AC 2007-1694: INTRODUCTION OF VIDEO JOURNALS AND ARCHIVES IN THE CLASSROOM

Alexander Haubold, Columbia University

John R. Kender, Columbia University

Introduction of Video Journals and Archives in the Classroom

Abstract

We report on two innovative approaches of using video recordings in project-based courses targeted at journaling student and team performance and project progression. The first approach is strictly managed by instructors and staff, and involves periodical recording of student presentations, which are made available to students for self and peer evaluation. The second approach is loosely managed by students, granting them artistic benefit to journal their projects' progression and team dynamics. We report on the successes and shortcomings of interacting with video in the classroom, and introduce our research and studies done in this field.

In this paper, we focus on the use of video in a large introductory engineering design course centered on project-based work performed in student teams. Student projects span a wide range of categories, for example, designing equipment for the disabled, building web sites, and developing architectural layouts for lab spaces. Projects are typically completed for not-for-profit organizations and are always aligned with a real client, who initiates the project. Students present on their progress to the client and the class twice a semester: once during a preliminary design review and once for the final project completion. Midterm and final presentations are video-taped by the instructional staff in a typical classroom environment. During the semester, teams conduct frequent informal meetings to discuss their progress, and are required to meet with their client at least once. At subjectively selected times, students record these events as part of their video journal. At the end of the semester, teams summarize their team and client interaction in an edited version of the footage.

Our engineering design course is offered to more than 150 students per semester, who are assigned to teams of 5-6 students. Inarguably, the introduction of interactive video requires extensive resources and places a high burden on the staff. Libraries of video recordings grow quickly, as does the need for students and instructors to locate video material without laborious manual search. Presentations must be disseminated quickly and effectively, while providing reasonable methods of searching the multi-modal material. Midterm presentation footage is particularly important for students to review their performance, while final presentations are interesting for future students to learn about completed projects.

In this paper, we discuss the positive and negative implications of using video in classrooms, and how students have overall benefited from the video archives. While presentation videos have proven to enhance student learning, video journals have in many ways distracted attention from the primary goal of the class. Our focus in this paper is a large engineering course, yet neither size nor subject inhibit our approach from finding application elsewhere. Similarly, the research we present for working with video archives is generally applicable in other classroom environments. We show how we have designed and evaluated a multimedia browser (*VAST MM* = Video Audio Structure Text MultiMedia Browser) to address seamless audio-visual recording and dissemination in a typical engineering classroom.

Introduction

With the advent of inexpensive technology, classroom environments are adapting new methods of conveying information to students. Projectors have long replaced television sets, pre-recorded video programs are incorporated into otherwise monologue-like lectures, and the internet-enabled computer has found wide acceptance as an interactive medium. In higher education, many universities have designed classrooms with extensive, yet also costly audio-visual production equipment geared towards offering long-distance educational resources, whether by mailing recorded media or making it available online. In most cases, the benefit of these high-cost resources is justified by business decisions of reaching beyond the resident student body.

The advantages of recorded media are manifold and require little justification. Recorded lectures serve as a versatile review and study tool, in particular for fast-paced science and engineering courses. Extensive research and studies on instructional video have been performed [1,2,3,4,7,8], although little of it has found actual application. Many interactive lecture video browsers continue to resort to the simplest of multimedia features, the most popular being a straightforward video player, which is sometimes annotated by periodically extracted snapshots. However, the field of multimedia is by virtue an assembly of multiple modalities, primarily defined by visual and audio sensation, and subsequently interpreted content of subjects and objects, for example blackboard writing, speakers, presentation slides, web page display, etc. [4] Automatic segmentation and detection of such content is not trivial, and most related technological innovations are experimental and inaccurate or demand highly tuned environments to work properly. This is not surprising since human perception is a highly complex process that is difficult to model. Manual analysis of content, on the other hand, is time-intensive and costly, and is justifiable in only few cases.

