

Design of a Web-based Synchronized Multimedia Lecture System for Distance Education

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Abstract

Currently, the WWW has created an open-environment for convenient delivering of the HTML pages and low-bandwidth video clips. Since the HTML pages can present static text and image in much higher resolution than that presented by a low bit-rate video clip, we believe that the optimal mode for a WWW-based distance lecture is to use (1) streaming video clips for the audio/video lecturing, and (2) dynamically loaded HTML pages to present the lecture notes navigation process. To this end, in this article, we have designed a "Live/On-Demand Synchronized AV/HTML Distance Lecture System" to synchronize the presentation of the streaming video lecture, the HTML-based lecture notes, and the HTML Navigation Events. We propose a "Web-based Synchronized Multimedia Lecture (WSML)" framework to automate the recording of the media presentation events based on the SMIL specification. The WSML framework consists of three major modules: (1) WSML Recorder- for recording the temporal information of the AV lecture and the HTML-based lecture notes navigation process. (2) WSML Event Server- for receiving, multicasting and depositing WSML events. (3) WSML Browser- for presentation of the synchronized AV lecture and HTML-based lecture notes navigation. To evaluate the performance of the propose framework, in this stage, we have applied the RealSystem to implement a prototype Synchronized AV/HTML Distance Lecture System using Java/Javascript. The prototype system demonstrates the feasibility of the proposed framework.

1. Introduction

The booming of WWW has created an open environment where information could be distributed rapidly on the Internet. Over these years, many online courses using the HTML pages as lecture notes have been offered [1-3]. However, without guidance, these HTML pages indeed could only serve as dumb networked lecture notes and are impossible to replace the traditional classroom lecture. For the last decade, the advent of modern data compression technologies has made online

A/V information distribution feasible. The innovations indeed provide a new manner for distance lecture [4-8, 14-16]. Certainly, incorporating Video into WWW could significantly improve the efficacy of Web-based distance education. To this end, previous research such as the Video Mosaic [4] (using self-designed VDP communication protocol to integrate the Video into WWW) has been devoted to developing Web-based video systems. The SMIL- Synchronized Multimedia Integration Language [17] has also been proposed recently to explore the synchronization issues of the networked multimedia presentation. On the other hand, various commercial software currently exists for audio [9, 10]/video [11] broadcasting and on demand over WWW. Among those, the most popular one is the RealAudio system developed by the RealNetworks. With their proprietary streaming and video compression techniques, the RealAudio possesses the capabilities of multi-bandwidth video transmissions and presentations on WWW. Providing satisfactory audio performance, the RealAudio System indeed meets the audio quality requirements for distance lecture. Yet, to compensate for the bandwidth on the Internet, the images of the video clips are highly compressed and thereby distorted significantly. In Figure 1, a low-bandwidth RealAudio video clip is shown to exemplify the image quality. Apparently, the texts inside these distorted lecture notes images are barely discernible. Under such circumstance, it is not possible to use simply the video clips to present the lecture note at low bit rates.

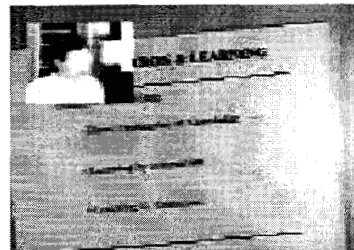


Figure 1. Distorted image of RealAudio at 16Kbps.

Since the HTML pages can present static text and image in much higher resolution than that presented by a low bit-rate video clip, it is naturally to believe that the optimal mode for WWW-based distance lecture is to use (1) streaming video clips for the audio/video lecture, and (2) dynamically loaded HTML pages to present associate lecture notes. Furthermore, the efficacy of distance lecture would be even better if the students could replay the teacher's HTML navigation process (such as highlight region, Mouse pen drag, scrolling bar movement ...etc.) [12]. Several studies have been done regarding the synchronization of the Video and the HTML navigation. The NHQT System [8] can synchronize the QuickTime video with the HTML navigation. The MANIC [7] system also successfully synchronizes the streaming audio (RealAudio) and HTML pages. However, both NHQT and MANIC only provide the lecture on-demand function and lacks the live lecture broadcasting capability. Besides, these systems are not SMIL-compliant and their lecture materials are inaccessible to the SMIL Player.

