A New Course in Multimedia Systems for Non-technical Majors

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Abstract

This paper describes a project which has developed, piloted, evaluated, and is currently disseminating, a novel course in Multimedia Systems for non-majors. The course forms part of the new Information Technology minor program at the University of Massachusetts Amherst. The primary objective of the course is to expose students from non-technical majors to the technical aspects of Multimedia Systems. The paper discusses a number of pedagogical challenges that we attempted to meet through a wide range of teaching innovations, and also discusses approaches to assess the students. Finally, we discuss the production of a complete CD/DVD set of all course materials with synchronized and searchable video lectures and samples of student work to facilitate future offerings of the course.

1. Introduction

The primary objective of the course was to expose students from non-technical majors to the technical aspects of Multimedia Systems. This included basic representations of media in computers, algorithms for image, video and audio coding, media architectures, media hardware and media authoring and delivery tools.

The course made extensive use of multimedia technologies to teach about multimedia systems[1], an idea that was founded in a larger NSF grant. This course was specifically focused to a student audience without a technical background. Figure 1 shows a lecture being delivered by Prof. Burleson to the class about the NSF funded WebDVD project, which concentrates on novel video-based instructional technologies. These technologies were used as subject matter for this course.

The fact that students had a non-technical background presented numerous challenges, the most significant of which was the technical diversity of the students in the course. We intentionally kept the course pre-requisites to a minimum, namely basic Web literacy, in order to attract a wide variety of students. In retrospect, this may have been too ambitious as it caused numerous challenges in dealing with students with widely varying backgrounds and objectives. However, it also led to an extremely dynamic course with many pleasant surprises and synergies across disciplines rarely found in a typical engineering course.

The course website[2], provides a fairly complete record of the course and is currently being supplemented with videos of all course lectures, copies of student work and a CD to allow widespread dissemination of the course material. The course contents and assessment consisted of three major components:

- Lectures/Discussions with five quizzes.
- 3 computer-based media projects.
- A final open-ended project, in which self-organized groups of 4 students planned, developed and tested a multimedia design project using both Web and CD-ROM technologies.

The remaining part of the paper is organized as follows. Section 2 talks about the course innovations. Section 3 talks about different assessment methodologies. Section 4 summarizes the instructor's impression about the course as a whole in terms its success. We conclude the paper by describing on-going and future work.
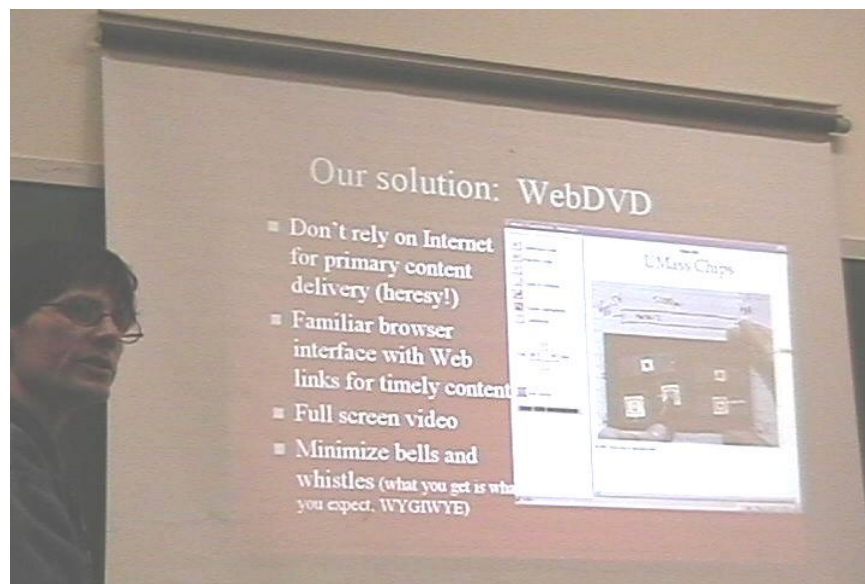
Figure 1. A lecture about the NSF funded WebDVD project which concentrates on novel video-based instructional technologies.