Other approaches to incorporating actively recorded video in the classroom have received comparatively little attention. However, the opportunities and advantages of recorded video resources outside the domain of instructional video are equally as promising as effective study tools. Instead of employing video as a passive tool, for example for viewing professional programs, students would benefit from interacting with this medium, either by producing their own material or using it for evaluation and improvement of professional skills.

We explore the incorporation of video recordings in a large engineering course for student presentations and team-based journaling of project progress. In this first-year undergraduate engineering course, students are introduced to the field of engineering design through community service learning while they work in teams of three to eight members. The non-trivial selection process of teams and role assignment within teams is further detailed in our related work [9]. Teams work on various community projects in categories such as disabilities, environment, education, architectural designs, information technology, a more thorough investigation of which is presented in [10]. The course approaches first-year engineering as a practical introduction while following several ABET criteria. From the perspective of professional skills, students learn to interact in small teams while they work with a real community partner on a real community design project. Students learn and practice communication skills as they collect design requirements, formulate problem statements, and exchange ideas and solutions with their client. From an engineering perspective, students are required to perform background research on technical, social, and ethical aspects of their project, produce drawings and prototypes, and justify their decisions using statistical or experimental data. We facilitate the technical development of the course by teaching the effective use of software suites such as Mathworks Matlab for numerical analysis and Alias Maya for two- and three-dimensional modeling and design work. Throughout the design process, teams must communicate their problems, ideas, and designs effectively to the client, peers, advisors, and instructors. Students are required to produce final reports, which summarize their projects' problem statements, functional requirements, constraints, and solutions. While teams must also include their views on team development, it is difficult to objectively weigh such opinions. Professional development and communication skills are therefore best captured and reviewed as audio-visual material, and therefore video recordings of selected stages of the overall design process best serve the goal of the course.

As milestones in the design process, student presentations are held twice a semester, once in the middle and once towards the end. Recordings of these events are an important learning resource for students and serve the purpose of self- and peer review in the on-going semester. In preparation for their final presentation in the course and for progressive improvement of their presentation skills, students benefit from reviewing their own performance and that of their peers from the midterm. Recorded presentations further provide a novel and visually appealing archive of past student and team performance, which can be evaluated by future teams for background research and development of communication and professional skills. However, without tools for searching, browsing, and dissemination of the extensive multimedia content, it would be difficult, if not impossible to effectively make use of it.

A less formal approach to making use of video recordings in the classroom places the students in charge of producing their own footage. Similar to presentation videos, the camera becomes an external view of team interaction and individual behavior. Additionally, teams record their client meetings and sire visits for purposes of archiving and review. Due to its subjective nature, students have complete control over content. Nonetheless, they are required to produce a short edited summary of their footage by the end of the semester.

Background

Production of edited videos is a time-consuming and costly endeavor. Depending on the level of quality, instructional videos require significant post-production only if external material is separately included or shots from multiple steady cameras are edited into one video. Alternatively, a camera operator is needed during the recording stage to perform tasks of switching video input sources (podium camera, view of computer screen, overhead camera, etc.) In either case, equipment and staff are necessary to produce reasonable quality videos.

Presentation videos would benefit from similar editing, but due to their intended use in the classroom environment, the cost and time effort are neither available nor justifiable. The ultimate goal of capturing presentation videos is to provide students with a means of reviewing their performance as opposed to creating professional films. For that reason, skilled camera operators are optional during recording. It is sufficient to set up a camera with a view of the stage where students present and presentation slides are projected. A separate fixed microphone installed on

Figures 1-3: Split panorama view of classroom: (top left) View of classroom audience, (top right) View of classroom audience and “stage”, (bottom left) View of stage.

stage is nonetheless imperative in order to adequately capture speakers. We do not use clip-on microphones, because they create an unnecessary distraction to the presenters. Moreover, the logistics of passing on such a microphone disrupts the flow of the presentation. A split panorama view of the classroom is presented in Figures 1-3.