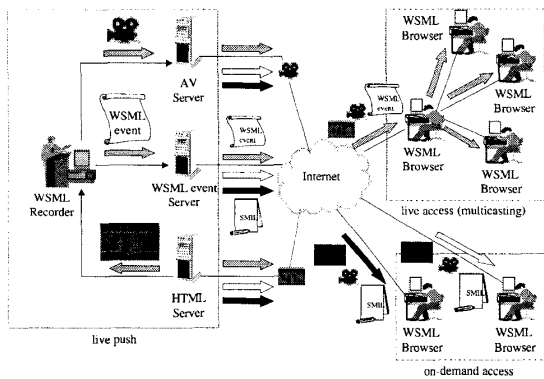


Figure 2. Framework of the proposed Synchronized AV/HTML Navigation Distance Lecture System (offering live multicasting mode and on-demand unicasting mode).

In this project, we aim to design a "Live/On-Demand Synchronized AV/HTML Distance Lecture System" by integrating and synchronizing the streaming video, the HTML pages, and the HTML Navigation Events. The proposed framework integrates the HTML and streaming video publishing techniques on WWW, so as to synchronize the presentation of video lecture clips, the corresponding HTML pages, and the lecture note navigation process in a WWW browser. We propose a "Web-based Synchronized Multimedia Lecture (WSML)" framework to automate the recording of these three media events based on the SMIL specification. Novel tools have been implemented using Java/Javascript to facilitate the authoring of the synchronization information between the

HTML navigation and streaming video clips. In this article, the proposed framework will be addressed and the detailed implementation of the authoring tool will be elaborated.

2. The proposed Framework

Our Web-based Synchronized AV/HTML Navigation Distance Lecturing System consists of three major modules (as shown in Figure 2): (1) WSML Recorder- for recording the temporal information of the AV lecture and the HTML-based lecture notes navigation processes. (2) WSML Event Server- for receiving, depositing, and multicasting/unicasting all WSML events. (3) WSML Browser- for synchronized presentation of the AV lecture and HTML-based lecture notes navigation.

2.1. WSML Recorder

The major function of the WSML Recorder is to record the video along with the associated events during the lecture. The recorder consists of (1) Timer, (2) AV Encoder, (3) Navigation Event Logger (as shown in Figure 3).

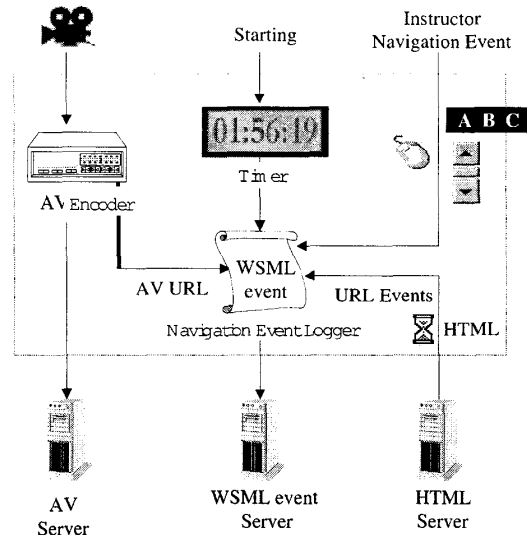


Figure 3. The components of the WSML Recorder.

- (1) Timer: to initialize the recording process. Each time the teacher starts the recorder, the timer will be initiated and become the time-line of the WSML. At the same time, the timer will automatically activate the AV Encoder and the Navigation Event Logger.

- (2) AV Encoder: to encode/deliver the AV lecture. The Encoder encodes the video and then sends the compressed AV lecture to the AV server for live broadcasting or subsequent lecture on demand.
- (3) Navigation Event Logger: to record the temporal information of the AV and the HTML navigation events. The major events occurred during typical HTML-based lecture notes navigation process include the mouse event, and the URL event (illustrated in Figure 4). Those events induced in the teacher site will be sent to the Navigation Events Logger for recording. The mouse events include information about the mouse drag coordinates, the highlighted regions, and the scrolling offsets. The URL events occur at the moments the teacher inputting URL, loading HTML pages by pressing hyperlinks, browsing backward, or browsing forward. The Navigation Event Logging process is exemplified in Figure 4. At instance T1, the AV URL and HTML URL1 are logged. At T2, the coordinates of the highlighted region will be logged. At T3, URL2 of the renewed HTML will be logged. At T4, the mouse drag coordinates will be logged. At T5, the scroll bar positions will be logged.

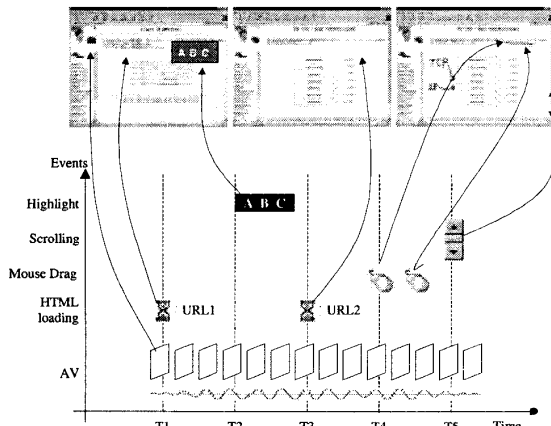


Figure 4. An example illustrating the event logging process using the Navigation Event Recorder.

