WAVE System

Wireless Audio Visual Entertainment System

UNIVERISTY OF SAN DIEGO
Final Project Design Review
ELEC 492
Fall 2005

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EXECUTIVE SUMMARY

The current method of connecting cable television throughout a house is extremely cumbersome. Poor planning may place the coaxial cables used for television transmission in an area of the house where the television is not desired or unable to be connected. It often requires, in order to remedy this, the interference with the interior design and aesthetics of the house. For reasons such as this, it is desired to have an RF wireless transmitter/receiver for the transmission of a television signal from a cable box receiver to a television set. Wireless transmitters/receivers are currently on the market but many lack the simple functionality of changing channels at the television. Currently, the only way to change the channel of the television being viewed is from the source of the transmitter. For the spring semester for 2005 we were able to design a wireless transmitter/receiver to broadcast an audio/visual signal with the ability to change channels from the same area as the television set being viewed. With the creation of this wireless system, we eliminated the need to run unnecessary cables while still providing the user with the same functionality. For the fall semester, the team was able to redesign and recreate a new wireless television transmitter along with new filter and amplifier design. A touchpad LCD was also programmed to act as a remote control, displaying channel and parental control options.

The project consists of three major parts. First, the wireless television transmitter was designed, where it receives the television signal and transmits it wirelessly using RF technology. Second, hardware was build and interfaced with the Amulet touchpad LCD to act as a remote control. This touchpad LCD is also used as a parental control device that restricts viewing time and the channel permissibility.

The results of this project are as follows:

- The television transmitter, including the filter and amplifier designs, was successfully designed, built and tested
- The touchpad LCD was programmed and tested to select desired channel
- The touchpad LCD was programmed and tested to select permissible viewing time and channel

Nishiyama, Christine
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Sangillo, Doug
Sexton, Paul

INTRODUCTION

Information technology such as the television is an integral part of the public's daily life. The public depends on television to stay informed on current affairs as well as to keep entertained. Television was invented about 75 years ago as a communication device for early scientists who worked as government officials. As the years went on, it became possible to transmit different frequencies and channels which formed different television stations. The invention and use of infrared (IR) remote controls with television sets soon followed. With the current technology there are many ways to transmit these signals, the most common being the use of coaxial cable.

PROBLEM STATEMENT

The current method of connecting cable television throughout a house is extremely cumbersome. Poor planning may place the coaxial cables used for television transmission in an area of the house where the television is not desired or unable to be connected. It often requires, in order to remedy this, the interference with the interior design and aesthetics of the house. For reasons such as this, it is desired to have an RF wireless transmitter/receiver for the transmission of a television signal from a cable box receiver to a television set. Wireless transmitters/receivers are currently on the market but many lack the simple functionality of changing channels at the television. Currently, the only way to change the channel of the television being viewed is from the source of the transmitter. For the spring semester for 2005 we were able to design a wireless transmitter/receiver to broadcast an audio/visual signal with the ability to change channels from the same area as the television set being viewed. With the creation of this wireless system, we eliminated the need to run unnecessary cables while still providing the user with the same functionality.

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MARKET AND BACKGROUND SURVEY

The WAVE system is a system that can wirelessly transmit a signal, usually cable television, from one side of a room (where the cable box is) to another (where the television is). We began by dividing the project into two parts, the Radio Frequency transmission (RF) and the Audio/Video VHF. The amplifier for the TV side was built from a development kit purchased from North Country Radio. This kit was then used as a stepping stone for further design and implementation. The TV transmitter is connected to the VHS player through a Audio Video output. Since the lab does not have coaxial cable outlet for cable television, a VHS video was played as a substitute. The TV transmitter amplifies the video signal coming in directly to the television with a whip antenna that is then picked up by bunny ears on the television side. The RF side takes a command from the user through infrared (IR) that is sent from the universal remote, then converts this IR signal to RF. The RF signal is sent to the VHS side where it is converted back into IR to change the commands on the VHS side. These parts were designed, built, tested, adjusted, retested, and eventually completed into their respective products. Finally, both sides were integrated into the final desired product, a wireless audio video entertainment system.

