EEL 4914 Electrical and Computer Engineering Design

(Senior Design)

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Voice-controlled IR/RF Remote Control

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Preliminary Project Proposal [ ]

Final Project Proposal [X]

Topic Index: 4.2

Project Abstract

Our team will be building a voice-controlled IR/RF remote control. Our design will contain rudimentary controls for a TV and will also be able to turn a household appliance on and off. The voice commands will be received through a microphone connected to a DSP board which will analyze the command, convert it to its respective code, and route it to either the IR or RF transmitter.

Introduction

The voice-controlled IR/RF remote will be very useful for those that are either handicapped or lazy. Though there are already voice-controlled remotes on the market, none of them combine both IR and RF. The combination of these technologies will allow the user to control a larger and more eclectic list of household appliances. Invoca (see References) seems to be the leading developer of voice-controlled remotes, but again, their remotes are only capable of IR.

Technical Objectives

The primary technical goal of the proposed project is to design and implement a voice-controlled IR/RF remote control with the following sub-goals:

- Voice-recognition – discern between different commands and voices
- Conversion of voice commands to digital signals to be sent by IR/RF transmitters
- Transmission of voice commands by IR/RF transmitters to household devices which will receive the commands through IR/RF receivers

The learning objectives of this project include the following:

- Time management
- Proper project planning
- Group coordination
- Learning new technologies (DSP, IR, RF, etc)

Study Plan

The classes that will help us most with this project are the following:

- EEL4744 (Microprocessors)
- EEL4750 (DSP)
- EEL4306 (Electronic Circuits 2)
- EEL4373 (Radio Frequency Electronics)

- EEL4514 (Communications)
- EEL4416 (Antennas)
- CIS 4930 (C++)
- CGS 3460 (C)

Knowledge of the Fourier transform from Communications and DSP will be used to implement the voice-recognition algorithm. The study of microprocessors and electronic circuits will be used to interface the DSP board with the IR/RF transmitters.

The software tools that we plan to use include the following:

- C/C++ (voice-recognition software)
- MATLAB (initial simulations and testing of the voice-recognition algorithm)
- VisualDSP++ (compiling the C code to download onto the DSP board)
- Assembly (interfacing the DSP board with the IR/RF transmitters; controlling IR/RF transmitters)

The DSP board will be the main component of our prototype. A microphone will be attached to the DSP board which has a stereo codec with a line-in. We are going to use available ports on the DSP board to interface with the IR/RF transmitters. The IR transmitter will communicate with a Sony television using Sony's IR remote control protocol. The DSP will control the IR transmitter. The RF transmitter will consist of a tone generator and an FM transmitter. The RF receiver will consist of an FM receiver and tone decoder. The FM carrier will be 902 MHz and the tones will be 4.5 kHz - 7.5 kHz. The RF receivers will interface with a logic-controlled adapter. The adapter will switch an AC-outlet signal with a relay. The adapter will have an AC-plug for a lamp.

The team will share the cost of all of these items. The DSP development board will be purchased from Analog Devices. All other components will be purchased from Digi-Key and Newark electronics.

Testing and verification will be done through MATLAB for initial simulations of the voice-recognition algorithm. The DSP board will be used for final testing and verification. Oscilloscopes will be used for RF testing. A milling device, available through the university, will be used to build the switching circuit.

Test and Validation Methodology

The testing procedure will begin with the voice-recognition software on the DSP. Each command will be tested for accuracy. The DSP will have output pins for testing purposes. The code will have built-in debugging routines. The goal of the project is for the remote to work correctly with voice commands from at least one particular team member. The optimum goal is for the remote to work correctly for all team members. The IR section will be tested using test code and an LSA to verify proper information transmission. The main goal of the IR section will

be successful communication with a Sony television. The RF transmitter will be tested using an oscilloscope. Once proper signal modulation is accomplished, the RF link between the remote unit and the adapter will be tested using an oscilloscope.

