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Screening and Assessing a Capstone Senior Design Project: Video Compression and Error Concealment Over the Internet*

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The Accreditation Board for Engineering and Technology (ABET) EC2000 criteria require that programs demonstrate the ability to work successfully on interdisciplinary teams. This can be accomplished, at least for electrical engineering programs, using teams of students where each individual is responsible for a design aspect that calls for different technical expertise. Thus a project that calls for knowledge in Digital Signal Processing (DSP), software engineering, telecommunications, and use of the Internet would qualify as a venue for demonstrating multidisciplinary teamwork, according to those who represent IEEE at ABET accreditation workshops. In this paper, we describe such a design project, where the goal of the project was the improvement of video quality for real-time video transmission over data networks. Since real-time video is considered, the development can be used for video-conferencing, real-time medical diagnosis, real-time control of industrial processes, or any other use of real-time video.

INTRODUCTION

THE ACCREDITATION BOARD for Engineering and Technology (ABET) EC2000 [1] criteria require that programs demonstrate the ability to work successfully on interdisciplinary teams. At ABET and IEEE training workshops, we found that this can be accomplished, at least for electrical engineering programs, using teams of students where each individual is responsible for a design component that calls for different technical expertise.

In assessment workshops held by the IEEE and attended by two of the authors it was stated that a multidisciplinary project may combine components from electrical, mechanical, biomedical, and computer engineering. Furthermore, it was stated that a project that combines components from both electrical and computer engineering is considered a multidisciplinary project. Thus, a project that calls for knowledge in DSP, software engineering, telecommunications, and use of the Internet would qualify as a venue for demonstrating multidisciplinary teamwork.

In this paper, we describe such a design project, where the goal of the project was the improvement of the video quality for real-time video transmission over data networks. In particular, we describe the project, the weekly activities of the team, the method for assessing teamwork, the results of the assessment of teamwork, and the outcomes of the project. We also describe the educational aspects, including the scheduling of weekly activities, and the technical aspects, which included software design using an H.263+ [2–4] compliant video compression software that was used for video-conferencing. This project was one of many projects proposed to senior electrical engineering students enrolled in a senior capstone design course which the students had to complete prior to graduating.

The paper is organized as follows. First we state the criteria used for project selection, then the project screening process is described, followed by a description of the composition of the team that conducted the project and the schedule of the technical activities conducted throughout the semester. Next the grading criteria are outlined, followed by a description of the project, the results of the project, and an assessment of the project.

CRITERIA FOR PROJECT SELECTION

In general, all the projects proposed for the senior design course at our institution had to meet the following criteria:

1. The projects proposed to students had to be based on knowledge learned in various courses in a typical electrical and computer engineering (ECE) curriculum. Student members who chose to work in a particular project should have the necessary prerequisite knowledge, and should

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be interested in the various design aspects of the project. However, the students were required to conduct library and Internet searches to enhance their knowledge in the areas pertaining to the design project of their choice.
2. The projects should have an industrial application.
3. The projects should preferably be multidisciplinary in nature, requiring the integration of knowledge from different disciplines.
4. The projects should be in the areas of expertise of faculty in the department of Electrical and Computer Engineering. This is to ensure that faculty member(s) from the department can supervise the team.

In general, any project requires a certain level of expertise. This is acquired by the students through the various courses in which they enroll and is enhanced during the course of the project. Furthermore, all of the design projects proposed to the students in the senior design course are different, and as such students working on different projects will refine different types of knowledge and expertise.

The project described is a model that met the aforementioned criteria. Four students who found the project attractive and were interested in pursuing careers in areas related to the project, or wished to pursue graduate work in the same area, participated in the project.

Prerequisite knowledge for the project

The project described here focused on the reliable delivery of compressed video over data networks. Students participating in the project were required to know about the various video and image compression standards such as H.263 [2] or MPEG-4 [5], to have a working knowledge of the C programming language [6], and know about the various transmission protocols used in data networks. Knowledge of video compression standards was acquired by the students in a senior level elective course (ECE417: Multimedia Applications), which all four students had taken. Similarly, all students knew how to program in C because all had taken the required sophomore level (ECE264: Advanced Programming) in C. As for the networking protocols, only two of the students had taken the senior level elective (ECE495: Introduction to Computer Networks). The other two students learned about the various networking protocols during the course of the project by consulting the text used in ECE495 and any material they could find on the Internet.