Regardless of production quality of classroom videos, dissemination and search/browsing of their content is not guaranteed without significant effort. Dissemination of video refers to the capability of distributing them to interested parties. Possibilities include transferring video content onto physical media, such as CD, DVD, or VHS, or making them available online either as downloadable files or streaming content. Production of physical media tends to be considered for long-distance learning, in particular when the availability of the Internet is not guaranteed. For classroom interaction videos, however, availability of communication resources is not a common problem. In addition, the prospect of creating personal copies of media presents a high burden for staff and instructors. Making the videos available for download or via streaming servers is a viable economic alternative.

All of these dissemination approaches suffer from severe drawbacks with increasing size of a video collection. In the absence of costly manual labor for creating searchable indices, a growing collection of videos becomes less useful for information retrieval, because the time spent on searching no longer justifies the intended use. We use our large engineering course as a motivating example for the need for novel search and index methods. In one semester, more than 150 students in over 30 teams present on various topics and projects. We record approximately 16 hours of video for midterm and final presentations combined. During the past 5 years with 2 to 3 semesters per year, we have collected 184 videotapes amounting to 162 hours of presentation footage. Over 1500 students and 300 projects have been featured in the presentation videos for midterm and final videos. While the amount of material grows linearly over time in a course, the massive amount of data still requires non-linear search and retrieval techniques, equivalent to those present for text corpora.

We address the high cost and time commitment necessary for creating readily searchable videos by introducing a set of tools that automatically segment, index, and annotate presentation videos. The workload on instructors or staff is minimal and requires only organization of material used during a video's analysis. The steps required are:

1. Capture video using either a fixed camera or an untrained operator.
2. Use commercial Automatic Speech Recognition (ASR) system, e.g. IBM ViaVoice to transcript audio track. No speaker or language model training is expected.
3. Collect external text references, whether presentation slides (PPT, PDF), detailed syllabus, or index from the course's textbook.
4. Use index tool, which performs automatic speaker segmentation, visual segmentation, extraction of keyframes, alignment of text to soundtrack, transcoding of video to a smaller-sized MPEG1 video format, and transfer of summary into a database.

The speech-to-text translation step is at present separately necessary, because our tool does not include a speech recognition system. Future implementations may remove this step.

We introduce a video browser dissemination tool for video summaries and streaming videos, which builds upon the above-mentioned database (Figure 4). Besides making available the video summary in various UI components, the video browser also contains a streaming video player. In earlier implementations, we have relied on the Java Media Framework (JMF) to supply video capabilities. However, due to platform incompatibilities, installation requirements, and severe drawbacks for streaming video, we have implemented a standalone Java-based MPEG1 streaming server and player. Our implementation requires no additional libraries, whether for video codecs or video rendering, other than the standard built-in Java Sound package. The advantage to our approach is a ready-to-use video browser on any Java-enabled platform. The video browser is started from the web using Java WebStart.

Segmentation and Indexing of Presentation Videos

The automatic creation of indices has been explored extensively for popular video genres, e.g. news, sports, and instructional video. Presentation videos differ from these genres in many ways, thus requiring the design of new methods.

A commonly used index is the transcript from the video's soundtrack. Unlike pure visual or audio data, text data can be searched easily and quickly, thus presenting an inexpensive but effective index. The creation of manual transcripts is time consuming and costly and typically requires a transcription service. Some universities use this approach to generate highly accurate

