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Multimedia Teaching on the Web*

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This paper describes a multimedia teaching-based project to help students understand and review lecture notes efficiently and quickly using the World-Wide-Web (WWW). The speed-variable and audio-driven capability of the Javascript-based project can allow students to review any page of the lecture notes at any time and at variable audio-playback speed (ranging from 0.5 to 2 times continuously) at the normal speaking pitch. In particular, the high compression capability (compression ratio up to 53:1) of the developed program can greatly increase the loading speed of the lecture notes from the Web server.

INTRODUCTION

IN ORDER TO complement our traditional means of lecture delivery and because of the special needs of some Hong Kong students who are sometimes shy to ask questions and/or whose English listening capability is not very good, we have considered the development of an innovative multimedia platform (hardware and software). This includes hypertext, video and audio clips and animation using the WWW authoring system such as CGI script and Javascript along with other commercial software. Among the key objectives of this work is to develop a platform which allows students to scan and compress the actual instructor's voice along with the instructor's lecture notes and other relevant materials. This allows students to have a self-access tool for reviewing the actual class lectures, for example at variable sound and video speeds.

AUDIO COMPRESSION

Putting course materials on the WWW is a good idea but dealing with the large size of audio files is still the real problem for Web access. Due to the limited network bandwidth available on the web (for example, although we have a 10 MB network on campus, students are using a 56K modem at home) it is obvious that forcing students to download huge sound files (especially WAV files) will make the application unusable. The audio for a typical lecture lasting for one hour will take up more than 30 MB space even when it is sampled at 8 kHz rate and 8-bit resolution (low quality, mono mode) in WAV format. Therefore audio compression is necessary for Web application. Based on Voxware's revolutionary MetaVoice technology [1], our Javascript-based program can compress the sampled-and-processed lecture recording by up to 53:1 compression ratio. For example, a 60-minute lecture audio recording can be compressed to 1 MB (VOX format) thereby greatly reducing the loading and access time of our WWW server.

THE PRODUCTION PROCEDURE

The whole process for this project can be briefly described as follows:

- *Step 1: Audio recording.* The whole lecture is recorded in a HiFi-VHS tape recorder (installed in our HKUST lecture theaters) using the HiFi audio-track for high-quality original audio (S/N ratio is more than 80 dB) [2].
- *Step 2: Audio digitization.* The recorded audio signal is sampled into the PC using commercial software called *Sound Forge* [3] through a 16-bit sound card and is saved in compressed WAV format files [2].
- *Step 3: Lecture notes scanning and processing.* The lecture notes are scanned slide-by-slide into high-quality BMP format files, processed carefully to remove unnecessary information using a commercial software called *PhotoShop* [4] and then converted into compressed GIF format files.
- *Step 4: Audio editing and processing.* The sampled audio WAV files are edited and indexed into audio-clips according to each slide of the lecture notes. Each audio-clip is further processed to remove the useless portions of the lecture such as 'Mm', 'Ah' and silence periods and then normalized to balance the voice level of the speaker without causing saturation using *Sound Forge* [3]. By doing so, we allow students to listen to the instructor's voice clearly in the minimum amount of time.
- *Step 5: Audio conversion.* Each processed high-quality but large-size WAV format audio clip is