2. Course Innovations

The course presented a number of pedagogical challenges that we attempted to meet through a wide range of teaching innovations. The innovations included:

- Comprehensive website: The Web was used extensively throughout the course to indicate the course schedule, lecture materials, quiz solutions and grades that were password protected. Beyond this conventional use of the Web, we also provided links to all student projects so that students could view each other's work. We found that having students place their work on the Web added an extra incentive for both completion and quality of assignments. The website also allowed work to be submitted or improved after the

deadline since each student had a unique assignment. The types of projects are described later in the paper. At the end of the course, with a fair bit of assistance from the TAs (Teaching Assistants), 100% of all assignments had been submitted.

- Guest lectures from the UMASS community: We used five guest lectures to supplement the professor's lectures on the topic of multimedia systems. The lectures provided differing viewpoints, presentation styles and expertise. Fred Zinn, a staff member from the UMASS Office of Information Technologies, presented an engaging talk on Graphic Design for the Web. Mike Chan, an ECE senior and TA in the course, presented a lecture on HTML, Flash and various Web technologies. Graduate Students doing research in Multimedia System implementation[1] gave the next three lectures. Jeongseon Euh presented a talk on 3D Graphics and its latest implementations in gaming products like the Playstation2 and the Microsoft Xbox as well as low-power research at UMASS. Sriram Srinivasan presented a lecture on multimedia capture, storage and playback mechanisms, focusing on the key interfaces between the physical world and the world of computing. Finally, Santhosh Thampuran presented a lecture on Mobile Multimedia which discussed devices ranging from cell phones and Palm Pilots to the latest in low-power, and operating systems and applications running on these devices.

- Computer-based Media processing projects: Three projects formed the core of the out-of-class work for the students. Each project involved a hands-on experiment with media processing software. Students ran experiments, presented data on the Web and answered questions related to the experiment.


Figure 2. Watermarked JPEG image.

Figure 3. Extracted Watermark JPEG image after Compression.

The first project studied image-coding formats, emphasizing the JPEG format and digital watermarking. Each student provided two of their own digital images and used one as a simple watermark for the other. A simple watermarking scheme using the MATLAB[3] program allowed students to observe the algorithm behavior and its impact on the resulting media quality. Figure 2 shows the original watermarked image (a realistic watermarking scheme would be much less visible). The JPEG compression algorithm was then used to observe the interaction between the watermarking and the video compression. Figure 3 shows the watermarked JPEG image after compression, illustrating how the watermark is corrupted by JPEG but remains somewhat legible. Students submitted their final work by posting it on a website. The project taught students a wide variety of media skills ranging from HTML authoring, image editing and image representations to statistical quality metrics. This project originated as a senior seminar project by one of the TAs, Mike Kelly.