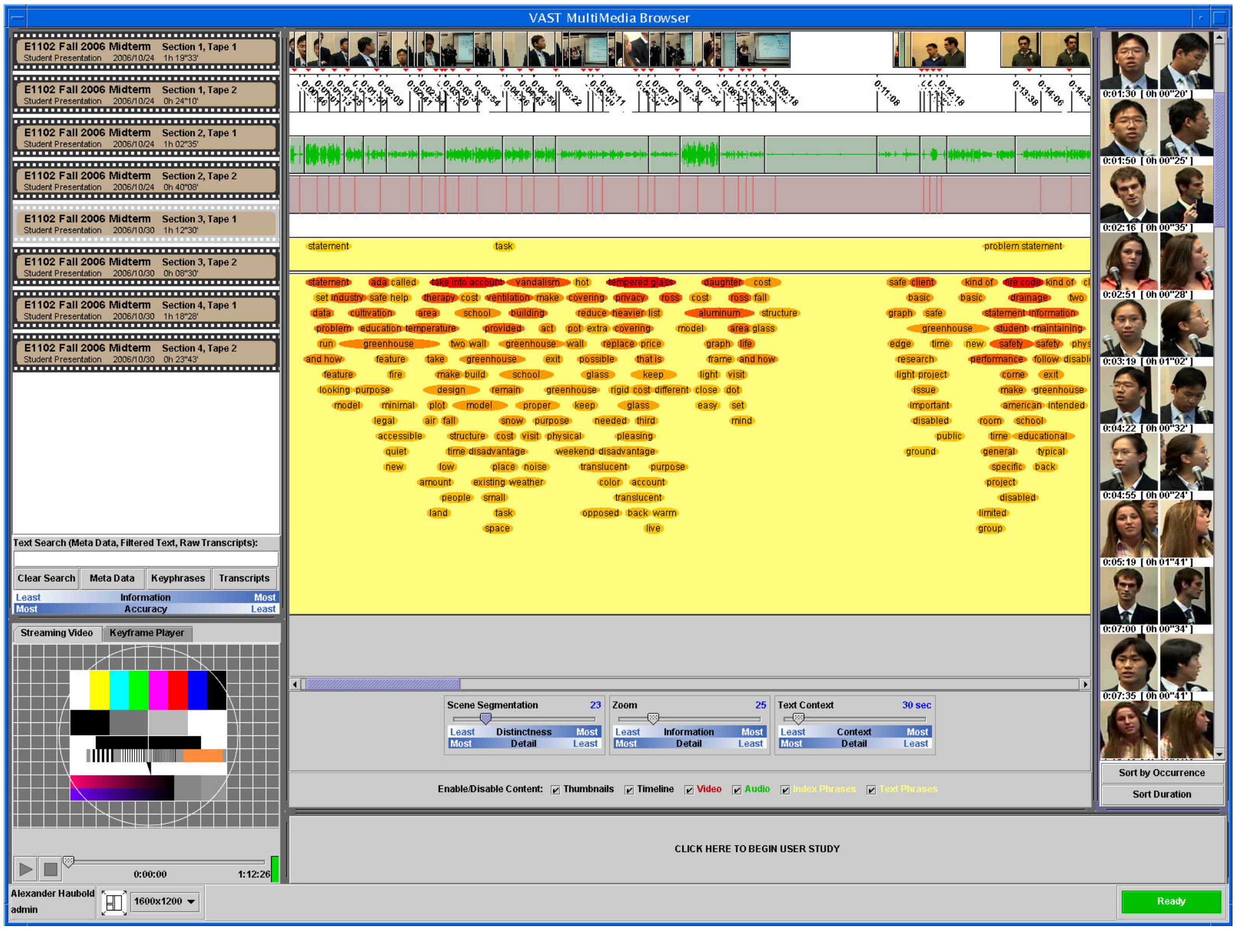


Figure 4: VAST MM (Video Audio Structure Text MultiMedia) browser. Featured on the left are videos from the course. Upon selecting a video, the video summary and streaming video is loaded. The summary features thumbnail keyframes, which enlarge on mouse-overs, speaker segmentation UI, video segmentation UI, keyword and key phrase UIs, a visual speaker index, and streaming and keyframe players.