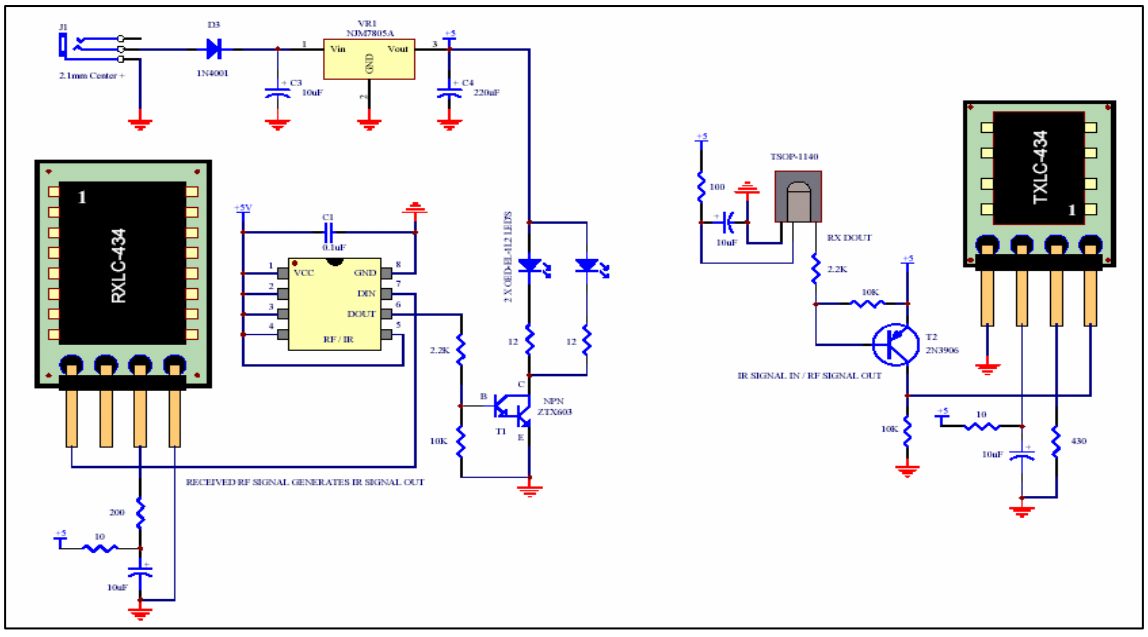

Figure 1: Schematic of kit that was built Spring 2005.

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Sexton, Paul

FUNCTIONAL REQUIREMENT

The designed device receives a cable television signal and wirelessly sends a chosen channel to output on a television in an area other than where the cable line is located. The complexity of the design exists in the channel selection. The user will have the ability to change the channel from the same area as the television set is located. This was accomplished by having a transmitter located with the television that waits until the user desires to change the channel setting. The transmitter sends the information to a receiver, located at the cable box receiver, using available frequencies in the RF spectrum. The receiver then changes the channel on the cable box using an infrared transmitter, which will in turn send the desired channel to the television set. The design enables the user to view a desired television channel from a location other than where the coaxial cable is located without the need to run coaxial cable through walls or rugs.

In addition to this basic functionality the standard universal remote was replaced with a touch screen interface. The remote itself has the ability to enforce “parental controls” disabling users from accessing restricted channels as well as monitoring television usage. The touch screen remote also displays the channel being viewed. The remote is essentially an RF transmitter sending the commands to control the cable box.

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FLOW CHART AND PROJECT SCHEMATIC

