Abstract - While extensive use is currently being made at our facility of video over IP as a distance learning delivery technique, the current archival scheme of using VHS tape leaves much to be desired from a timeliness and complexity perspective. Our goal is to deploy and test a simple scheme that captures encoded video packets directly from the network, and immediately converts that into the QuickTime format for studying by learners, and allows faculty to review their presentations. The capability to automatically capture, translate, and transfer classroom lectures to a server for students to view on demand, not only improves remote teaching capabilities, but provides a new basis for offering online programs. Additionally, this provides a critical “backup” for those inevitable technical difficulties that prevent or disrupt real time broadcasts.

Index Terms – classroom capture, distance learning, video over IP

OBJECTIVE

It is becoming commonplace for classroom material such as powerpoint presentations to be available online for student access outside of the classroom. Other tools provide more sophisticated capture of classroom content, such as tablet based computers, smartboards, and other in-room technology allow the dynamics of a class to be captured. Despite this technology, the basic classroom visual and audio content, whether lecture, question and answer, or general interaction, are often too cumbersome to capture and archive.

Therefore, the objective is to provide inexpensive, readily accessible recordings of video classrooms as a learning tool. This is accomplished by capturing packets associated with lectures delivered over IP video, translating them to QuickTime video player format, and storing them on a web server. Lectures will then be online, available on demand, thus, making remote education accessible to the largest audience possible. The entire process will be automated, requiring no intervention by support personnel. Lectures will be available within minutes after class completion, eliminating the previous delay and dissemination challenges associated with taped lectures, while still permitting distribution via data CD if necessary. While this system is only effective in a class equipped for videoconferencing, an inexpensive and automated system may make it feasible to capture content from such a facility even when it is only used for local classes.

IP based videoconferencing has become a common format for real time distance learning environments[1], and is being used extensively for delivery of classes between the Georgia Tech Atlanta and Georgia Tech Savannah campuses. Historically, these classes have been recorded using VHS equipment. Those tapes provide: 1) a backup in case of failure of the delivery technology, 2) a crucial component for non-classroom based students who receive the materials via U.S mail service, 3) review material for students.

Technology is moving to direct electronic capture. This is often achieved by placing a computer with a video capture card in the classroom, and feeding the NTSC video and audio signals from the camera or display into the capture card. This content can then be encoded and moved to a web server, as well as archived.

While such a scheme is a drastic improvement over the VHS tape, our current effort focuses on a variation that reduces the cost and provides additional features in capturing a complex multipoint interaction between many classrooms. Additionally, some educational applications may entail use of facilities too small to warrant dedicated capture systems[2].

The basic components of the system are shown in Figure 1. A primary site equipped with multipoint capable IP video codec (classroom #1) may engage in a class that involves both classroom #2 and classroom #3. This involves four video +audio streams, Classroom 1 to Classroom 2, Classroom 1 to Classroom 3, Classroom 2 to Classroom 1, and Classroom 3 to Classroom 1. Note that no direct connection exists between classroom 2 and classroom 3. A packet capture of the encoded content associated with the network traffic to and from classroom 1 will allow all four streams to be captured.

The captured packet data has already been compressed by the classroom codec, so a compression algorithm is unnecessary. Therefore, the capture system does not require a fast CPU or hardware based capture compression. At sites
where the network topology has a single link between many different classrooms, one capture system may be able to capture the packets between several independent classes which are occurring simultaneously. Such a link often exists in conjunction with the Internet connection to the campus or the fiber connection to a building or facility.

Once content is captured, it can be formatted and indexed for distribution via a web server. QuickTime format provides two important capabilities: documented format information published by Apple Computers, Inc, and suitable H.261 and H.263 decoding so that the video content does not require end processing (beyond header formatting) by the capture system.

Classroom content obtained from the system allows for web distribution of content, as well as (manually produced) CD copies of content to be distributed by US mail. The capture system provides only partial protection against network delivery failure since the system can only capture the content if it reaches the capture system.

The long term goal is to integrate this capture system into a complete educational system[3]. This involves creating long term online archival of the data, along with appropriate indexing both by content and by course and date. This can then be used as the data to support both course authoring and long term learner centric reviews of material presented in previous courses or previous years.

CURRENT STATUS AND ONGOING EFFORT

Figure 2 illustrates the major technical steps of this process. The component “Real Time Packet Capture” represents the process of capturing encoded media streams, with some real time filtering so that most of the captured data is pertinent to the classroom. “Post Capture Stream Analysis” eliminates non-pertinent streams, and correlates the audio and video components to each classroom. This step is critical to producing a complete representation of a class, as multiple sites and the resulting multiple streams must be sorted and correlated into a coherent representation of the course. “Content Transcoding and Formatting” creates QuickTime format files. Transcoding of the audio is necessary due to incompatibilities in encoding. The “QuickTime content on Web Server” represents the student accessible resource.

These steps have been accomplished in manual sequence and during the summer of 2006 the process will be automated, so that Web content is generated as soon as the packet data streams are terminated. Initial classroom use will begin during the fall of 2006, with preliminary student feedback available by October 2006.

The issue of having multiple streams will need to be addressed in future work. The complete collection of video and audio streams may represent a large amount of either redundant data or material with little educational value. Redundant data may be produced, for example, when a primary site sends the same video content to two remote sites. Material with little educational value may include images of students in a remote site listening to a lecture that is represented by another video stream (although such material may provide some useful feedback on student attentiveness).

Development of a methodology to sort this into educational relevance would be useful. Established techniques used in videoconferencing multipoint units, such as “image follows voice”, may provide some assistance. An initial approach of combining all video streams into one large image is being considered. This can be used in conjunction with audio combining techniques to produce one composite audio track.

EVALUATION PROCESS

Educational evaluation of the system will focus on the use of the system by classroom based students for studying and review. The primary means of short term evaluation will be based on tracking student access to the review material via web server logs. Additionally, student questionnaires as part of the course evaluation will be used for comments on the value of the recorded material. Both online access and questionnaire based evaluations will be compared to the students’ location relative to the instructional faculty. While our faculty may occasionally rotate sites in a multi-site scenario, there is typically a primary location from which the instructor participates. Online usage and questionnaire results will therefore need to be separated into primary site and remote site students to compare the system’s impact on local versus remote instruction.

While a comprehensive set of long term evaluation parameters has not been formalized, other factors, including the media used in class, active versus passive student involvement, course content, course level, and instructional style may need to be considered. This usage will also be compared to overall attendance numbers, as it is possible that making the classroom content increasingly available outside of the class will reduce attendance and, therefore, overall achievement.