transcripts for lecture videos. ASR software provides a cost effective approach to extracting text transcripts from videos in little time. However, unlike news, sports, or instructional videos, presentation videos exhibit several audio qualities that negatively impact automatic transcription. From the perspective of audio quality, varying speaker styles result in varying signal strength and consistency. Because presentation videos do not primarily focus on precise scene setups, presenters position themselves at varying distances to the microphone. Some speakers remain still during their speech, while others maneuver about the stage. Some engaging presenters remove the microphone from its stand and inadvertently produce a steadily fluctuating volume by constantly moving the microphone. An unavoidable domain-specific problem with student presentations is the highly varying speech pattern exhibited among the large number of students. Those with natural or trained skills speak confidently and clearly, while those who are inexperienced or uncomfortable tend to have problems reaching the audience. This is an unsolvable problem, because by nature student presentations are intended to demonstrate these human qualities to the students for their learning experience. Finally, most commercially ASR software relies on an a priori “training” process, in which the software “learns” a speaker’s characteristic speech patterns. Once used for speech recognition, the ASR engine maps the speaker’s speech patterns to words in its dictionary. Even during post-training use, ASR software improves the speaker model. The training process works very well if performed on a small number of people, for example for a series of lectures by one or two instructors. With a large sample size of more than 150 students per semester, like those in our engineering course, building training sets becomes an unrealistic task, and it defeats the purpose of generating low-cost searchable video summaries.

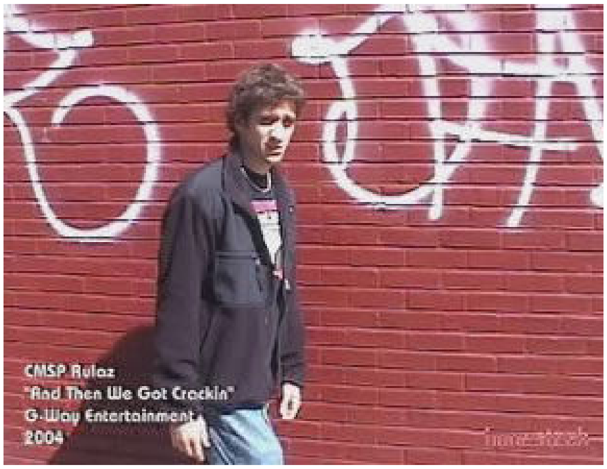
We therefore use the trained speaker model of one average speaker for audio data from many student presenters. We have observed that while more than 75% of words in ASR transcripts are incorrectly identified, the remaining words are descriptive enough to formulate a general idea about presentation content. This set of words not only includes typically well-identified stop words (this, that, the, I, we, of, …), but also salient words (wheelchair, swing, material, …). However, it is not possible to extract or even identify complete meaningful sentences. We have therefore designed and tested a method by which highly inaccurate ASR transcripts are filtered with a set of keywords and key phrases taken from an external contextually relevant corpus [5,6]. The resulting, much smaller list of words and phrases are to more than 90% accurate and provide a meaningful textual index into the videos. The external corpus is taken from students’ presentation slides or content index from the course’s textbook.

A common visual indexing cue used in video browsers is a set of representative video snapshots, which reduces the original large number of video frames to a comparatively small set. Extraction of such key frames is typically based on visual segmentation of video footage into seemingly independent scenes or shots, from which one representative frame is characterized as the key frame. Various approaches exist depending on production quality and genre of video material. Highly edited news videos can generally be segmented into short duration shots by detecting “obvious” cuts, which occur when scenes change abruptly. Unedited presentation videos contain few or no cuts, thus requiring a more suitable method of differentiating between shots. We combine two approaches, each measuring a different event in raw video footage. Events such as presentation slide changes or relatively fast-paced actions are detected similar to scene cuts by measuring the visual difference between consecutive video frames. Slow-paced events, such as a camera panning or zooming, a person walking in and/or out of the camera’s view, or animated presentation slide effects are detected by comparing the overall color change between more distant video frames. We use an empirically determined distance of 4 seconds (120 frames). This approach is particularly helpful in the absence of presentation slides, which are neither guaranteed to be captured during recording nor are they an absolute necessity for presentations. (Figures 5-7) In a final step, cues from both segmentation methods are superimposed, redundant nearby cuts are filtered, and key frames are extracted for all resulting shots. The eventual number of significantly important key frames cannot be statically fixed during the automatic segmentation of a video. Because shot boundaries do not exist from intended cinematographic scene cuts, but are determined on the basis of likelihood, the final desired number of visually significant scenes is determined dynamically via a user setting. The user has the ability to set the granularity, which at one extreme selects only the most significant changes, and at the other extreme shows all significant changes, including the least significant ones.