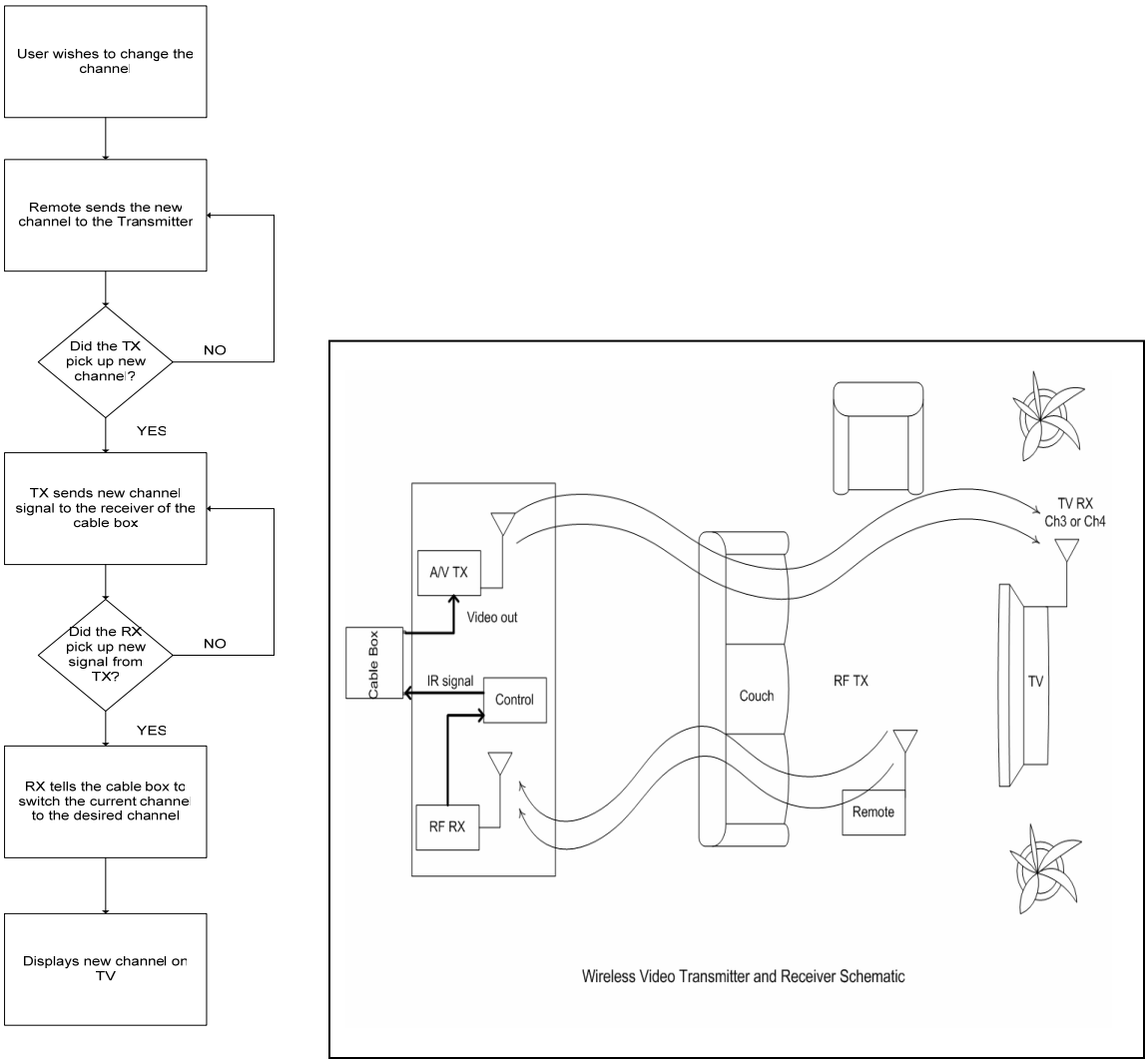

Figure 2: Flow Chart and System Schematic

Nishiyama, Christine
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Sexton, Paul

TECHNICAL SURVEY

For the design of the WAVE System, there were many aspects of engineering that we considered including: analog circuit design, digital circuit design, microprocessor programming, and RF technology.

Television modulator and transmitter:

The Motorola MC44BC375 audio and video transmitter was used to modulate the coaxial signal to the television. This chip was chosen for its low power, low cost feature and was easily mounted on the PCB. This chip also has a feature that can broadcast the desired signal either over channel three or channel four. The oscilloscope was used to test the transmission of frequency.

Video filter:

In order to "clean-up" the output of the video signal a third order passive RLC band pass filter that passes 60-72MHz has been designed. The requirement for this is the software program, PSpice. Upon the completion of the design, the filter was integrated into the PC board using Express PCB.