Expected Outcome

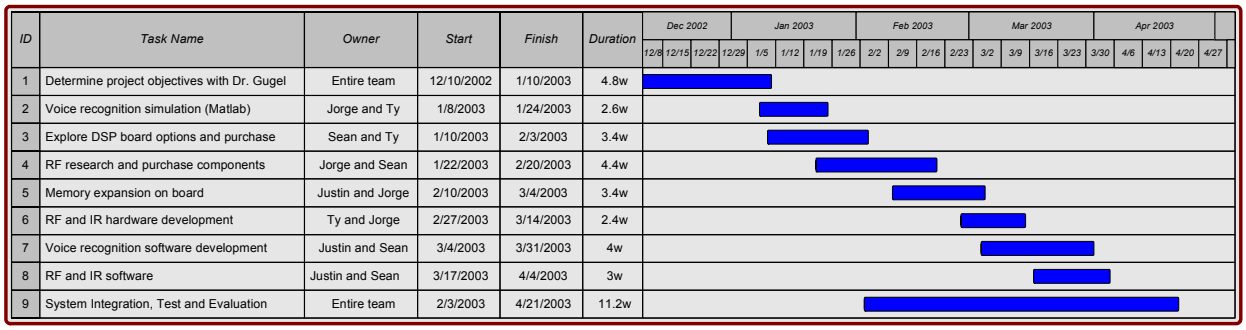
The expected final outcome is a robust, voice-controlled remote control for multiple household devices. It is our desire that the remote will handle different commands similarly and will be able to perform as the user would expect. Initially, it is our intention that the remote will control both a TV and a light switch through voice commands from the user.

There are no features of the final design that will be user-controlled. The user will only be able to use the remote for the devices that we've specified and only for the commands we've encoded. Most, if not all of the design will be fixed. We will decide which devices the remote is going to control and which commands the remote will accept for the various devices.

In our most optimistic estimation, the remote will be able to handle voice commands from every member of our team. In the worst case, the remote will be fine-tuned to a particular member's voice.

Study Organization

ID	Task Name	Owner	Start	Finish	Duration
1	Determine project objectives with Dr. Gugel	Entire team	12/10/2002	1/10/2003	4.8w
2	Voice recognition simulation (Matlab)	Jorge and Ty	1/8/2003	1/24/2003	2.6w
3	Explore DSP board options and purchase	Sean and Ty	1/10/2003	2/3/2003	3.4w
4	RF research and purchase components	Jorge and Sean	1/22/2003	2/20/2003	4.4w
5	Memory expansion on board	Justin and Jorge	2/10/2003	3/4/2003	3.4w
6	RF and IR hardware development	Ty and Jorge	2/27/2003	3/14/2003	2.4w
7	Voice recognition software development	Justin and Sean	3/4/2003	3/31/2003	4w
8	RF and IR software	Justin and Sean	3/17/2003	4/4/2003	3w
9	System Integration, Test and Evaluation	Entire team	2/3/2003	4/21/2003	11.2w

