Framework for Cooperative Synchronous and Asynchronous Distributed Engineering Education

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Abstract

The Georgia Tech Regional Engineering Program (GTREP) was originally created to provide the opportunity for students in southeastern Georgia to earn a Georgia Tech undergraduate engineering degree without leaving the region. Students complete two years of general education and engineering prerequisites at their home institutions before beginning the Georgia Tech curriculum as juniors. Georgia Tech courses are taught both by local faculty in southeast Georgia and remotely by faculty on the main campus. This system is further complicated by the fact that courses are delivered to three partner institutions as well as the GTREP facilities.

In order to effectively deliver course content in this situation, we have developed a combined synchronous and asynchronous system for content delivery. Asynchronous course content creation is based on the inFusion system we developed for rapid multimedia content generation. In order for faculty to become involved in the development of online or computer enhanced lecture materials, the production process must be easy and convenient. Faculty use a very simple interface to synchronize graphics, video, and audio into a coherent presentation viewable in any browser. A portable production system can consist of as little as a laptop and a USB camera. Instructors, even with little or no previous experience with inFusion, can create effective and engaging online lectures without the need for additional production personnel. The presentation format is flexible, allowing the presenter to change backgrounds, the elements included, and the layout. This flexibility allows an instructor to tailor his presentations to his teaching style, the learning style of his students, and the material. Any of the media windows can be made "hot," with links to supplementary material, readings, or other lectures. These links can change as the presentation progresses, allowing the creation of context-sensitive links to additional material.

The inFusion system allows easy creation of course content modules, which has increased faculty involvement in the creation of a large library of lecture materials. This involvement has allowed us to begin a remote master's degree program serving the general community and allowing GTREP to have a graduate component. We have also been able to generate a large library of tutorial and review content for computer enhanced courses. However, courses must also include a synchronous element, which in this case must be distributed to multiple locations from disparate faculty locations. In order to facilitate synchronous delivery, we have implemented an IP-based

scalable delivery system which allows course lectures, individual office hours, and tutorial sessions to be broadcast to multiple facilities from any one of five distributed classrooms and seven group study facilities distributed across four campuses.

The GTREP program is an ideal testbed for novel distributed education methods. In this paper, we present some results for the combined approach we have developed, and outline plans for future scaling as the GTREP program expands.

1. Introduction

Georgia Tech is involved in a number of distance learning initiatives, including a new online Masters program in Electrical and Computer Engineering and a campus situated in Metz, France, that also offers Masters degrees in Electrical and Computer Engineering. This campus, known as Georgia Tech Lorraine (GTL), opened its doors to students in the Fall of 1991. Since the number of faculty at GTL has never been large enough to support a complete Masters Degree program, a number of courses are typically offered through the Georgia Tech Center for Distance Learning. These courses, which are taught by Georgia Tech faculty to students in Atlanta, are videotaped, and the tapes are shipped once a week to GTL.

The Georgia Tech Regional Engineering Program (GTREP) is an academic collaboration between Georgia Tech and three partner institutions: Armstrong Atlantic State University (AASU), Georgia Southern University (GaSou) and Savannah State (Savannah State) University. During the freshman and sophomore years of the program, students are enrolled through one of the three partner institutions. These universities offer all of the mathematics and science courses and some of the engineering courses required in the first two years of the Georgia Tech engineering curricula. Students also have the opportunity to register for some Georgia Tech courses during this time.

Prior to their junior year, students apply for transfer admission to Georgia Tech and complete their degree program as a Georgia Tech student. Students remain physically located at the campus of the partner institution, but are taught by local Georgia Tech faculty supplemented by distance learning connections to the Atlanta campus. Non-engineering portions of the degree program continue to be offered locally by the partner institutions during the junior and senior years. Students graduating from GTREP receive a Georgia Tech degree with the designation Regional Engineering Program.