In general, Signal Processing and Communications is a popular area in many ECE curricula. In our department, six undergraduate courses in Signal Processing, of which ECE417 and ECE495 are two, are offered every year and are very popular among our students. In fact, these courses have the highest enrollment figures among all of the senior level courses offered by the department. As such, the pool of students that could have worked on this project is not very limited.

Industrial application of the project

Transmission of compressed video over the data networks has become a very widely used tool for many different applications. It was only a matter of time before this technique would fully evolve to include real-time video. Such real-time video will allow the utilization of the Internet; for example, for video-conferencing, diagnostic medical procedures, and industrial process control as well as many other technologies. Real-time data, such as video and audio, are not immune as they are being transmitted over the Internet. It is in fact more critical during real-time transmission to deal effectively with common Internet problems such as loss of data and lack of bandwidth. If excessive data is lost during the transmission of medical images, for instance, an improper diagnosis could be made, which could deny a patient lifesaving treatment. If an infrared video image of a boiler is sent over the Internet and the data cannot be interpreted correctly by a control system, a boiler that is too hot could explode.

The completion of the project sparked the interest of local industry to the extent that all the students who participated in the project received multiple job offers from local industry because of their involvement in the project. Furthermore, local industry have indicated through surveys and also to the Dean of the School, through the Dean's Industrial Advisory Council, that they would like to see more projects of the same nature as that described here.

The multidisciplinary components

The project described here was multifaceted, in the sense that its technical requirements included:

- in-depth understanding of the H.263 [2] video compression standard;
- a good working knowledge of the coders and decoders (codecs) used to implement the standard [3];
- knowledge of how to modify the coding of a video sequence by:
  a. modifying the quantization tables [2] in accordance to the varying state of the network at any given time
  b. modifying the decoder [3] such that, depending on the amount of degradation an image incurs compared to the prior image, it would be replaced by the prior image in the sequence
- knowledge of transmission protocols such as TCP, UDP, and RTP [7, 8].

In addition, the students involved in the project were required to demonstrate the following:

1. creativity;
2. teamwork;
3. critical thinking and brain storming;

4. oral presentation; and
5. writing a professional report.

Faculty expertise

There were two faculty members overseeing the entire senior design course. One was responsible for soliciting projects from the various faculty in the department or from industry, as well as monitoring the students' progress and inviting various speakers from industry. The other faculty was responsible for assessment. In addition, there was a third faculty member; the one who proposed the project and who directly supervised the team of students who participated in the project described here. The latter's expertise is in video compression and the reliable delivery of video over data networks.

THE SCREENING PROCESS

All proposed projects are subject to a screening process. This entails that each proposing person should complete a form giving information about the following: whether the project meets all ECE Program Outcomes; what prerequisite knowledge is needed for successful completion of the project; the number of students required to complete the project within one semester; and the non-overlapping responsibilities of each team member. The committee overseeing the course then selects the projects deemed appropriate and presents them to the students enrolled in the course. These in turn select a project, form a team, and put forward a proposal on how the team will complete the project. The committee then checks the following:

- Does the team have the prerequisite knowledge to complete the project?
- Is there enough work assigned to each student in the team for the duration of the project?
- Is the expenditure needed for completion of the project reasonable?

COMPOSITION OF THE PROJECT TEAM

There were four students in the team that selected the project described in this paper. Each student was responsible for a different aspect of the project. The following describes each member's primary responsibility. The choice of tasks and person to perform the tasks was agreed upon by the faculty and the team after meeting several times to discuss how the project should proceed.

- *Team Member #1*: This team member oversaw the modification of the software to match the project's goals. In addition, this team member acted as the team leader and would report to the faculty member overseeing the team progress and any problems the team faced. This, however, did not prevent the other team members from consulting the faculty individually.
- *Team Member #2*: This team member was in charge of selecting inexpensive hardware, such as a 3Com HomeConnect PC digital camera [9] and a bandwidth monitor, to perform the project.
- *Team Member #3*: This team member was responsible for interfacing the hardware and software used with the Internet.
- *Team Member #4*: This team member was in charge of testing and integration.

It should be noted, however, that all members participated in all aspects of the project. Thus, for example, all participated in the actual writing of the various C language functions necessary to complete the project, except that this was done under the supervision of team member #1. Also, team member #2 collected information on the different kinds of products offered by different vendors and made recommendations to the team and the supervising faculty. The final decision on which product to use was made by the entire team of students.