2.2. WSML Event Server

The WSML server is responsible for the receiving, recording and transmitting of the WSML events. In the live broadcasting lecture mode, The WSML Event Server receives various WSML events from the Navigation Events Logger, and then broadcasts to the students who use WSML Browser for lecture presentation. At the same time, those events will be encoded (by the SMIL gateway)

into SMIL 1.0 compliant format to be deposited in the SMIL database for future on-demand requests. Figure 5 illustrates the interactions among the WSML Recorder, WSML Event Server, and WSML Browser in the live broadcasting mode and the lecture on-demand mode.

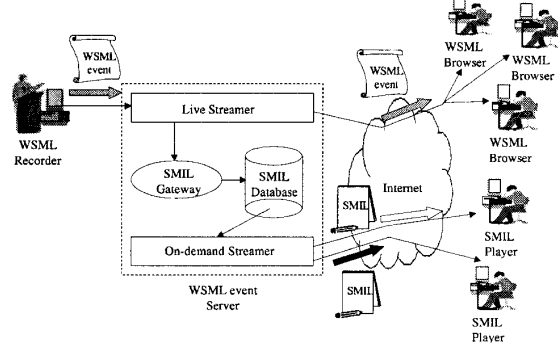


Figure 5. The detailed interactions among the WSML Recorder, WSML Event Server and WSML Browser in the live broadcasting and on-demand mode.

2.3. WSML Browser

The WSML Browser is for presenting the AV lecture and replay the corresponding HTML navigation processes based on the information broadcasted from the WSML Event Server (as shown in Figure 6). The major components of WSML Browser include WSML Reader, Event Handler, AV player and HTML browser. Take the WSML events illustrated in Figure 4 as an example, the WSML Browser will present the WSML in the following sequence (c.f. Figure 5):

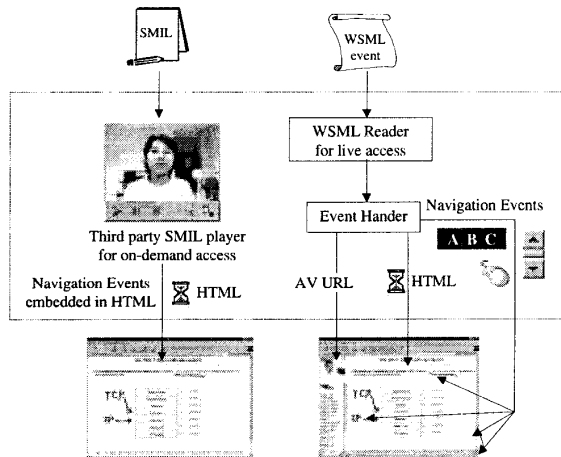


Figure 6: Framework for the WSML Browser

T1: the WSML Reader receives the AV URL and HTML URL from the broadcasting WSML Event Server and sends them to the AV player and HTML browser respectively. The AV player then start playing

the AV lecture. At the same time, the HTML browser will also begin to present the HTML-based lecture notes.

T2: according to the timeline of the AV player (or system clock), the Event Handler sends the highlight event information to the HTML browser to present the highlighted region.

T3: the Event Handler sends the URL renew event to the HTML browser to reload new HTML page at URL2.

T4: the Event Handler sends the mouse drag event to the HTML browser to present the mouse dragged trace.

T5: the Event Handler sends the scrolling event to the HTML browser to adjust the vertical page scrolling offset.

3. System Implementation

Currently, in our system, the live broadcast WSML events are formatted in a self-designed Tag Description Language. The format of a specific Tag is as below:

```
<media_type action = value start_time [~ end_time]>
```

The following is an example of WSML events which describe a synchronized Video/HTML presentation with mouse drag and scrolling events.

```
<video play = pnm://www.mcl.csie.ncnu.edu.tw/chap15.rm T1>
<html load = http://www.ncnu.edu.tw/slide1.html T1>
<event highlight = (68, 21, 78, 47) T2>
<html load= http://www.ncnu.edu.tw/slide2.html T3>
<event drag = (30, 40) T4>
<event scroll = (34) T5>
```