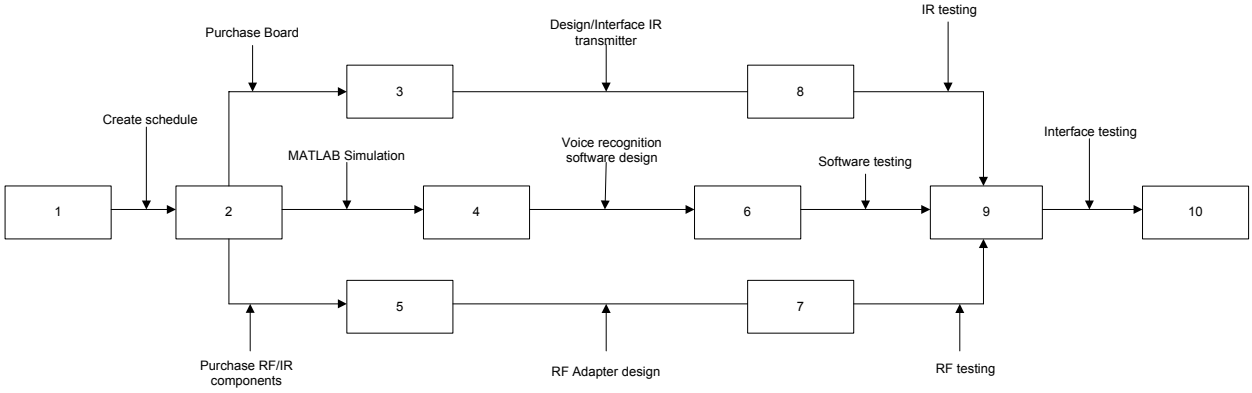


Gantt Chart

The nine major phases of the project are seen above in the Gantt chart with the owners listed next to them. The major portion of the project will be the system integration, test and evaluation phase, which will last 11 weeks. Our major milestones are listed below:

1. Successful operation of voice-recognition software
2. Successful communication with television
3. Successful RF link communication
4. Successful Integration of voice recognition software, IR communication, and RF link

A PERT (Program Evaluation Review Technique) chart is supplied on the following page to further elucidate the anticipated direction of the project.



PERT Chart

References

Analog Devices. “DSP Knowledgebase.” Analog Devices .1,Febuary 2003.
< http://www.analog.com/FAQs/CDA/FAQs_Section_Home/0,2026,DSP,00.html>

Couch, Leon W. Digital and Analog Communication Systems. NJ: Prentice Hall Inc. ,2001

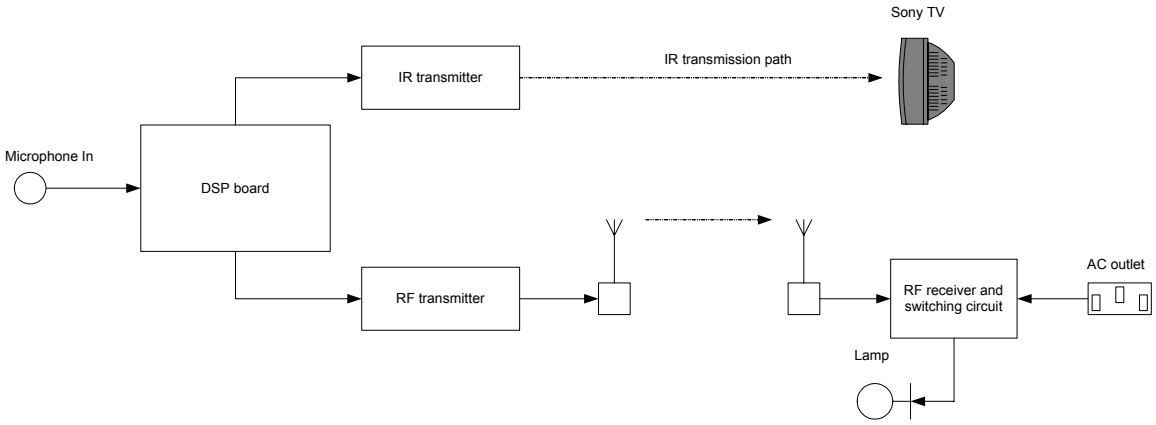
“Remote Control Manual” Invoca. 1 Feb 2003 < http://www.invoca.com/standard.pdf>

Supplementary Information

Project breakdown:

Hardware design and implementation	20%
Software design and implementation	25%
Design integration	20%
Test and validation	30%
Documentation	5%

Block Diagram of Voice-Controlled IR/RF Remote Control



Materials and Resources

- DSP development board with a floating point unit
- Microphone
- FM transmitters and receivers
- IR transmitter
- Tone generator and tone decoder
- AC relay
- Logic ICs and passive components
- Antennas
- Amplifiers