The second project introduced video compression concepts. Students used a Web-based video compression tool[4] that allowed 15 different algorithm parameters to be chosen and applied to 4 different video sequences. Each student was given a different portion of the parameter space to explore, thus each assignment was unique. The Web-based program allowed students to run their experiments from any Web browser, providing greater flexibility than the first project. At several points, we did experience severe loading of our server due to the many large jobs being run as the deadline approached. Figure 4 depicts this project. At the end of the assignment, students were asked to tabulate the resulting compression ratio and computation time for each sample in a Microsoft Excel spreadsheet and post it on their website.
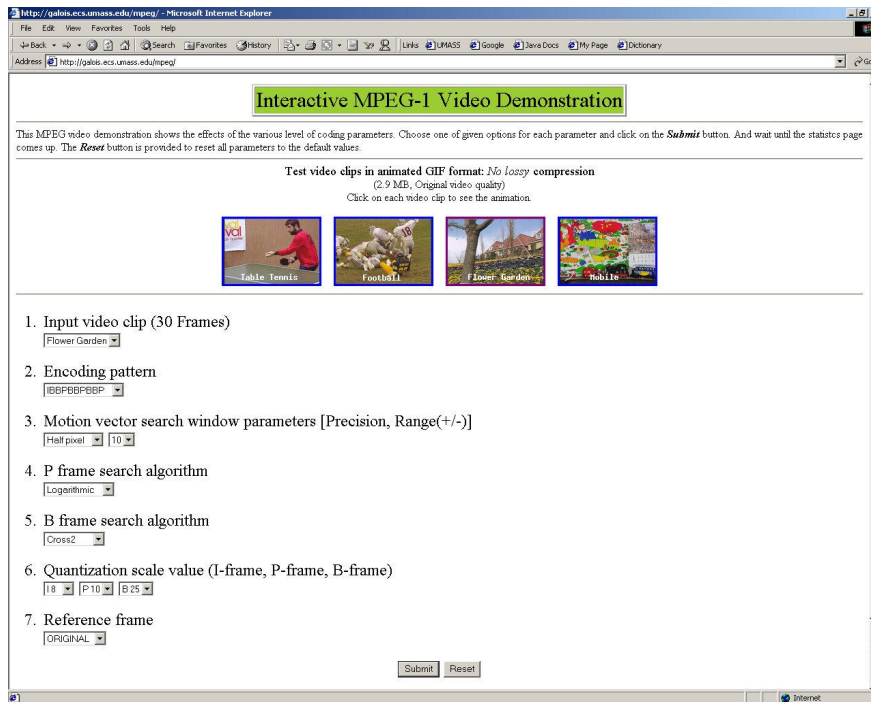
Figure 4. A snapshot of the Web-based program that allows students to choose any of the four different video sequences and algorithm parameters for video compression.
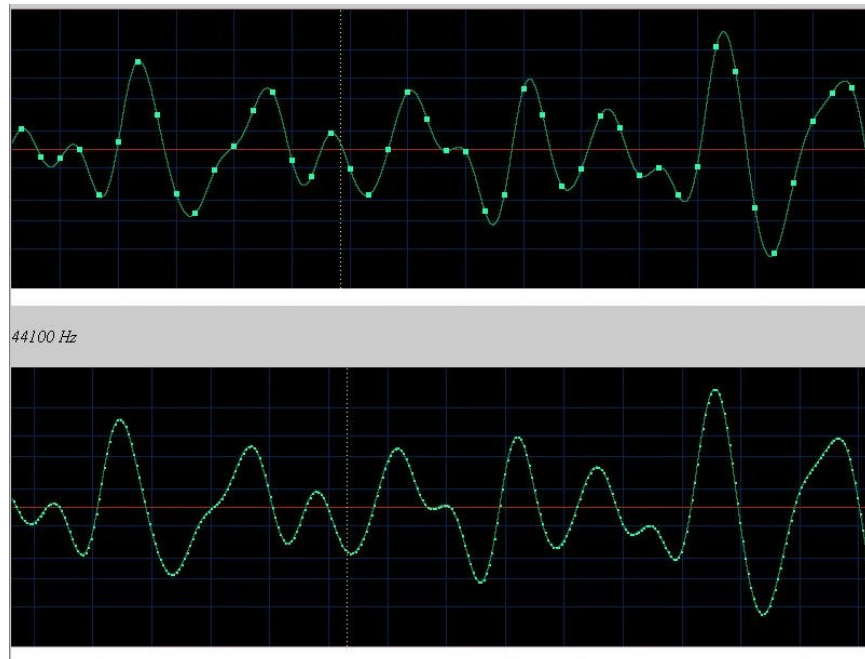
Figure 5. Screenshot of a WAV file at two different sampled rates at 16 bits resolution. Courtesy Cool Edit Software5.

This allowed the students to participate in part of the larger NSF-funded project (NSF Grant No. 9988238) in content-dependent video coding algorithms.

The videos provided a very tangible demonstration of media algorithm behavior. Students also learned about video processing experimental techniques and presentation of data in spreadsheets.

The third project introduced concepts in audio coding using a free program called Cool Edit[5]. Students downloaded the program and ran it on audio samples to observe the impact of different sampling rates and bandwidths. Figure 5 depicts project 3. As in project 2, we gave each student a customized assignment to emphasize their personal contribution to the overall group experiment as well as preventing any issues of students submitting other's work as their own. Students again used Microsoft Excel to graphically present their results and posted the report on the Web.