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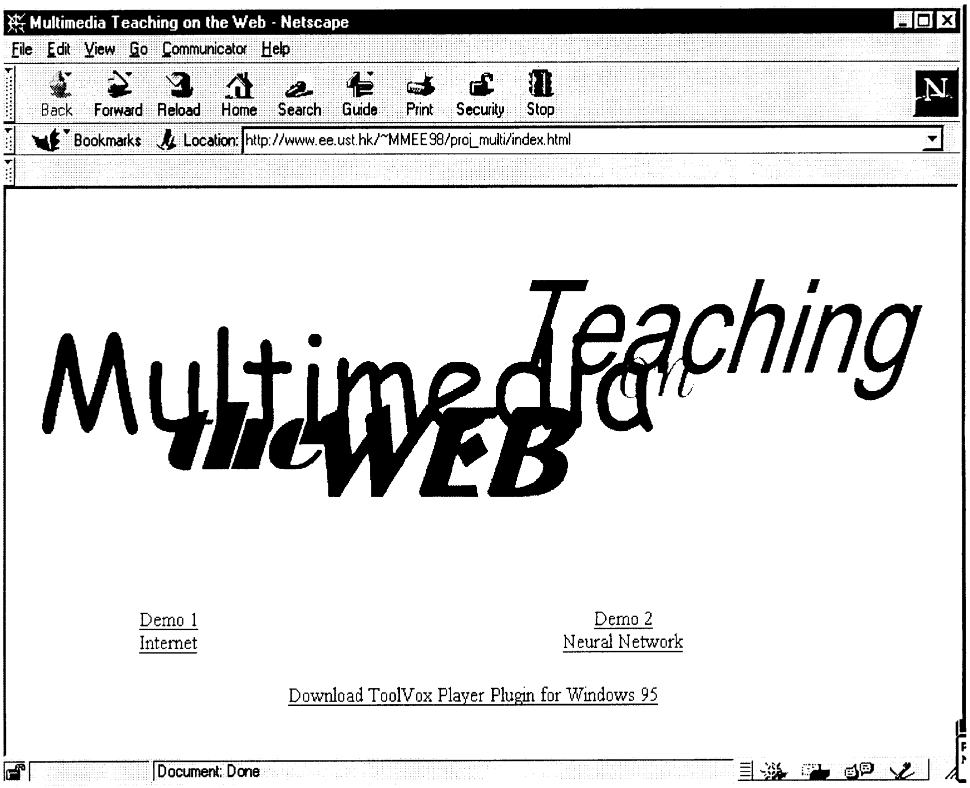

Fig. 1. The demonstration Web page.

converted into highly compressed VOX format audio clip using Voxware's encoder [1].

- *Step 6: Integration.* The processed VOX audio clips and GIF lecture notes slides are linked together so that they can be controlled by our Javascript-based program.

RESULTS AND DISCUSSION

The results of the project can be seen through an on-line presentation on the Web site http://www.ee.ust.hk/~MMEE98/proj_multi/index.html (Fig. 1)

