Real-time Streaming Technology in Educational Settings

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Abstract: Streaming media is a method of making audio, video and other media files available in real-time, with no download wait, over the Internet or corporate Intranets. This paper briefly introduces the application of real-time streaming technology in educational settings. This paper also shows two case studies where simple virtual classrooms are used to support real classroom environments. It is shown that the usage of technology enabled methods including streaming technology in university campuses results in a model that works equally well for distance students and learners in virtual campuses.

1. Introduction

In network delivered multimedia files the term streaming refers to the process of delivering audio, video clips, or other media presentations in real-time to on-line users. A clip can be viewed or heard almost immediately as it downloads from the streaming server. In this case users do not have to wait until the media file is completely downloaded before playing it back on their computers. Streaming can be live or non-live. Webcasting generally refers to live streaming.

There are several reasons why downloading media files including video and audio clips before playing back is less than ideal situation for hearing and viewing media files over the public TCP/IP network. For instance, if a user on a low bandwidth connection (and even high bandwidth) wants to move forward in the video they have to wait till the whole file is downloaded before they can view something in the future. Also, if a user only views a small portion of the stream and they are on a high bandwidth connection they are likely to have downloaded the whole file after only a few seconds. This will cost the user extra bandwidth because web servers typically download as fast as they can. Web sever do not have Intellectual Property control and so a publisher will not be able to prevent users from downloading the media file for re-using. The fundamental nature of web servers is to allow download of files not protecting the copyright of materials moving all over the Internet. Also web servers are not capable of live delivery of media files. There are other reasons as well, which proves the superiority of dedicated streaming servers over the standard web servers in the delivery of multimedia files.

Educational institutions have long been a testing ground for the latest technological breakthroughs that change the way academics work and live. Examples include the use of streaming technology and application of interactive and dynamic Web environments in traditional educational institutions. The integration of Web-based resources into traditional teaching materials has already changed the face and culture of teaching and learning in many places. The web has created new opportunities and challenges for professional educators at tertiary teaching institutions worldwide. It is shown that in a well-designed web-based support system, students take more responsibility for their own learning, and instructors function more like coaches and mentors for a new generation of professionals [1].

The outcome of research and development work in utilizing new and emerging educational technologies in traditional educational institutions also found its way to serve distance students. Currently, national and transnational virtual universities along with educational establishments are offering online continuing education courses and corporate training using Web-based courseware integrated with stream multimedia modules. In fact,

virtual classrooms that are used to support real classroom environments in traditional universities have been found to be very attractive in virtual campuses all around the globe [2].

This paper briefly introduces the application of real-time streaming technology in educational settings. In a simple setup the streaming technology is used to deliver synchronised text, images and other media files over the network. In a more complex setup, streaming is used for network delivery of interactive multimedia modules. To further explore the application of streaming technology in educational setting two case studies are illustrated and explained in terms of the module structure and the method of delivery. The multimedia modules illustrated in this paper are;

1. a simple “virtual classroom” offering standard Power Point slides synchronised with streamed voice narration from taped lectures, and
2. a stream video presentation in which the video is indexed to the table of the content.

Both modules are delivered to students over a low bandwidth modem connection.

An interesting feature of most streaming server programs is that they allow client machines to directly negotiate with the server to access the part on the video file it wants. Normally, after a short pause the user can jump to anywhere in the movie. The video can be indexed to a table of contents and can also automatically "flip" pages in an adjacent frame according to markers embedded in the video. The combination of powerful compression algorithms, extensive features that are associated with streaming servers and integration with Web make it possible to use video effectively over the network.

2. Multimedia Files for Network Delivery and Streaming

Though it would be useful to utilize desktop videos for course material presentation and distribution, till recent times this was limited to a corporate environment or on-campus environment where students have access to high-speed lines directly. In a broad term, the delivery of media files on the Web has always been limited by the bandwidth that is the capacity of communication lines or channels. Development in this field is happening in two directions: faster connections and communication technologies that are altering the capacity of the communication channels and new multimedia technologies for the Web, such as streaming audio and video, shockwave, and others that are allowing for better delivery of media on the Web.

The delivery of a virtual classroom uses real time streaming technology. With real-time streaming, a user can play an audio or video file as soon as his/her computer is receiving the initial part of the file. The user keeps playing the file while the remaining parts are downloaded. This makes real-time streaming significant. For example, a student can start listening and/or viewing an hour lecture over the network almost instantly. With no streaming, the student needs to download the entire file before he or she can start using it. Receiving multimedia files via low speed dial up connections makes real-time streaming even more useful.