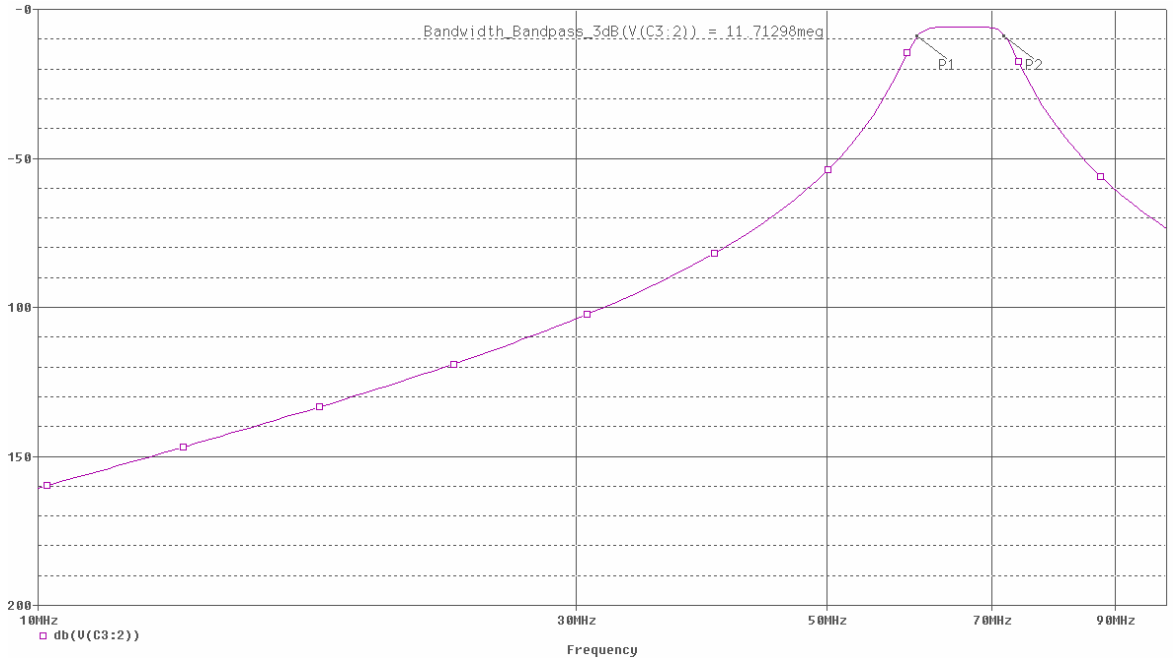

Figure 2: Frequency response from PSpice

Sharp Infrared Protocol:

It was imperative to the project's success that the IR protocol for the cable box (Sharp VCR) was attained. Sharp Inc. refused to provide the team with the function codes so the team was forced to determine them by our own process. In order to accomplish this, the previously designed IR circuit was hooked up to an oscilloscope, and the IR codes needed to control the VCR were determined.

PIC18F452:

The PIC microcontroller is being prototyped on a PICDEM 2 Plus Demo board. All the code for the PIC is written C and complied on a PC. The PC communicates with the demo board through a "puck" serial interface.

GUI Touch-screen Display:

The touch-screen display is programmed from a PC using HTML. The engineer used an HTML editor such as FrontPage to edit the different display screens or pages that was utilized to interface with the user. These pages are then loaded from the PC into the flash memory of the touch-screen display using an RS-232 serial connector. The display was then integrated with the external PIC controller using ASCII commands to communicate.

Express PCB and Hardware Testing:

All of the different systems and subsystems have to eventually be laid out onto a PCB. This requires the knowledge of the Express PCB software. In addition, the boards and related hardware have tested and debugged, using the appropriate lab equipment, before they were used in the design.

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SPECIFICATION

Microcontroller (PIC 12F675)

The PIC 12F675 8-pin, 8-bit CMOS microcontroller was central to the system. This chip accepts an analog signal and outputs a serial signal modulated at 40 KHz. The PIC 12F675 was chosen because of the ease with which it operates in this system allowing for a minimal amount of hardware.

Microcontroller (PIC 18F252)

The PIC 18F252 microcontroller was used to perform several different features unique to the WAVE System. These functions included displaying the channel, to regulate a viewers weekly TV time, as well as to perform a 'parental control' feature. The memory size, input/output pins, speed, and the ability to communicate with the Amulet Display account for most of the reasons why this device was chosen.

Transmitter and Receive (of control signal)

The touch-screen LCD acted as a remote control, which generated a signal that is sent to the PIC 18F252. The transmitting device received a signal from the PIC and broadcasted the proper instruction over radio frequencies (RF) a desired 300ft. The receiver converted the RF signal to IR and transmited the IR a 30ft to the cable box.

Transmitter and Receiver (of the broadcasted television)

A transmitter and a receiver were used to broadcast and accept the television signal. The antennas in these devices had a radial field distribution with a length that corresponds to the frequencies of operation, which are 54-72MHz and 76-88MHz. The desired radial field distribution is 300ft from the source of the transmitting antenna.