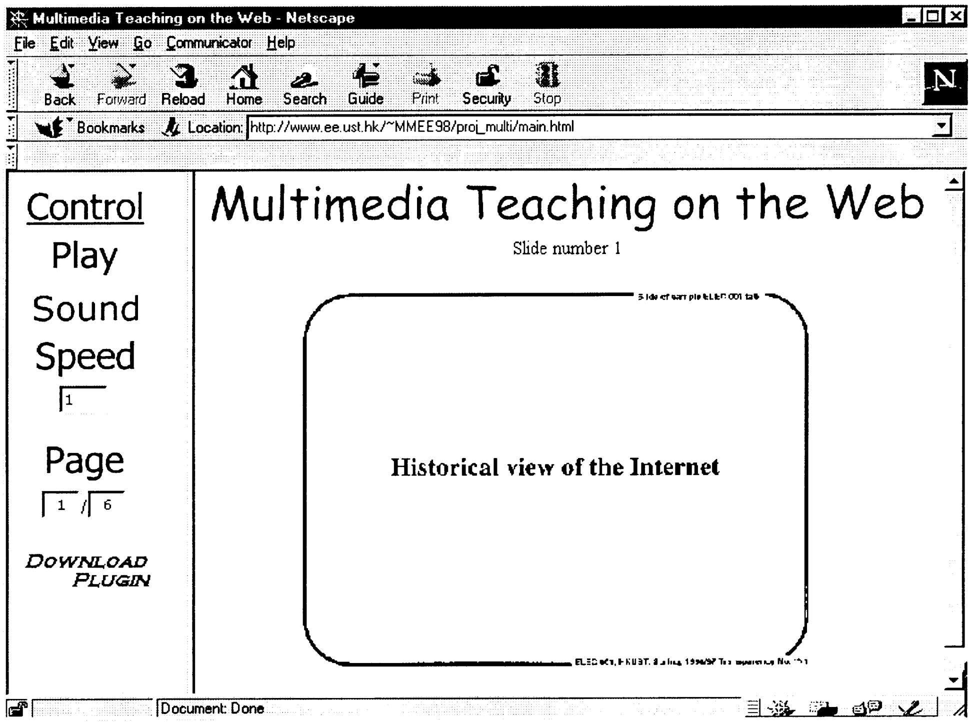

Fig. 2. The control frame and notes frame in demonstration 1.

In the above demonstration web page, two demonstrations can be found. The first one deals with 'Internet Technology' and the second topic is the 'Neural Network Technology'. The plug-in is also provided for download.

Students can login to the Internet and open the Web site. The class notes or slides will then be displayed on a right-hand-side frame (notes frame) with the control buttons placed on a left-hand-side frame (control frame) of the screen (Fig. 2). Written by Javascript language, the control buttons can be shown interactively; that is, students can see those buttons only when they point their mouse on a particular area. For example, if students point their mouse on the left-half area of the word 'Play' inside the control frame window, they will see a 'play' button displayed with a description box just below it. If they point their mouse on the right-half area of the word 'Play' inside the control-frame window, they will see a 'stop' button (Fig. 2). This feature allows students to use the program intuitively.

Students can click the 'play' button to play back the notes and click the 'stop' button to pause the playback to review that slide of notes in detail. Students can also turn the sound on by clicking the left-half area of the word 'Sound' (a 'sound on' sign can be seen, Fig. 3) when they need the speaker to explain the notes or turn it off by clicking the right-half area of the word 'Sound' (a 'sound off' sign can be seen at this time) when they need to go through the notes silently (Fig. 3).

Below the word 'Sound' is the other word 'Speed'; students can decrease the speed of the audio playback by clicking on the left-half area of this word 'Speed' (a '−' sign can be seen to show the function) or increase the speed of the audio playback by clicking on the right-half area of this word 'Speed' (a '+' sign can be seen). The playback speed is shown in the box just below the word 'Speed'.

Changing playback speed normally causes the change of voice pitch, but our developed program can maintain the voice pitch within an acceptable range even when the playback speed varies greatly. Using this attractive feature of the developed program, students can review a particular slide being explained by the lecturer slowly (the speed can be adjusted continuously down to 0.5 times the normal speed) when they cannot understand the material explanation at the normal speed. Students can also review the whole lecture assisted by the lecturer in a fast way (up to 2 times faster than the normal speed) at normal speaking pitch.

The next control word below the speed box is 'Page'. Students can jump to the next page of the notes by clicking on the virtual button '+' shown by pointing the mouse on the right-half area of this word 'Page' or go back to the previous page of the notes by clicking on the virtual button '−' shown by pointing the mouse on the left-half area of the word 'Page'. The number of the most recent slide is displayed in the box just below the word 'Page'. As a result, students can go to any particular page they need to review at any time (Fig. 3).

From the above explanation and from the demonstrations, we can see that our program allows students to review the lecture notes using