Major players in streaming audio and video contents are Real Network technology offering server and client software, VXtreme's Web Theater Client, and Vivo active power player. Around mid 1996, the Real Network introduced its first real-time streaming technology for audio signals. This allowed the production of real audio files. It also provided filters to be used in conversion from a variety of audio formats into real audio sound through an advanced encoding process. This process incorporates a very impressive compression algorithm, and the encoded file, depending on the setting may deliver a CD quality sound output. The impact of real audio on the Internet was huge. In over a year, the Real Network introduced the production of real video files along with conversion and encoding for "avi" and "QuickTime" video files.

3. Virtual Classrooms

Web-based instruction can be supplemented by audio and video files to closely simulate a real classroom environment. The end product is commonly referred to as a virtual classroom. Streaming technology is the basic technology used in delivery of educational multimedia modules over the network. Such a setup is commonly referred to as a “virtual classroom”. A virtual classroom in its relatively complete form contains a small size video clips that shows the class activity as well as a series of text pages and images representing the content of the blackboard and the overhead projector screen. The key issue in developing a virtual classroom is the synchronization between audio, video, text, and images and so forth during the presentation.

From developers of the educational resources perspectives, the whole point behind streaming files is they can synchronise the playback of an arbitrary file such as text, images etc. For instance, one can synchronise a shockwave animation with audio to deliver the operation of an electric car over the

internet. In a virtual classroom environment, one can synchronise the playback of a class video with images taken from the blackboard or the overhead screen as the lecture progresses.

Real System [3] and Apple's QuickTime [4] streaming technologies allow the use of scripting languages to control the player or more importantly the integration with the browser so that one can embed the player and control it using Java script. Exposure to Java is useful as it ensures the developers can use the wealth of Java in "virtual classrooms" in the view of network delivery of educational resources.

4. Case Study One: ELEC101 Virtual Classroom

An example of a virtual classroom is explained in this paper. The Web Edition of "Fundamentals of Electrical Engineering (ELEC101)" [5] is a simple virtual classroom environment that uses the "real-time streaming technology" to deliver synchronised Power Point slides (images) and audio files (the lecturer voice) over the Internet. Rather than replacing the conventional lecturing of ELEC101, the web edition was designed and implemented to help students who need to review important pointers of major topics. Students need to have a freely available Real Player and perhaps a headphone set so that they can hear the lecture and view the overheads in computer laboratories or at home using a standard 56kbps dial up connection on PC, Mac and UNIX platforms.

To ensure students using different computers of any power and different connection of any speed could retrieve ELEC101 virtual classroom four options, namely plain, synchronised, controlled synchronised and power-point slide/script were provided, as shown in Figure 1, ELEC101 World Wide Web Edition.

In plain format, students first receive a page containing thumbnails of available overheads. The Real Player will start working as soon as students click on a thumbnail to view the actual overhead. Then, they step to the slide they are interested in, and hear the associate audio clip with each slide. Students may control the Real Player operation, and they also have standard navigation tools. The Real Player may be used as a plug-in program or as a Netscape or Internet Explorer helper application. The latter means by clicking on the real audio icon, the browser lunches the player and from there, students control the player operation; recording, playback, rewind and so forth. They may also use standard previous and next buttons to move around. A screen caption of the plain format is shown in Figure 2.

In synchronised format, students receive power point slides and their associated sound. The audio file automatically updates the slides displayed as the lecture progresses. The controlled synchronised option of the ELEC101 displays projected slides on the screen and plays the corresponding sound. In this mode of operation, students step to the slide they are interested in and start the player. While the audio is playing, it will automatically update the slide as the lecture progresses. Alternatively, students can jump to a new slide by clicking on thumbnails listed on the left frame, and the audio will jump to follow. To start listening to the audio from a particular slide, students may type the slide number in the space provided in control section and press the enter key.

Figure 3 shows a screen caption of ELEC101 in controlled synchronised mode of operation. Provisions also were made for students using computer without a sound card. In this case they view a slide on one window and read its corresponding text on another browser window.

The virtual classroom presented in ELEC101 uses the "real system 5" that is a portable and cross-platform system; players are run on Mac, PC, UNIX and servers on NT, Win95 and Unix. Real system 5 allows the use of scripting languages to control the player or more importantly the integration with the browser so that one can in fact embed the player and control it using Java script. Exposure of real system 5 to Java is useful as it ensures the developers can use the wealth of Java in network delivery of educational resources.

The ELEC101 virtual classroom environment was used by students in spring session 2000. The entire concept of virtual classroom and the application of streamed and synchronised audio file were found by students very exciting and motivating. The setup is available on the Internet for public use [2].