2. Distance Education Issues

Due to its distributed, multi-institutional educational nature, GTREP faces significant distance education issues, including:

- Synchronous versus asynchronous content delivery [1].
- Student-instructor and student-student interaction[1,5].

- Telepresence for educational delivery and collaboration.
- Development of educational tools and educational content to support GTREP's educational mission[2].
- Assessment of the pedagogical effectiveness of both tools and content.
- Incorporation of Artificial Intelligence techniques in the online component of course and curriculum delivery, such as learner modeling and intelligent tutoring systems[3,4].
- Providing support for ubiquitous education, including context-sensitive delivery of educational material[5].

3. Asynchronous Delivery: inFusion

There are many advantages to offering courses over the Internet instead of using more traditional methods, such as videotapes, and there is no question that Internet distance learning will become widespread in the future[8,9]. In fact, today we are currently witnessing an explosion in the delivery of on-line courses[10], and some universities are putting complete degree programs on the Web. The Internet offers the ability to deliver courses throughout the world, any time and any place. Internet-based courses also offer the student fast and efficient navigation through a lecture, fast retrieval of multimedia content, and course and lecture indexing. Internet courses may also offer keyword searches through multimedia content, self-assessment tools, interactive content, and hyperlinks to related course material.

In spite of these advantages, there are some problems and pitfalls in offering courses over the Internet. Some of these will disappear in the future, while others will continue to present difficulties for the foreseeable future. We have found at Georgia Tech that, in spite of seminars that we have given to faculty to encourage them to get involved with Internet distance learning, faculty participation is spotty at best, although faculty curiosity and interest is high. Other studies indicate that the faculty at Georgia Tech is not alone regarding their reluctance to participate in distance education[11]. Another aspect of distance learning that some instructors will find to be a serious drawback is the lack of contact with students, and the enlarged role that faculty must assume in encouraging and facilitating interaction with the students, which is unnecessary in traditional settings.

In order to mitigate the effect of these drawbacks to asynchronous distance education, we designed the inFusion system for multimedia content creation. The end result is a PC program for producing course “modules” that is powerful, yet easy to use. The user interface is illustrated in Figure 1.

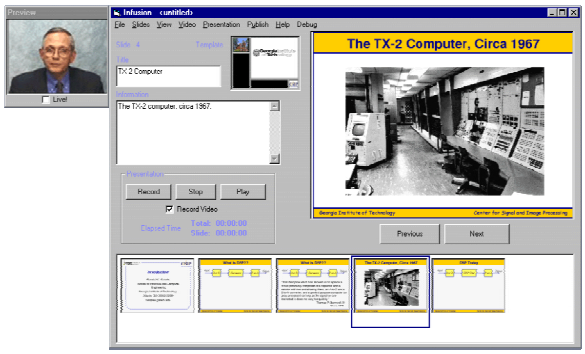

Fig. 1. The user interface.

The instructor needs to provide only postscript files containing the slides or individual images of the slides in GIF, JPEG or PNG format. Then, with a video camera focused on the instructor, a lecture module that includes synchronized video, audio, images, outline and annotation is captured to disk. Once the video has been encoded, the tool is then ready to automatically generate all of the necessary streaming media files. An example illustrating the presentation format these files generate is shown in Figure 2. The presentation format is flexible, allowing the user to change backgrounds, the elements included, and the layout. This allows the creation of lectures including only audio, or with additional information in the windows around the slide, thus allowing the instructor to tailor the presentation to his teaching style or the learning style of his students. Any of the media windows can be made "hot-clickable," with links to supplementary material that change as the presentation progresses. This allows a single window to be used as a "Supplementary Information" window, with extra readings or links that correspond to the portion of the lecture currently being viewed. The primary advantages of these tools are simplicity and portability. Although many of our online master's and continuing education courses are filmed in a small studio, instructors can capture lectures in their own office, at home, or in the classroom.