Figures 5-7: Camera shots when presentation slides are not present: (top left) Prototype demonstration, (top right) Q&A from students, (bottom left) Q&A from audience member.

Key frames are an invaluable visual tool for an alternative to viewing the entire video or using the positioning peg to skim a video. Analog to a full video player, we also include a key frame player, which plays back the video as a slide show. In user studies we have observed that this player is favored over the full video player when students are searching or browsing. Nonetheless, it does not replace a full video player for in-depth analysis of a student performance.

We introduce a novel visual index of speaker faces for search and retrieval of presentation content from particular students. Lecture videos tend to be hosted by one, sometimes two instructors, which does not merit a separate speaker index. Summaries for news videos could benefit from a speaker index, because in addition to “what” is being said, there exists an interest for “who” said it. For presentation videos in particular, where the students more so than content are the focus of attention, there is an inherent need for identifying a person with a video segment. Using speaker segmentation as the basis for separating each student’s contribution, a subsequent extraction of the speaking head is performed to capture a snapshot of the speakers. A list of speaker head images is then available in the video browser for quickly locating individuals. The more natural approach of identifying each speaker by name is considered a subsequent step, which relies on face matching. We do not presently implement this technique, but intend to do so in the future.



Figures 8: Journal summary video in the form of a rap music video. While highly creative and entertaining, the video lacks work on the course project.

Figure 9: Journal summary video showing work in the "field". Inclusion of shots showing a project site or other project-relevant material helps to convey the problem and goals.

Journal Videos

We have observed that while presentation videos are an important and useful vehicle in the classroom, team-based journal videos in the format we have explored are less useful and are in some instances counter-productive. There exist several fundamental problems with granting students the full artistic right to producing a short summary video of their semester progress. At the same time, many of the student-produced videos have exhibited Hollywood-like creativity (Figure 8), unfortunately in most cases with a trade-off in project deliverable quality. One of the most important pedagogic goals behind requiring students to summarize their experience and progress is to provide a realistic view of team interaction. In many cases, however, the selected scenes from the uncut journal video are either bad examples, or are merely staged. At best they extend to entertainment value.

Video footage related to client interaction, client meetings, or field trips to a project's site insofar as applicable, had a much higher success rate (Figure 9). Such material is invaluable as it describes a project and its goal pictorially. Successful projects oftentimes were accompanied by a reasonable amount of such footage.

We have modified the initially lose task of producing a summary video showing team development and client interaction to a stringent set of requirements targeted at producing a video that describes the semester project: The video must include the following themes. A) 2 minute introduction to the problem, including excerpts of meeting with clients, interviews, physical area where problem exists, whether a web site, park, office, playground, etc. B) 2 minutes on team working on problem, including interesting excerpts of meetings, visits to related sites, businesses, stores, etc. C) 2 minutes of final deliverable and evidence of the solution's applicability. This may include an animation, images, a prototype, models, plans, etc.