SCHEDULE OF TECHNICAL ACTIVITIES CONDUCTED THROUGHOUT THE SEMESTER

During the course of the project, the following activities were conducted within a 15-week period (see Table 1). Throughout the semester, students gave three oral presentations. The presentations were graded by the faculty member overseeing the entire senior design course and the students in the class. In addition to working on their design, the students were required to attend a number of lectures/presentations, throughout the semester, that were offered by different speakers from industry and other departments in the school. Table 2 outlines the in-class activity during the semester. Throughout these lectures, students learned how to provide information by offering facts and expressing opinions, exploring the ideas of others, interpreting and clarifying ideas, learning how to coordinate together, and, finally, learning how to perform a critical analysis of an idea and verifying it with respect to data.

GRADING CRITERION

Grading of student progress was based on the following:

- progress reports presented throughout the semester;
- the final presentation;
- feedback from the project adviser; and
- the final report.

The students were also provided with a perception checklist that comprised the following questions:

1. Please provide the problem that your team is

Table 1. Timetable of student activity

Time Frame	Activity
First three weeks	Students were introduced to various projects. Teams were selected. Four projects were proposed, of which the project described herein was selected by four students.
Following two weeks	Performing literature search on the transmission of video over data networks and understanding the various problems that arise during transmission.
Following two weeks	Searching for existing transmission techniques for solving the problem. Proposing approaches that emphasize encoding and decoding via variation of the quantization tables, and the concealment of the errors caused by data loss during transmission. The approach to meet these objectives was to use and expand knowledge learned in signal processing courses that cover material related to the current video compression standards, such as H.263+ [2] and MPEG-4 [5]. The objective was to design an approach that will solve problems involving the real-time transmission of video using low data rates.
Following five weeks	Designing, debugging, and trying out the software used to achieve the objectives.
Following two weeks	Refining the design.
Final week	Writing the final report.

experiencing currently and you would like to resolve.

2. On a scale of 5, rate the team ability in the following:
   a. ability to solve problems;
   b. ability to seek ideas and inputs;
   c. ability to work as a team;
   d. ability to seek feedback from others on personal performance; and
   e. ability to encourage and support risk taking.
3. What do you support most about your executive team?
4. What would you most like to change about your executive team?

DESCRIPTION OF THE SAMPLE PROJECT: RELIABLE DELIVERY OF COMPRESSED VIDEO OVER THE INTERNET

Since any communication link has a limited bandwidth, transmitting video will require that the data be compressed prior to transmission. This renders the data vulnerable to transmission losses. The effects are normally experienced in the form of jerky video, as well as low-quality images. The goal is then to attempt to alter the compression factor and consequently the data rate at the sending end to permit a graceful degradation of image quality at the receiving end in the event that the available bandwidth becomes constrained. This is done by changing the quantization parameters, thereby reducing the data rate, and by performing error concealment at the receiving end in the event that the arriving video has been subject to data loss during transmission. In order to tackle this problem and better manage the entire project, the students broke down the project into the following components and investigated them individually:

- the hardware needed to perform the project;
- bandwidth requirements;
- how to reliably transmit the data across a data network; and
- compression and decompression.

A description of each component follows.

Hardware

A video camera was used to capture images of the user. The camera that was utilized was the 3Com HomeConnect PC digital camera [9] with a detachable Universal Serial Bus (USB) cable. At the time the project was conducted, this was the piece of equipment that fit within the project's budget.

Bandwidth

To determine which video codec to use during transmission it was necessary to monitor the bandwidth of the network. This was accomplished

Table 2. In-class activity throughout the course of the semester

Time Frame	Activity
Week 1	Lecture that introduced the course and the various projects submitted
Week 2	Continuation of project description
Week 3	Group selection and planning
Week 4	Lecture on group dynamics
Week 5	Oral presentation—first progress report
Week 6	Lecture on design methodologies
Week 7	Lecture on leadership
Week 8	Lecture on electronic manufacturing
Week 9	Oral presentation—second progress report
Week 10	Lecture on writing instructions and format
Week 11	Lecture on human factors
Week 12	Lecture on reliability
Week 13	Draft of the final report submitted
Week 14	Final report submitted