Power Supply

Only one of the parts of the device needed to be plugged into a wall. However, the 120 VAC coming out of the wall will have to be dropped down to 5 VDC to be used for logical operations. The remote control used a 9V battery.

Physical Description

Since the device will be situated near the television, the IR-RF and converter maintained compact size and aesthetically appealing physical characteristics. The device did not exceed 3/4 of a cubic foot.

Other interfaces

The system was designed to interface with standard television remote controls.

METHODOLOGY

The first step of the project was to complete the tests. These tests demonstrated the basics of a working system for this project. Once these tests were completed the team continued to integrate the system.

The construction of the device had been broken down by its two main functions. The first function was to transmit infrared signals through walls. This was accomplished by transmitting an RF signal from the PIC and then converting it to infrared once it has been received in another room. The serial data was then sent to the TXLC-434 transmitter module and the data will be received by the RXLC-434 receiver module. The 8-pin programmable PIC12F675 microcontroller received the RF signal, modulated it to 40 KHz and transmitted it to an IR LED. The team designed the entire system on printed circuit boards.

The next task that the device achieved was broadcasting a cable television signal over one of the designated frequency bands of a television channel either 3 or 4 (60-72MHz). In order to complete this step, a printed circuit board of the audio video modulating and transmitting chip was configured with our design.

The audio/video signal was tested to show that it functions as expected. Since the quality of the audio/video signal that the system transmitted was not initially acceptable. The team will design two components. The first was to design a VHF filter to improve the quality of the video signal. Secondly, the transmission amplifier was designed in order to sending signals for greater distance, while at the same time, strengthening proximity signals. These two elements were constructed and operated successfully.

After the hardware on these two major sections was composed, the team began programming the PIC 18F252. The programmer's main goal was to integrate all of the different elements of the project so that they all work smoothly. This required several different functions. These functions include obtaining the ability to communicate effectively with the Amulet Technologies touch-screen, operate as a typical remote, send the proper signal, display the channel, regulate a viewers weekly TV time, and perform a 'parental control' feature.

PRELIMINARY TEST PLAN

There are several different tests that the WAVE team has completed this semester. In the first test, the team confirmed that the clock works and that the computer software which programs the PIC communicates with the demo board. This was accomplished by writing a clock program and burning it onto the demo board. The success of the initial project allowed the team to continue testing. In the next test, the team obtained the IR signal from the transmitter on the oscilloscope, which allowed him to recreate the signal using the PIC 18F252. The test shows that the team can create the signal to be sent via IR to the receiver at the TV.

In another phase of testing, the team has tested and modulated the TV transmitter. Due to unacceptable quality, the team ran several tests to identify the problem with the system. The system was modified resulting in a much more clear quality video and audio signal. On this side of the board, future tests will seek to combine the transmitter and the filter.

In the most recent phase of testing, the team is seeking to communicate effectively between the touch-screen LCD display and the PIC. On the LCD side of the system, tests have been run to program the device. The output of the LCD has been observed on the computers serial monitor. However, the device has not been able to communicate with the PIC 18F452. The tests on the PIC's side of the communication line have shown similar results. The output of the PIC can be observed from the serial monitor of the computer, but it has not been able to instruct the LCD.

There are several tests that will need to be run to obtain a working device. There needs to be a test run to obtain the instructions from the remote control. This test is not difficult but essential to obtain a working device. The communication between the PIC and the LCD is essential to the working system and is the next test to be run. The completion of these tests should result in an easily accessible integration of the system for the final project.

MAJOR ALTERNATIVES

The project overall was a success. However, as in any project, improvements can always be made. One of the major improvements to the system would be to improve the quality of the video signal. Please see the 'RECOMMENDATIONS' section for more information on these improvements.

CONSTRAINTS

The greatest constraint faced by the team was time. The team felt very limited by the small amount of time that was available to design. The two semester format only lended itself to basic applications and really did not afford the team the luxury of prototyping and refining the design. The time constraints also allowed the team to increase the complexity of the design to a level of uniqueness.

DELIVERABLES/EXPECTED RESULTS

To this point we have redesigned our UHF/VHF amplifier. Previously it was part of a kit and was not up to the standard that the group had set. A circuit was designed, built, tested, and in the process of debugging. Already it is an improvement to the previous transmission. To further clear the picture and sound, a filter was designed to narrow the pass band to the desired 60MHz – 72MHz range.