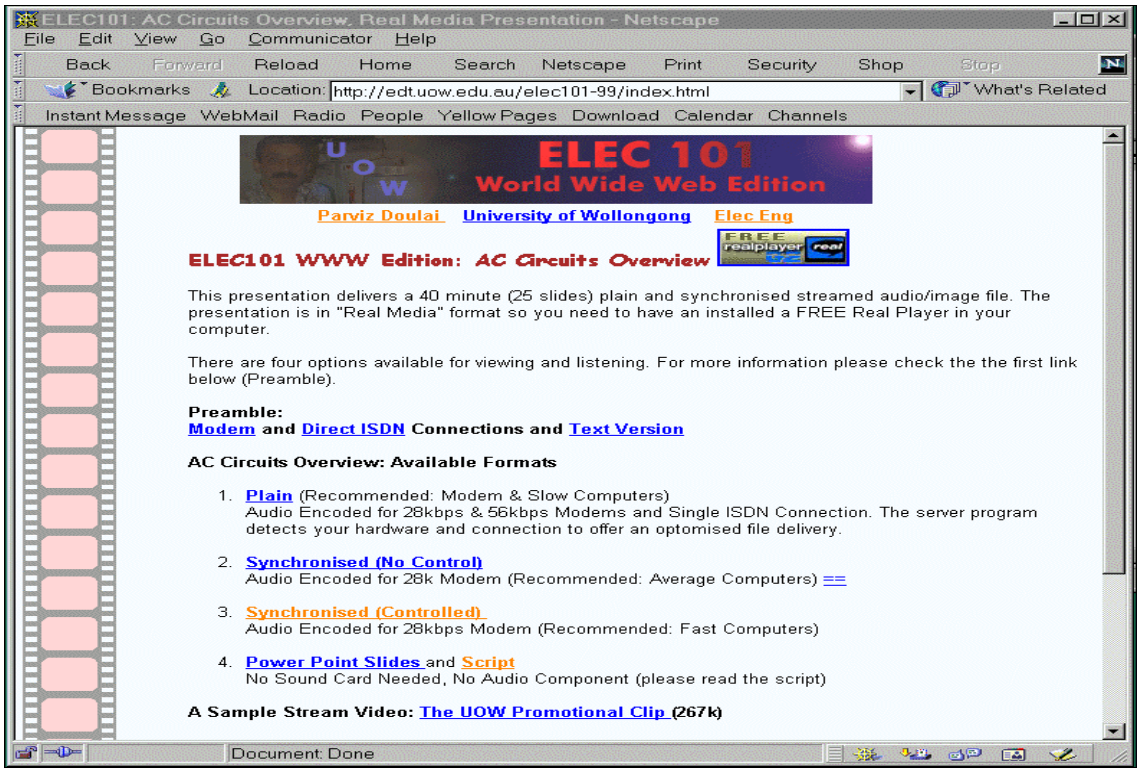

Figure 1: ELEC101 Virtual Classroom, World Wide Web Edition of ELEC101

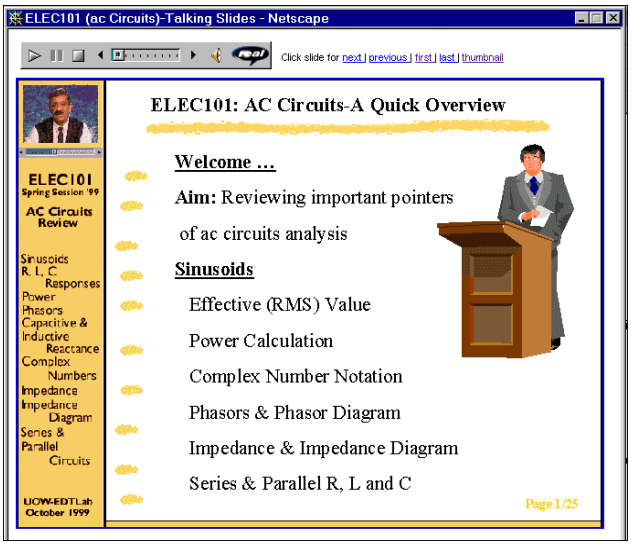

Figure 2: ELEC101 Plain Format

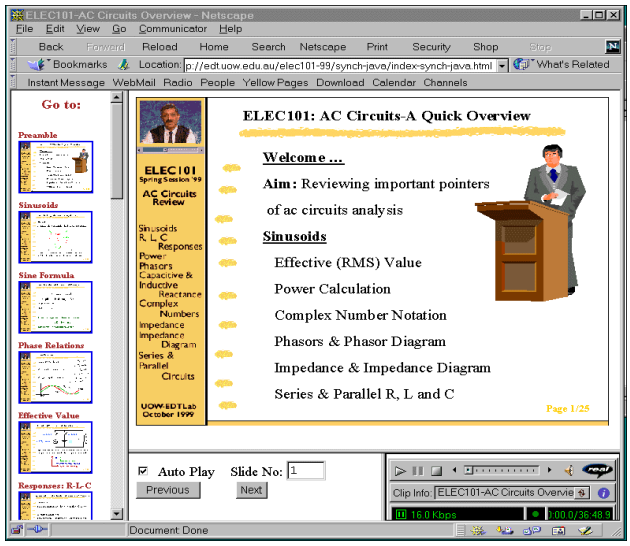

Figure 3: ELEC101 Controlled Synchronised Format

5. Case Study 2: Stream Video Integration into Virtual Classrooms

Due to the recent availability of video compressor/decompressor (codec) technologies with compressions designed for web delivery, it is now possible to use video as an effective resource in a web-based instruction environment. Different client programs are now available to make movies with different data rates, and different streaming server programs are now available to negotiate with the client machines to deliver stream video at relatively high quality even via narrow bandwidth of modem connections [2].

A stream video presentation was included into a combined final year and Master subject (ELEC476/912) learning environment to provide background materials for students group projects.

This module was offered in two formats to meet low- and high-end Mac, PC and UNIX platforms as well as slow and moderately fast network connections.

In both formats an audio-visual file synchronised with text and images was used to create a simple virtual tutorial class. An interesting feature of this presentation, as shown in Figure 4, is that the video was indexed to a table of content, and that was done through markers embedded in the video file during the encoding process. These enabled students to click on items listed in the table of content (left window) in order to view its associated video along with its synchronised text and images in allocated areas within the presentation window.