- Final projects: The final projects provided a culminating group design experience for the course. The objective of the final project was to use the skills and concepts learned in the course to plan, develop and test a multimedia presentation on both Web and CD-ROM. Groups of 4 students were self-organized just prior to Spring Break. Topics were chosen and a proposal was submitted which outlined the proposed presentation and a detailed work plan for its completion. The six projects were presented during the final 3 class meetings and the final website and CD-ROM were due on the last day of class. The final projects provided an opportunity for the students to be creative in their choice of multimedia content while using the techniques of media processing learned in the class. The six projects were:

  o How to burn CDs
  o Beginning guitar
  o Music production and marketing
  o Amherst restaurant guide
  o Guide to UMASS for prospective foreign exchange students
  o Motorcycling safety 101

Each project used combinations of images, video, audio, HTML, PowerPoint, and various programming tools. The three TAs were each assigned 2 groups with whom they worked closely to overcome any technical problems as well as staying on schedule. The results of the final projects can be viewed on the course website.

The enthusiasm and personal aspects that students put into the projects were particularly noteworthy. The large groups presented typical challenges of coordination and communication.

- Quiz, on-line quiz, and pyramid exam: One third of the course grade was based on 5 in-class quizzes drawn from the lecture material. These quizzes were largely factual but included some open-ended problems as well, which proved frustrating for some students. Two of the quizzes used the pyramid style that we learned in a UMASS STEMTEC

workshop. The pyramid groups were assigned and the group portion of the quiz counted for 20%. We discussed this format both before and after the quiz and the students in general were happy with it, especially since it allowed them to work together. Very few of the students knew each other prior to the class so the pyramid quizzes provided a small group interaction which helped facilitate the larger final project groups later in the semester. The fifth and final quiz covered a wide variety of material from the 5 guest lectures and two of the professor's lectures and thus was a bit of a challenge. To address this large challenge, the quiz was open-notes (all notes were available on the Web) and the questions involved applying the ideas from the lectures to the final group project which was by then well underway. For example, a guest lecture on mobile multimedia was covered by a question which asked students how their final group presentation could take advantage of and be modified for a mobile terminal environment (e.g. PDA or cell-phone). The pyramid format was also used for this final quiz, and the pyramid groups corresponded to the final project groups.

- Current events for class discussion: Throughout the course a point was made to integrate current events in multimedia to initiate class discussion. One of the liveliest discussions centered around the well-publicized court case on peer-to-peer audio exchange (i.e. MP3, Napster, etc.). Many students spoke up who had previously been silent during the more technical sections of the lectures. Some healthy controversies arose about ownership of artistic property. Finally, we discussed the implications of the technical aspects of digital media processing on the social and economic ramifications of their use. Other topics included laws about cars and cell-phones, the Microsoft monopoly case, and the Playstation2/Xbox rivalry.

3. Student Evaluations:

- Entry evaluation: On the first day of class a survey was passed out which provided us with data on student demographics, computing skills and objectives for taking the course. We immediately recorded this data and put it up on a Web page entitled "Who's in the Class". The students were a diverse group including 5 women, 4 graduate students, and 4 non-white students. There were 6 sophomores, 9 juniors, and 9 seniors. Majors varied from Education, Psychology, Management and Political Science to Exercise Science and Computer Science. The three TAs for the course included an Indian female graduate student, an Asian-American ECE senior and a white ECE senior.

- Mid course evaluations: We used a variety of surveys and questions on quizzes to obtain additional formative assessment of how the class was going. In particular, we asked the students about the computing level required for completion of the projects, the technical level in the lectures, and the format and content of the quizzes. Several times, feedback from these mid-course surveys caused us to revise upcoming aspects of the curriculum.

- End of course evaluations: The student evaluations from the course have been studied and a number of conclusions have been drawn. The overall response was bimodal. A group of about 7 students considered the course one of the best they had taken on campus. Another group of similar size was less satisfied and considered the course

below average. The remainder lay in the middle region. Criticisms included: lack of organization, unrealistic expectations of computing ability, overly technical presentations of material, and quizzes which went too far beyond what was covered in class. Suggestions for improvement included: providing students with a book or note packet, providing additional direct support with computing assignments and revising the advertised course description to more accurately reflect the requirements, pre-requisites and content of the course.

4. Summary

In conclusion, based on the evaluations of the students, the TAs, the instructor and various external observers, we felt that the course was a success. The following ideas were successful:

- Offering a technical course to non-majors and exposing them to a wide variety of topics in multimedia systems.
- Providing an experience for exploration of a particular project in depth using a diverse group of students and tools.
- Using guest lectures from the UMASS community, integrating research and information technology into the curriculum.
- Capturing the course through the use of low-cost video, Web site and CD-ROM.