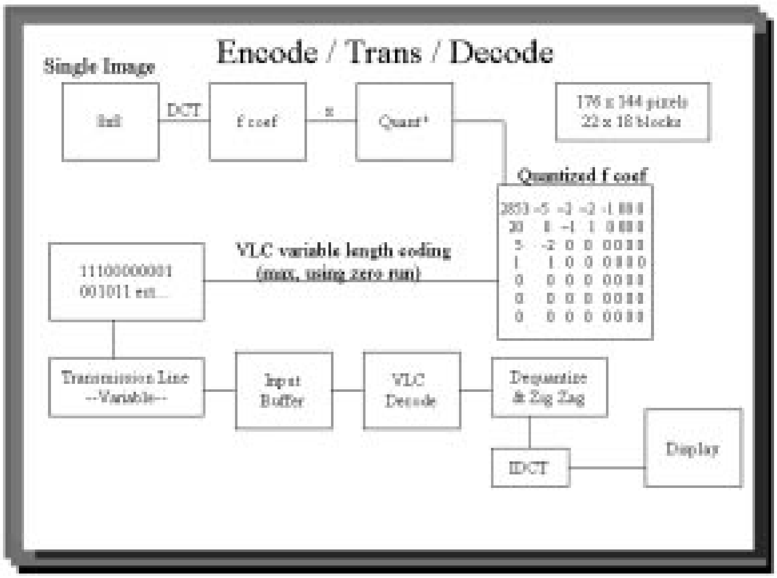

Fig. 1. Block diagram of the coding/transmission/decoding process.

by the use of a bandwidth meter, the DU meter by Hageltech [9].

Networking

Compressed video is sent from one computer system to another computer system by way of a network. Since the networks use protocols, which are sets of formal rules describing how data is to be transmitted, the students had to learn about the Transmission Control Protocol/Internet Protocol (TCP/IP) suite [7]. This suite includes telnet, File Transfers Protocol (FTP), and User Datagram Protocol (UDP). In addition, the students investigated RTP [8], which, at the time the project was conducted, was a proposal for a new protocol for transmitting real-time video.

Compression and decompression

To achieve real-time transmission of video, it is necessary to transmit between 25 to 30 frames/second. This would require transmitting 207.36 Mbits/sec to 248.832 Mbits/sec through the network, in the case of ITU-R 601 images, or 15.2 Mbits/sec to 18.25 Mbits/sec, for QCIF images, respectively. Most networks cannot carry multiple streams with such bandwidths, hence the need for compression. Compression was accomplished by utilizing a software implementation of the H.263+ standard [2]. In general, a video sequence is compressed by first dividing each frame in the sequence into blocks and monitoring the motion of each block. Rather than sending the information about each block all the time, the information is sent only once and information about the direction of motion of the block is sent from then on. Furthermore, rather than sending each block the first time, each block is transformed and the transform coefficients are then quantized. It is these quantized coefficients that are actually transmitted after being entropy coded (see Fig. 1).

Design objectives and approach

Video compression can be implemented in software, hardware or a hybrid of software and hardware. Although each approach has similarities to the others, each has numerous advantages and disadvantages. Table 3 gives the specific advantages and disadvantages for each implementation.

The software application is ideal for this project because of its portability and low cost. Figure 2 illustrates the components utilized in the project. First, the 3Com HomeConnect PC digital camera [9] was used to obtain video data. The interface between the digital camera and the computer system was accomplished with a detachable USB cable. Video can also be gathered using a parallel port connected to a digital camera. The computer system in turn was utilized to compress the video which was subsequently transmitted across a data network to a receiving computer system. The

Table 3. Comparison of the hardware and software implementations of video compression

Implementation technique	Advantage	Disadvantage
Software	Portability/Multiple applications/Easily modified (SDK)/Low cost	CPU usage
Hardware	Speed/Accuracy	Application specific High cost
Hybrid of Software & Hardware	Speed/Accuracy/Easily modified (SDK)	Limited applications High cost