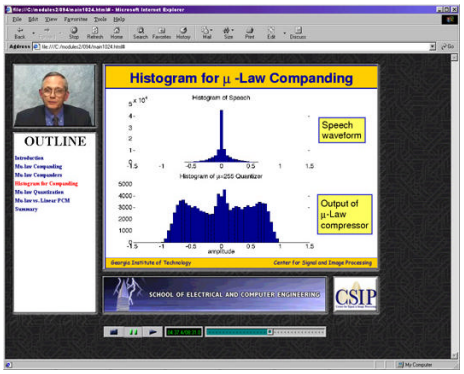

Fig. 2. Screen shot of a presentation produced using inFusion©.

There are two approaches that may be used for online course presentation. The first is to "capture" the classroom during a live lecture, and place it on the Internet for distance learning

students. The second is to produce lectures or lecture modules outside of class in a studio or office, and produce an Internet version of a course. In the second case, our tools allow simple capture and placement on the Internet. In addition, the unique elements of internet-based education such as increased interactivity and hierarchical arrangement of information are easy to implement. In the classroom, the tools would be used to capture the events occurring during the lecture, possibly including whiteboard notes, and all of the timing information for synchronization. The resulting presentation could be used as is or modified to match the particular teaching style of the instructor. Construction of additional multimedia files could be done outside of class at a later time.

With a simple set of tools to bring synchronized and indexed audio easily onto the Internet, the next set of issues that should be addressed center around how to make effective course content that will enhance the learning environment for the student.

4. Integrating asynchronous and synchronous delivery

Our flexible distance learning framework offers the opportunity to redefine the classroom concept, and to expand the set of tools available to the instructor. These tools can be grouped into two categories: lecture delivery and enhanced materials. The first can be further subdivided into synchronous and asynchronous modes of delivery. One advantage of the inFusion asynchronous delivery mechanism is that inFusion modules can be used as enhanced materials to supplement courses that are delivered synchronously.

The communication requirements inherent in the teacher-student relationship are another obstacle that must be overcome in a remote learning environment[13]. In some courses, we are currently using traditional teleconferencing via Polycom systems for group sessions. We have also used Internet based video conferencing for online office hours between students and teachers. We are expanding the use of the Internet based solution for cost reasons, and availability to the student population. Several packages are being evaluated for use in the production environment; Microsoft NetMeeting and Netscape Conference are primary candidates.

Finally, as course development tools and software become more sophisticated and readily available, we may find the student being able to proceed through the course using a path that depends on his/her learning styles. We expect, for example, learning theory to become increasingly important in developing Internet-based courses in the future.

Over the next few years, we will begin to see some new technologies being used in courses that are delivered over the Internet. These new technologies will undoubtedly include the following: Tools that will automatically search and index audio using voice recognition technologies, The incorporation of natural language interfaces for information searching and retrieval, Synthesis of speech from text to facilitate learning for the visually impaired, and automatic captioning for the hearing impaired.

However, perhaps the most important change that the next century will bring is the availability of production tools that will enable faculty to develop and deliver courses easily across the Internet. Today, the process is extremely expensive and time-consuming. As a result, Internet education is not yet widespread. We believe that Internet distance learning will continue to gain momentum and, given the need for production tools, they will begin to appear on the marketplace.

5. Conclusions

GTREP faces many distance education issues, and our experience to date indicates that the program's success will depend on how well these issues are addressed.

We believe that the Internet will be used extensively in the future to deliver educational material to remote students or distant educational institutions. In addition, we expect that the corporate environment will rely more heavily on the Internet in the future for delivering training materials or corporate information to their employees. As a result, there will be a heavy demand for simple and effective content production and delivery tools. In addition, there will be a lot of discussions on how to most effectively train and educate the "Internet Student." In this paper, we have described some of our efforts in developing effective tools for publishing Internet-based courses, and we have outlined some of the things that we believe will be necessary and important for an effective learning environment for the student.

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BACKGROUND

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