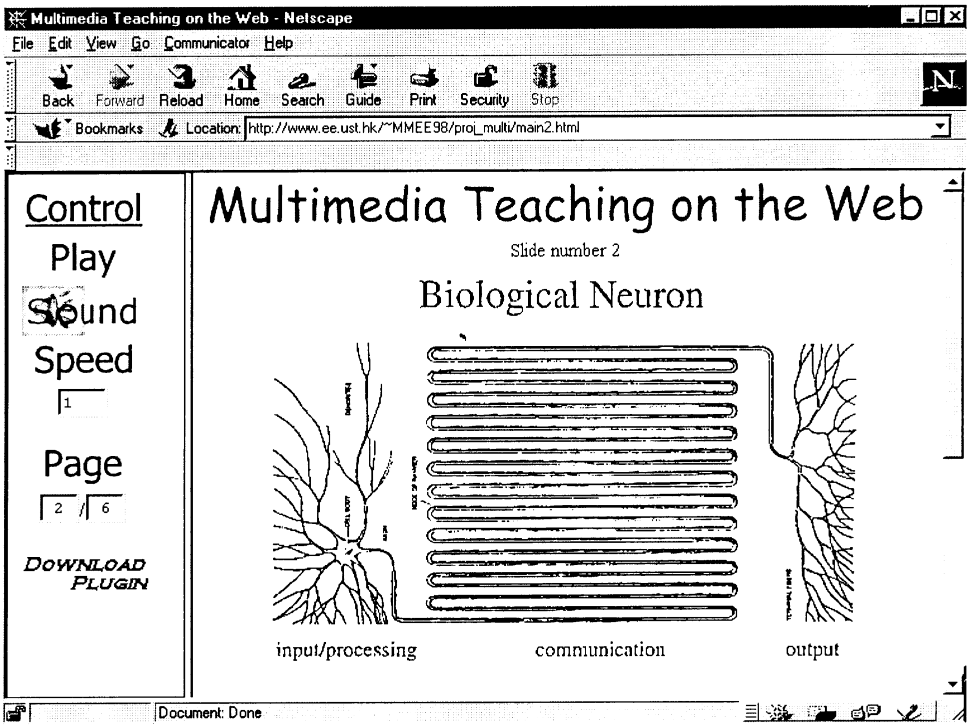

Fig. 3. The control frame and notes frame in demonstration 2.

any comfortable audio-playback speed (ranging from 0.5 to 2 times continuously) at any time. Students can choose any particular page of the notes to playback and the program can change the page automatically when the audio clip for a page of a given lecture notes has finished (audio-driven). Students can also choose a different playback speed, which can be in a continuous mode, at anytime during the playing phase.

The results from the demonstrations show that the sound quality is quite acceptable even when it plays back at 2 times faster or 0.5 time slower than the normal speed.

CONCLUSION

In this paper, we have presented the result of an ongoing multimedia teaching-on-the-web project which can help students in reviewing any part of their lecture notes efficiently and quickly on the web, assisted by the lecturer's real voice playing back at variable speeds with a normal speed talking pitch. This project has been recently used in the course Electronic & Information Technology (ELEC001) in the Electrical & Electronic Engineering Department at HKUST and the response from the participants has been positive.

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Jackey Cheung received his B.Sc(Eng) Degree in first honor (ranked No. 1 in class); and he obtained his M.Phil Degree in the Electrical and Electronic Engineering from the University of Hong Kong (HKU). Since August 1995, Jackey has been with the Department of Electrical & Electronic Engineering at the Hong Kong University of Science & Technology (HKUST) to teach courses, lead research projects and develop industrial training programs.

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Dr. Letaief is the Editor for Wireless Systems of the IEEE Transaction on Communications, a Technical Editor of the IEEE Communications Magazine, and an Editor of (Kluwer) Wireless Personal Communications Journal. He has been a guest Editor of the 1997 IEEE Journal on Selected Areas in Communications Special Issue on Computer-Aided Modeling, Analysis and Design of Communications Links. He is also a guest Editor of the 1999 (Kluwer) Wireless Personal Communications Journal Special Issue on Intelligent Multimedia Systems, Terminals, and Components. In addition, he served as the Technical Program Chair of the 1998 IEEE Mini-Conference on Communications Theory (CTMC'98) which was held in Sydney, Australia, November 1998.

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Philip C. H. Chan (SM '95) was born in Shanghai and raised in Hong Kong. He received his BS degree in electrical engineering from the University of California at Davis, where he graduated with highest honors and departmental citation. He received his MS and Ph.D. degrees in electrical engineering from the University of Illinois at Urbana-Champaign under Professor C.T. Sah. He stayed at Illinois initially as an IBM Postdoctoral Fellow and later as Visiting Assistant Professor in Electrical Engineering.

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