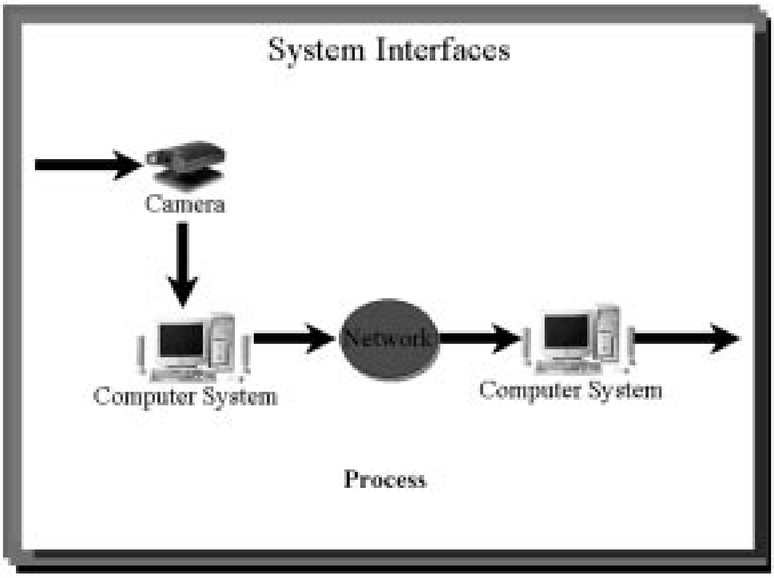

Fig. 2. System used to perform project.

network in the illustration can be either the Internet or some local area network. The receiving computer system decompressed the received data and displayed the video on a monitor.

The first objective of the project was to improve the quality of video transmission over the Internet. Specifically, this design was to allow the image quality to decrease gracefully with decreasing available bandwidth, while allowing real-time video transmission and reception. Since the varying bandwidth restricts the speed of the transmitted data stream, reducing the data rate of the compressed video will permit graceful degradation in video quality during the periods when the available bandwidth is restricted. To achieve this, the data stream must be monitored to guarantee a minimum data rate for acceptable quality of image reproduction. This minimum data stream will be referred to as the *visual threshold* of the quantized DCT coefficients. The size of the data stream can be decreased by increasing the size of the quantization step, and hence decreasing the number of DCT coefficients that have non-zero value (see Fig. 1).

The second design objective was to perform error concealment for the received video. This involved two different error concealment approaches: low motion and high motion concealment. The low motion technique repeats the previous block of data if the received present block exceeds predetermined error limits. The high motion approach repeats the entire previous frame if the received present block exceeds predetermined error limits. The error limit value for each design is determined using the motion estimation process within the H.263+ codec [3]. Low motion error concealment implementation will take place during a slow motion video like an evening newscaster talking with little motion in the background. Implementation of high motion error concealment will occur with fast changing frame information as during a football game broadcast. The desired result of the high motion design will allow the frame to repeat, causing the video to appear jerky. The desired result of the low motion design will allow the frame quality to decrease, showing some blockiness within the video. The procedures for error concealment are implemented at the decompression side of the process (see Fig. 3).

EXPERIMENTAL RESULTS

The following describes the experiments and simulations conducted by the students to implement and test their approaches. To test their ideas the students compressed three video sequences, *Akiyo, Carphone*, and *Foreman*, each consisting of 300 frames, which were stored locally at the transmitting end, at varying data rates. The *Carphone* sequence has a substantial amount of changes in the background regions of the sequence. The *Foreman* sequence has less block motion and higher frame data changes than the *Carphone* sequence. The *Akiyo* sequence has very little motion and mostly unchanging frame data.

Quantization-shift

The students implemented a quantization-shift on an 8×8 block of DCT coefficients. This was done to illustrate the decrease in transmitted data rate with the implementation of the quantization-shift. The data collected included the quantization table, the quantized DCT coefficients, and the video data stream before and after variable length coding was performed. This collected data is used for calculating the average bit length of the transmitted data stream. When performing the experiment, an 8×8 block of DCT coefficients