An LCD was chosen for the display of the project. This is a critical component to the design as it will not only display the channel, but also control the parental controls, channel controls, and permissible viewing amounts. This is being programmed using HTML programming software.

At the conclusion of the semester, the project will include a fully functional user friendly display. This will include channel changing and restriction capabilities. Also, the project will include a UHF/VHF amplifier of our own design that will send perfectly clear and audible transmissions with the help of the previously designed filter. Lastly, the project will include a previously designed and implemented IR/RF converter, but modified to a more convenient size and encasement. These components will be combined to complete the wireless audio visual entertainment system.

To this point:

- Redesigned UHF/VHF amplifier with filter
- LCD Chosen
- Partial programming of display
- Partial IR/RF reconstruction

At end of semester:

- Programming for parental controls
- Programming for permissible viewing times
- IR/RF reconstruction completed
- Second phase PCB construction
- Completed WAVES system

TEAM PERSONNEL

Since time was critical factor in the completion of this project, different areas of the project was designated to different group members. Four people was sufficient enough to complete the tasks given.

Development Task	Christine	Douglas	Paul	Rob
Video filter design	x		x	
TV amplifier design	x			
Transmit and receive TV channel	x		x	
PCB board layout of the filter and amplifier	x		x	
PCB board layout of the TV transmitter	x			
PIC programmer for TV selection		x		x
Touchpad programmer		x		
PCB board layout for remote control		x		x
Hardware design for remote control		x		x

Table 2: Group Task delegation for fall 2005

The team was divided into two major parts: software engineer who consisted of Rob and Douglas and the hardware/RF engineers who were Christine and Paul. Christine was the team project manager who was responsible for the organization of all binder items as well as all written reports. She was also the principle hardware and RF engineer who designed the PCB layout, filter design and amplifier design. Paul was also responsible for designing and creating the PCB layout of the transmitter. He was also successfully soldered all of the components of the PCB. Rob was the principle software engineer who created the program to send IR code to mimic a remote control. Douglas assisted in the programming of the PIC as well as programming all of the component of the LCD graphical user touchpad as well as creating the PCB hardware layout of the RF transmitter of the remote control.

ABET REQUIREMENTS

The WAVE System was designed and constructed in order to satisfy both the requirements and expectations of the team members as well as the faculty. The team aimed to design within a desired set of constraints without feeling limited creatively. There was a delicate balance in order to keep the project challenging and interesting and also within the scope and ability of a senior design. The most significant constraints felt by the group were economic, time, and complexity. The team was limited financially and therefore had to keep spending for the project within the allotted budget. The team also had to finish the entire design from conception to demonstration in two semesters, which was a very restrictive constraint that the team had to consider. The complexity of the design had to be kept within the ability of the team as well as within the technological constraints of the lab equipment. Overall the team delivered a working design meeting all requirements as well as the additional "bonus" subsystem functionality. The ABET outcomes were achieved at the highest level attainable by the team.

CONCLUSION AND RECOMMENDATION

At the conclusion of our project, we were able to meet all of the goals that were set at the beginning of the course. As far as hardware specifications, sound transfer was near perfect and video transfer was adequate. The designs of the circuits involved were satisfactory for the needs of this project. The amplifier circuit had two separate amplifiers that were tested at separate times and both were acceptable. Furthermore, the IR/RF circuit design and implementation was done without a recognizable fault.

The only deficient component of the hardware was the quality of the video picture. This was a main concern over the course of the project, and it was rectified with the use of a band-pass filter to restrict the range of allowable frequencies. However, after four separate designs, the same problem continued to remain in that the required values of certain capacitors and inductors were not available. The available values closest to our specifications were adequate enough for color transfer, but with noise and static. Another factor was the quality of our antenna receiving the signal. Given the values of parts desired and a more sufficient antenna, the project will meet every aspect desired.

The project as a whole was very successful. The circuits design accepted signals from a remote control, interpreted what was desired by the user, and made the appropriate actions. Even with the inadequate parts and antenna, the project still accomplished what was asked to a satisfactory level, and given the desired materials, would work flawlessly.