Our initial four-semester attempt at including video productions in the classroom was accompanied by on-line material related to video editing software and equipment usage. Student teams shared low-end digital video camcorders and used Apple iMovie to edit their material. While students had no difficulty acquiring basic skills in video editing, we have observed that quality of final videos varied significantly due to level of interest and prior knowledge. Short lectures on the following topics are necessary: A) storyboarding, selection of appropriate content, B) a selected editing software, e.g. iMovie, C) 3D animation basics (as an extension to the already instructed 3D modeling software, Maya), and D) composition, required inclusion of references and titles, and fundamentals of video formats. We have found that without such instruction, most videos lack the quality for publishing online.

User Studies and Evaluation

Periodically we administer user studies to evaluate the usefulness and benefit of recorded presentation videos and the tools we have developed to build an effective video library.

Since the successful launch of VAST MM, we have administered a user study to 167 students to measure the added benefit of video libraries on background research. We have previously found that background research is one of the weakest components of final project reports. We attribute some of this observation to the lack of prior exercise in this field, while a significant part is also due to the rush of jump-starting a project. However, we find that background research into prior work is non-trivial, in particular when means of searching are not readily available. We therefore designed an assignment by which students were asked to find prior video presentations relevant to their current project. Using VAST MM, students were required to find, summarize, and articulate their opinion about the selected projects. This user study was unsupervised, and students were given one week to complete the assignment on their own time. In our evaluation of written reports we have found a significant qualitative increase compared to prior background research performed by students. This qualitative difference is evidenced by students finding prior incarnations of their projects, finding background information on continuing community partners, or finding topically similar material. While performing this research in the audio-visual domain, students also exercise the task of refining their search in order to attain better results when searching in other corpora.

To quantitatively evaluate VAST MM, we administer task-based experiments, which measure the effects of various UI components, focusing on duration, completion, and accuracy of student responses. Students are also required to complete a survey from which we gather their general acceptance of the tool. We have collected data over a two-year period (4 consecutive semesters) from 598 participants. Adjustments and improvements to the video browser are made after each term, taking into account results from our user studies and suggestions from surveys.

User studies with measurable effects are not trivial, in particular in a multi-modal domain. We have designed a set of 5-7 tasks related to search and summarization of video content, which students must complete. These tasks are comparable to typical queries that students may perform given a set of videos containing many presentations:

1. Find your own appearance in the video.
2. Locate the portion of the video in which your team discusses topic XYZ.

3. Find the beginning of your team's presentation.
4. Find the presentation on subject XYZ (titled ABC).
5. Using the available keywords for the presentation located between TIME1 and TIME2, summarize the project's goals as best as possible.

The user study is carried out in our lab environment during class with 10-15 students at a time, while the remaining student work on their projects. We note that the lab is fairly noisy and not comparable to an office or study room environment. External distractions occur frequently, and add to the casual environment in which students tend to work in teams.

After a short introduction and training session on using the video browser, each student begins the user study at their own leisure. Once started, search and retrieval tasks appear in the interface, and students can use any of the available features to complete the tasks. Because our course is separated into 4-5 sections without interaction between sections, students are familiar only with the presentation content in their own section. To simulate a realistic environment, tasks unrelated to a student's own team always target another course section.

While students complete user study tasks using the video browser and its retrieval features, all actions are logged with time stamps. Completed tasks are measured by their accuracy – for search-related tasks students must find and mark the answer on a timeline; summarization tasks are measured by the quality of the worded response. Tasks that are explicitly skipped count as incomplete, for example when a student is unable to locate an answer. Tasks answered in too short of a time period, which occurs when students intentionally or unintentionally skim through the user study, are ignored altogether.

We define several criteria for evaluation. Completion rate denotes the number of tasks completed properly. A lower value indicates that tasks were skipped often, whether due to frustration of not finding the answer, or advertently/inadvertently skipping tasks. Accuracy measures the temporal distance between a user's selection and the correct answer for tasks related to searching. Finally, we measure the temporal duration of a task.