To facilitate the browsing of the WSML, before storing to the WSML Event Server for future on-demand requests, the MSML events are processed by the SMIL-gateway and then encoded into SMIL documents. Since the SMIL applies the DTD tag, we will be able to use SMIL syntax (such as the <par> tag) to represent the temporal relation among the AV lecture, HTML pages, and HTML navigation events. The following is an example SMIL document describing a synchronized Video/HTML presentation: (assume the elapsed time between T1 and T3 is 50 seconds)

```
<par>
<video src="pnm://www.mcl.csie.ncnu.edu.tw/chap15.rm">
<text src="http://www.ncnu.edu.tw/slide1.html" begin="0s">
<text src="http://www.ncnu.edu.tw/slide2.html" begin="50s" >
</par>
```

To evaluate the feasibility of the proposed framework, in this stage, we have built a prototype distance lecture system using RealAudio System [11]. The RealPlayer plug-ins embedded in the Netscape Navigator is used as the AV player in the WSML Browser. The RealServer is

used as the AV server and the RVEncoder as the AV Encoder respectively in the WSML Recorder. The synchronization of AV the HTML pages is implemented using the "rmmerge" provided by the RV Encoder which actually embed the HTML URL events into the AV bit stream (as shown in Figure 7). To design a platform independent WSML system, we choose the Java/Javascript for the system implementation. By the Live-Connection technology, the RealPlayer is able to provide function call to Java/Javascript to synchronize the presentation of HTML and AV materials (as shown in Figure 8).

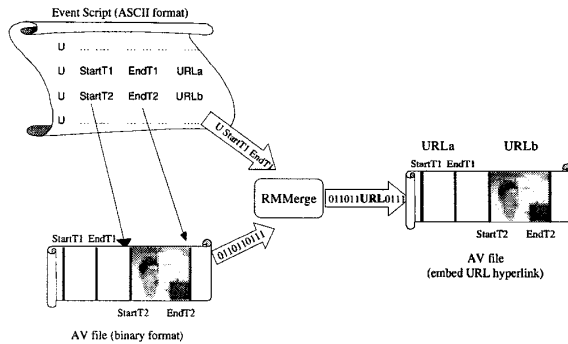


Figure 7. Embedding the HTML URL into the RealAudio bit stream.

In this stage, using the Real System as core components in our prototype system, we have completed the URL Loading Event in the WSML Recorder. Using the Event Handler provided in Javascript, the system would be able to acquire the URL of HTML pages. However, we have found that the Real System lacks the mechanism for handling the change of HTML URL information. Under such circumstances, whenever the HTML-based lecture notes changes the URL, the "rmmerge" need to be re-applied to embed the synchronization information into the RealAudio stream. Currently, we are trying to apply the Java Media Players (defined in the Java Media Framework) as our AV media player to replace RealAudio system. The Java Media Players are able to present various media including MPEG-1, AVI, QuickTime, WAV, AU, MIDI. Also, we are designing the SMIL-gateway to be able to encode the synchronized lecture based on the SMIL 1.0 Specification.

4. Conclusion

In this article, we have designed a "Live/On-Demand Synchronized HTML-AV Distance Lecture System" to synchronize the presentation of streaming video lecture, HTML-based lecture notes, and HTML page Navigation

Events. We proposed a “Web-based Synchronized Multimedia Lecture (WSML)” framework to automate the recording of these media presentation events. The WSML framework consists of three major modules: (1) WSML Recorder- for recording the temporal information of the AV lecture and the HTML-based lecture notes navigation processes. (2) WSML Event Server- for receiving, depositing, and multicasting/unicasting WSML events. (3) WSML Browser- for presentation of the synchronized AV lecture and HTML-based lecture notes navigation.

To evaluate the performance of the proposed framework, a RealSystem-based prototype Synchronized HTML-AV Distance Lecture System has been implemented using Java/Javascript. The prototype system certifies the feasibility of the proposed framework.

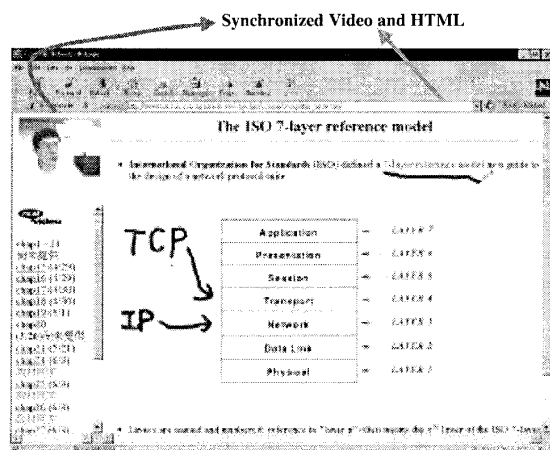


Figure 8. Snapshot of the Web-based Synchronized Multimedia Lecture System.

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