Recommended improvements to the course include:

- Covering less material (a perpetual problem in the instructor's courses)
- Providing a printed book or set of notes
- Providing better computer support for students with little computer background
- Providing more direction on group projects.

5. Specific plans for improvement/dissemination

Future offerings of the course will be facilitated by the improvements we are making to the curricular materials. Our first objective toward this end is to produce a complete CD/DVD set [1] of all course materials with synchronized and searchable video lectures. At present, we do have a fully developed version of the course running on a CD. Figure 6 is a snapshot of this course running on a CD. The application through which the course is presented is called CD-MANIC. This work[6] is being done in collaboration with the RIPPLES[7] group in Computer Science, ripples.cs.umass.edu. We hope that the CD/DVD version of the course will allow distance education offerings of the course[8] (e.g. through National Technological University) as well as assisting future live offerings at our partner institutions (Smith College, ENST/Paris, Technologia Monterey/Mexico, Kwangwoon/Korea).

The instructor is also considering writing a book for the course that would be available in both print and on-line versions. He is currently corresponding with Prentice Hall about this idea and has received favorable responses based on the potentially large audience and the novelty of both the course content and the presentation formats.
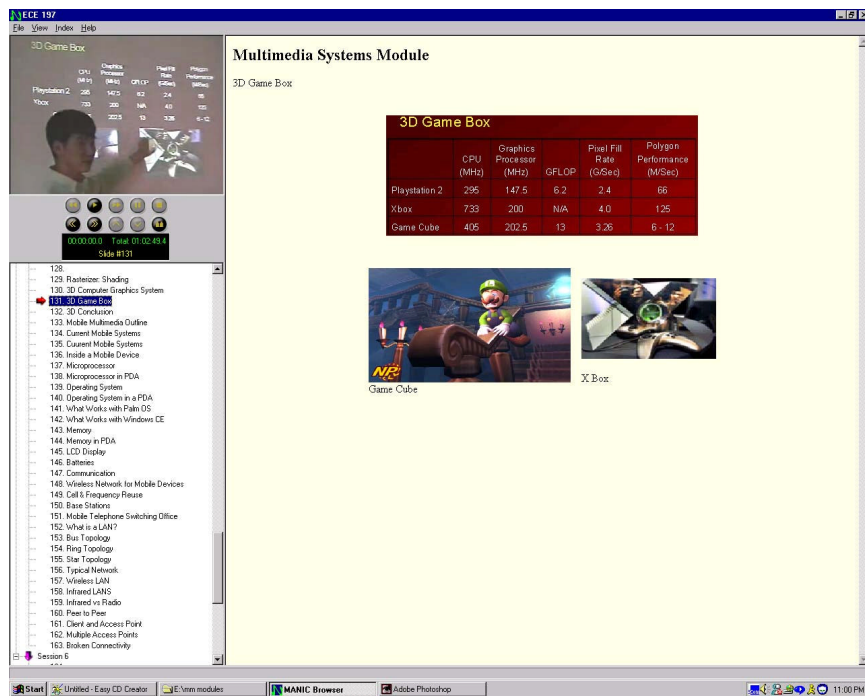
Figure 6. The course running on a CD. The application used for presenting the course is called CD-MANIC. The window on the top left is the video. Below this window are the VCR and the navigational controls. The window below that displays the index and the main win

One novel idea that we have considered is the concept of course upgrades that would be provided to students who have already taken the course. This would consist of a CD/DVD containing lectures, projects and quizzes for various short modules on recently emerging topics in multimedia systems. Examples include the MP3Pro audio standard, the JPEG2000 image standard and Interactive Immersive technologies that combine 3D graphics, computer vision, video and audio. These topics are built on the topics in the initial offering of the course and will show the students how they can extend what they learn through various forms of continuing education. The format of the upgrade modules will be similar to our existing CD-MANIC modules.

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STEPHEN KELLEY is an undergraduate student in the Bachelor's Degree with Individual Concentration (BDIC) major focusing on Interactive Multimedia and Computer Graphics at the University of Massachusetts Amherst. He was also responsible for editing the entire semester's lectures into one six-hour module in the Computer Science department using FinalCut Pro and CD MANIC software. He was also a student in the pilot offering of the course.