The PIC/Remote subsystem design was delivered with total functionality. It met all of the requirements and design specifications as well as achieving the additional challenges that were set forth. The remote controlled the VCR and provided the parental control options to the user. The design was realistic and incorporated the use of many different areas of electrical engineering including; RF, computer programming, digital logic design, microcomputers, micro-controllers, and PCB design and layout. This system encompassed and required the demonstration of knowledge and experience only attained after working diligently within an excellent electrical engineering program. Suggestions for improving this subsystem are limited. Reducing the remote's size and creating a more ergonomic design, creating a marketable image, and improving on ease of use are some of the improvements that could be implemented in the future.

REFERENCES

- www.vishay.com
- http://rentron.com/IR_TO_RF.htm
- www.linxtechnologies.com
- www.reynoldselectronics.com
- www.northcountryradio.com
- www.digikey.com
- www.amulettechnologies.com
- www.microchip.com
- www.mouser.com

BUDGET SUMMARY

The cost for fall 2005's proposal amounts to $601. With the funding of the Associated Students of USD and ViaSat, the project was more than adequately funded.

Estimated cost for Fall 2005

Purchased From	Part Name	Cost
Mouser	Amulet LCD Display (touchpad)	$249.00
Mouser	Xicon Antenna	$2.63
Digikey	Hardware (chips etc.)	$200.00
	PCB board design (x3)	$150

TOTAL $601.63

Table 1: Estimated Cost of the proposed project

GROUP TASK

Since time was critical factor in the completion of this project, different areas of the project was designated to different group members. Four people was sufficient enough to complete the tasks given.

Development Task	Christine	Douglas	Paul	Rob
Video filter design			x	
TV amplifier design	x			
Transmit and receive TV channel	x			
PCB board layout of the filter and amplifier			x	
PCB board layout of the TV transmitter	x			
PIC programmer for TV selection				x
Touchpad programmer		x		
PCB board layout for remote control		x		x
Hardware design for remote control		x		x

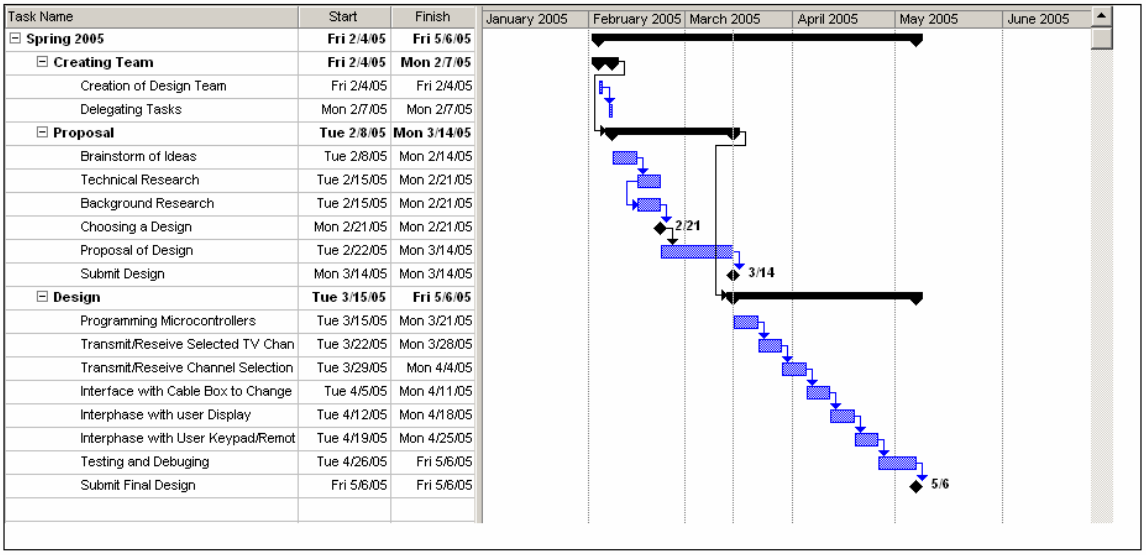
Table 2: Group Task delegation for fall 2005

Nishiyama, Christine
Raney, Rob
Sangillo, Doug
Sexton, Paul

PROJECT TIMELINE

The project was completed within the given 2 semester. The Gantt chart for both Spring and Fall semester is shown below.

