of WWW pages.

Animation of PowerPoint® slides: FineRecordSystem records one slide as one jpeg file, so the changes within one slide cannot be recorded. Microsoft Producer can synchronize slide animation with video object.

We have not yet evaluated the effect of this fine-grained recording, so we will do some controlled experiments and evaluate the effectiveness of FineRecordSystem.

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Figure 1: An instance of encoding screen for WWW page

Figure 2: An instance of the playback tool