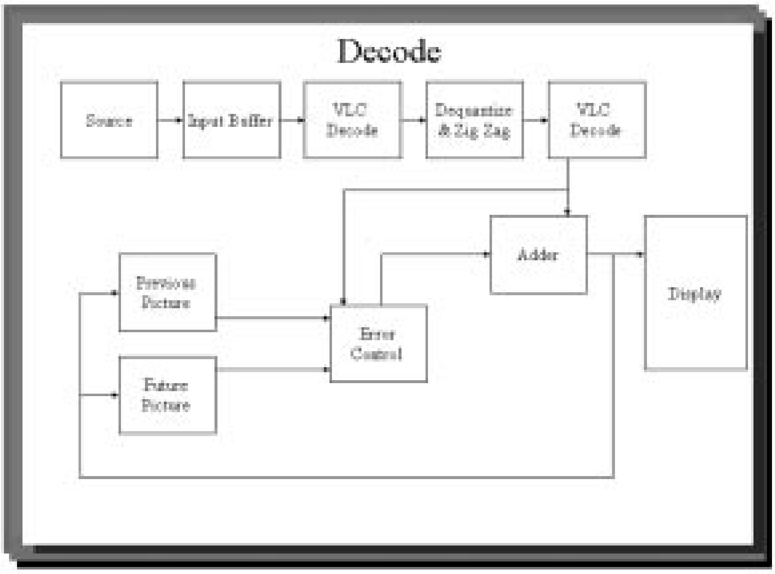

Fig. 3. Frame error control diagram illustrating the error concealment design for high and low motion video. Error control block compares present, previous and future picture data for the implementation of the high and low motion error concealment process.

was first quantized and coded using a Variable Length Code (VLC). A quantization-shift was applied to the quantization table and the original 8×8 block of frequency coefficients was again quantized and coded using VLC. This process was repeated using values of 1, 2, 3, and 4 for the quantization-shift, for every 8×8 block of DCT coefficients. Table 4 gives the effect of varying the quantization-shift on the size of the data stream when the *Carphone* sequence was encoded at a target data rate of 32kbits/sec.

Error concealment: repeat block/frame

The students implemented a form of error concealment in which a damaged portion of the current frame was replaced by the corresponding area in the previous frame. This performed well in the case of the *Akiyo* sequence but not as well for the *Carphone* and *Foreman* sequences, due to the amount of motion exhibited by these sequences. Figure 6 illustrates the regions in a frame from the *Akiyo*, *Carphone*, and *Foreman* sequences, respectively, that can be replaced from the previous frame without greatly affecting the visual quality of the reconstructed sequence. Figures 4 and 5 depict the effect that a quantization-shift of 10 has on the visual quality of a decoded image.

ASSESSING THE PROJECT AND THE TEAM

Assessment of the project is based on an assessment plan developed in-house by faculty in the department [11–15]. This is based on two kinds of assessments, the first being the traditional assessment of the quality of work done and the technical aspects of the project, and the second being an assessment of teamwork. Both assessments were conducted throughout the semester to give students continuous feedback.

The assessment of the technical aspects of the project was given a separate grade from that of the assessment of the teamwork, and was based on the following:

- Progress reports presented orally throughout the semester. These were given a weight of 10%.
- The oral presentation of the final design. This was given a weight of 10%.
- The written final report. This was given a weight of 10%.
- Feedback from the project adviser. This was given a weight of 10%.
- Work quality and the final product delivered. This was worth 50%.
- Feedback from all ECE faculty and visitors

Table 4. Effect of quantization shift on transmission time and size of compressed sequence

Quantization-shift value	Average size (kbits)	% Decrease in size	Transmission time of 200 bits at 16 Kbps
s = 0	1.968	–	24.6 ms
s = 1	1.859	5.56%	23.2 ms
s = 2	1.843	6.35%	23.0 ms
s = 3	1.718	12.7%	21.4 ms
s = 4	1.515	23.0%	18.9 ms

Fig. 4. Original frame from *Carphone* sequence.

Fig. 5. Frame compressed at a target data rate of 32kbits/sec and quantization-shift of 10.

from industry attending the final presentation. This was given a weight of 10%.

The assessment of teamwork was conducted through surveys, which asked students the following:

- What are some of the major teamwork problems facing the team?
- Would you like your project advisers to help you solve the teamwork problems?
- On a scale from 1 (worst) to 5 (best), rate the team ability in the following:
  solving technical problems;
  seeking input from expert sources;
  working as a team;
  seeking feedback from others on your team on personal performance; and
  encouraging and supporting risk-taking by members of the team.
- What do you like most about your team?
- What problems concerning your executive team would you like solved?

RESULTS OF THE ASSESSMENT OF THE TECHNICAL ASPECTS OF THE PROJECT

Students were evaluated individually, based on their progress in the design throughout the semester. Feedback from the supervisor and the team members (students evaluated each other) was incorporated into the evaluation. Table 5 shows the evaluation of each team member.

Results of the assessment of the teamwork aspects of the project

This part of the assessment is based on the evaluation of the team by a number of faculty members, consisting of the instructor, the supervisor, and the faculty members who attended the presentation. Table 6 summarizes each student's performance.