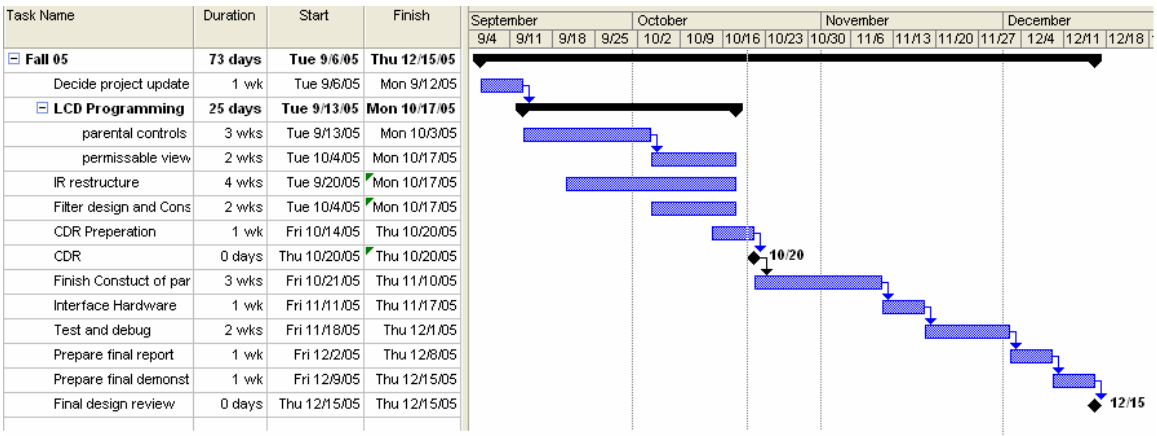
Spring 2005



Task Name	Start	Finish
Spring 2005	**Fri 2/4/05**	**Fri 5/6/05**
Creating Team	**Fri 2/4/05**	**Mon 2/7/05**
Creation of Design Team	Fri 2/4/05	Fri 2/4/05
Delegating Tasks	Mon 2/7/05	Mon 2/7/05
Proposal	**Tue 2/8/05**	**Mon 3/14/05**
Brainstorm of Ideas	Tue 2/8/05	Mon 2/14/05
Technical Research	Tue 2/15/05	Mon 2/21/05
Background Research	Tue 2/15/05	Mon 2/21/05
Choosing a Design	Mon 2/21/05	Mon 2/21/05
Proposal of Design	Tue 2/22/05	Mon 3/14/05
Submit Design	Mon 3/14/05	Mon 3/14/05
Design	**Tue 3/15/05**	**Fri 5/6/05**
Programming Microcontrollers	Tue 3/15/05	Mon 3/21/05
Transmit/Reseive Selected TV Chan	Tue 3/22/05	Mon 3/28/05
Transmit/Reseive Channel Selection	Tue 3/29/05	Mon 4/4/05
Interface with Cable Box to Change	Tue 4/5/05	Mon 4/11/05
Interphase with user Display	Tue 4/12/05	Mon 4/18/05
Interphase with User Keypad/Remot	Tue 4/19/05	Mon 4/25/05
Testing and Debuging	Tue 4/26/05	Fri 5/6/05
Submit Final Design	Fri 5/6/05	Fri 5/6/05

Figure 4: Spring 2005 Project Schedule

Fall 2005



Task Name	Duration	Start	Finish
Fall 05	**73 days**	**Tue 9/6/05**	**Thu 12/15/05**
Decide project update	1 wk	Tue 9/6/05	Mon 9/12/05
LCD Programming	**25 days**	**Tue 9/13/05**	**Mon 10/17/05**
parental controls	3 wks	Tue 9/13/05	Mon 10/3/05
permissable view	2 wks	Tue 10/4/05	Mon 10/17/05
IR restructure	4 wks	Tue 9/20/05	Mon 10/17/05
Filter design and Cons	2 wks	Tue 10/4/05	Mon 10/17/05
CDR Preperation	1 wk	Fri 10/14/05	Thu 10/20/05
CDR	0 days	Thu 10/20/05	Thu 10/20/05
Finish Constuct of par	3 wks	Fri 10/21/05	Thu 11/10/05
Interface Hardware	1 wk	Fri 11/11/05	Thu 11/17/05
Test and debug	2 wks	Fri 11/18/05	Thu 12/1/05
Prepare final report	1 wk	Fri 12/2/05	Thu 12/8/05
Prepare final demonst	1 wk	Fri 12/9/05	Thu 12/15/05
Final design review	0 days	Thu 12/15/05	Thu 12/15/05

Figure 5: Fall 2005 Project Schedule