We have observed very positive developments with the continuous improvements to our video browser. Overall task completion rates have improved from 82% to 92% over 4 semesters. For the most characteristic search task of locating an unfamiliar presentation in a set of several videos, the completion rate has improved from 58% to 73%. Accuracy, too, has increased overall, but we note an interesting "trust" effect. In the absence of a text search feature, which is particularly useful when locating unfamiliar material, students apply more care in locating the correct response in the entire set of videos, which requires more time but increases accuracy. Surprisingly, if a text search engine is used, accuracy drops significantly from 4 to 229 seconds, while completion increases from 52% for 73%. Analysis shows that the average is due to a number of outliers with high off-target answers, while the remaining 80% of students still mark the correct answer within an error margin of 4 seconds. We believe that the high off-target responses are due to students trusting the search results, which correctly narrow the search domain to one video, but do not identify the approximate location of the results. If the exact answer cannot be found, the next best answer is to select a random location in the video. In the next iteration of the tool, we are including a feature by which search terms are highlighted in their matching locations in the video.

Our approach of filtering inaccurate speech transcripts and prioritizing key words and phrases in the interface has proven to be a successful summarization tool. During the first 3 user studies, we have tested presentation summarization by providing a multiple-choice task. In our most recent iteration, students were required to articulate a response using only the available keywords. The quality of answers suggests that the selection of words and phrases is sufficient for forming a general idea about the content of a project.

Analysis of time required to fulfill tasks shows an overall decrease with an average of 100 seconds per search or summarization task. Search tasks for unfamiliar content by far outweigh all other tasks with an average of 5 minutes. However, we should note that the correct response for a question of this type is found in a window of 5-10 seconds from video footage with duration 23,380 seconds (6.5 hours). For summarization tasks we observed only a nominal increase in duration, which is due to the shift from multiple choice to freeform responses.

In general, we can conclude that our methods of video analysis and our tools for searching and visualization are effective for information retrieval in video libraries. User studies have helped identify shortcomings and strong points, and addressing them in subsequent improved versions resulted in improvements in search and retrieval. Being a multi-modal domain, video summaries require analysis and UI tools for various modalities. Our selection and enhancement of visual, speech, text cues and their UI components indicate that our automated analysis of video are effective for increasing accuracy and completion, and decreasing duration of search and summarization tasks.

Surveys show an overall approval for the availability of videos for self and peer review. The tenor from our survey responses is comparable to the statistics computed from user studies. A number of students would like to see an increased use of video beyond review of their performance, for example for review of lab lectures.

Conclusion

We have reported on novel approaches to using video in the classroom. Presentation videos and journal videos serve as a medium for students to learn and interact with. As opposed to lecture videos, which are passively captured and serve as supplemental review material, presentation and journal videos engage students in different ways. Presentation videos are intended to give students a means to review and evaluate their own performance, while journal videos are a valuable tool for students to summarize their project work in an appealing way. Our evaluation shows that presentation videos are very effective; as are the tools we have developed for dissemination, search, and retrieval. Without the necessity of expensive video editing equipment or staffing requirements, our automated tools are sufficient for incorporating video into the classroom. Through exit surveys we have gathered a majority of student interest and enthusiasm towards the availability of video material.

Journal videos produced by students, while theoretically effective, require rigorous rules. Our initially lose requirements granted students the desired artistic rights, but result in a widely varying and undesired qualities. Nonetheless we have observed that teams who have used this technology responsibly have generally been able to better present their projects.

We continue to evaluate the use of video in the classroom. Our present studies show that student show a strong interest in interacting with video, and that the inclusion of video presents many benefits for the successful completion of the engineering design course. As is the nature of the course, future semesters will experience incremental changes. We intend on increasing the interaction with video material by making available more videos to build a larger archive of reference material. In the present semester, we are video-recording laboratory sections in which we are teaching the effective use of software packages, such as Mathworks Matlab and Alias Maya. We intend on evaluating the availability of this reference material by comparing student performance to prior semesters.

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