Students realized the benefits of technology-enhanced resources that were incorporated into their on-campus course delivery. Students' comments and feedback on the course content, the method of delivery and available tools and resources for case studies shown in this paper are archived in [2].

6. Conclusion

The web and its associated educational delivery technologies can support highly dynamic and interactive educational materials to be used either for on-campus education or distance students. This paper showed two examples of virtual classrooms using stream synchronised audio/video and image files. It is envisaged that the usage of technology enabled methods in face-to-face university instruction results in a model that works equally well for distance students and learners in virtual campuses.

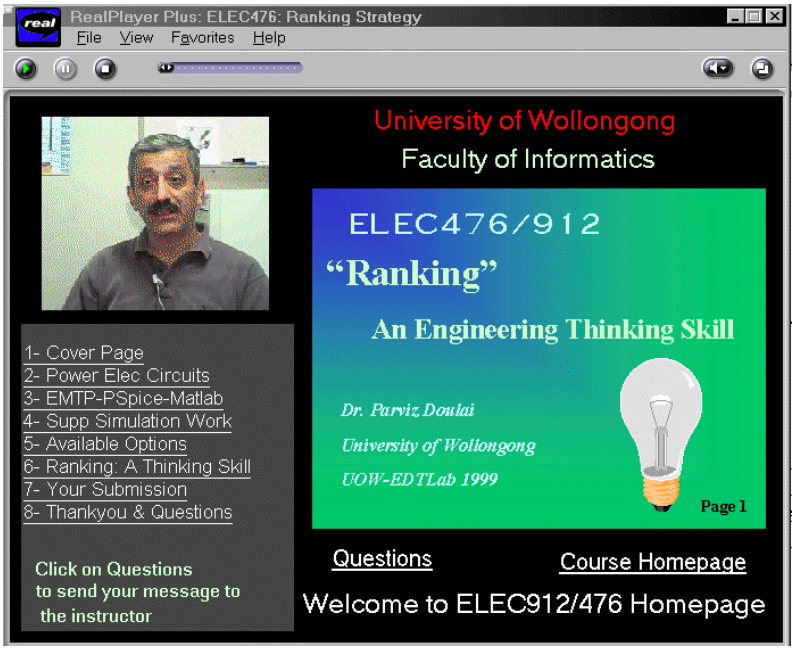

Figure 4: ELEC101 Stream Video Incorporated into Web-Based Instruction

Reference

[1] P. Doulai, *Preserving the Quality of On-Campus Education using Resource-Based Approaches*, Proceedings of the International WebCT Conference on Learning Technologies, University of British Columbia, Vancouver, Canada, June 1999, pages 97-101.

[2] The Educational Delivery Technology Laboratory (EDTLab) http://edt.uow.edu.au/edtlab/portfolio.html/

[3] Real Network http://www.real.com/

[4] Apple Quicktime, http://www.apple.come/quicktime/

[5] ELEC101 World Wide Web Edition http://edt.uow.edu.au/virtual-classes/ac-circuits/

[6] P. Doulai, *Experiences with Dynamic Web and Streaming Technologies to Support First Year Core Subject in Electrical Engineering*. In Proceedings of the Australasian Universities Power Engineering Conference and IEAust Electric Energy Conference, pages 429-435, Darwin, Australia, September 1999.