CONCLUSION

The paper describes a project that was selected as an example of how a capstone senior design project can provide a venue for assessment of a multidisciplinary teamwork project for electrical engineering majors for EC2000, while simultaneously being used to assess EC2000's technically related outcomes. Readers can utilize the project described as a model of a multidisciplinary project where hardware and software engineering components are combined in one project.

For this project, the project components included hardware and software design in video compression, use of the Internet to transmit audio

Frame from *Akiyo* sequence
Low block motion
Small data frame changes

Frame from *Carphone* sequence
High block motion
Medium data frame changes

Frame from *Foreman* sequence High block motion
Large data frame changes

Fig. 6. Frame regions that can be replaced from the previous frame.

Table 5. Evaluation of every student, based on the technical aspects of the project

Item	1st Student	2nd Student	3rd Student	4th Student	Overall
Technical competencies	A	A	B+	A	A
Product testing	A	A	A	A	A
Analysis and interpretation of data	A+	A+	A	A	A
Success of the design	A+	A	A	A	A
Quality of the design	A	A	A	A	A
Instructor evaluation of teamwork	A	A	A	A	A
Creativity	A	B+	A	A	A
Writing skills	B+	B+	B+	B	B
Oral presentation skills	A+	A	A+	A	A

Table 6. Student evaluation, based on his/her performance within the group

Item	1st Student	2nd Student	3rd Student	4th Student	Team Grade
Quality of the design process	A	A	A	A	A
Internet and library research	B+	A	A	A	A
Identification of the problem	A	A	B+	A	A
Use of engineering principles	A	A	A	A	A
Use of design principles	A+	A+	A	A	A
Consideration of alternatives	A+	A+	A	A	A

and video, and communications. The project was completed satisfactorily and students met the design specifications. The students were able to achieve a good level of success in the implementation of the quantization table modifications in order to compensate for varying bandwidth and implemented a form of error concealment.

The implementation of error concealment for video compression standards in the project sparked the interest of local industry, to the extent that all the students who participated in the project received multiple job offers from local industry because of their involvement in the project. Furthermore, local industry have indicated that they would like to see more projects of the nature as the course described here.

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APPENDIX A: THE SCORING RUBRIC FOR SENIOR CAPSTONE DESIGN PROJECTS

1. This capstone rubric was developed, based on the measurable outcomes that the ECE Department agreed could be assessed in the senior capstone course, EE 492.
2. The form is designed to give feedback on the various components of the projects as well as to assess the project reports for both ABET and NCA outcomes assessment.
3. You may use + and − if it helps you to score the student projects on a letter grade basis. If you use a numerical scale (0–4), you can assign decimal fractions (0.5 works best).

Judging Level	Description
Poor	Demonstrates lack of understanding Not of passing quality Like the letter grade 'F', 0 points on the IUPUI grading scale
Marginal	Demonstrates passing level of work but not much more Like the letter grade 'D', 1 point
Satisfactory	Demonstrates sufficient mastery of the basics to be considered a graduate of the program but falls short of being considered competent in the subject Like the letter grade 'C', 2 points
Competent	Demonstrates a working knowledge of the basics of the material but lacks complete mastery Like the letter grade 'B', 3 points
Excellent	Demonstrates understanding of the principles, concepts and methods. Able to use knowledge in innovative and clever ways Like the letter grade 'A', 4 points

Paul Salama received his B.Sc. in electrical engineering (First Class Honors) from the University of Khartoum in 1991, and his M.S.E.E. and Ph.D. degrees from Purdue University in 1993 and 1999, respectively. He is currently an Assistant Professor at the Department of Electrical and Computer Engineering, Purdue School of Engineering and Technology, Indiana University–Purdue University Indianapolis (IUPUI). His research interests include image and video compression, image processing, transmission of compressed video, ill-posed problems, and medical imaging. Dr. Salama is a member of SPIE, Tau Beta Pi, and Eta Kappa Nu.

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Charles F. Yokomoto holds the rank of Professor of Electrical and Computer Engineering at Indiana University–Purdue University Indianapolis (IUPUI). His interests in the area of teaching and learning are in learning styles, personality type and personal heuristics, and problem-solving. He is also the Director of Assessment for the Purdue School of Engineering and Technology at IUPUI and has been highly involved in the development of outcomes assessment processes.