Automatic Volume Control
Project Proposal

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1.0 Introduction

1.1 Statement of Purpose

A common problem that anyone who loves music runs into is when they are listening to a song on their stereo in one room, but they need to walk to another room for a moment. What do you do to avoid this problem? Some turn up their stereo really loud so that they can hear it from further away, and some grimace and hurry so that they only miss 20 seconds of their favorite song. But what if there was a way to adjust the volume of the stereo based on the distance that the listener is from it? That is exactly what our senior project addresses. With our Automatic Volume Control system, the volume of any sound system can be adjusted simply by the distance that the listener is from it so that no matter what distance they are from it, it sounds about the same volume. This system will also be able to function with different speakers in different rooms, so that the closer speakers play the music as you move from one room to the other. By carrying an active device like a smart phone, the listener's position will always be known relative to the speakers in order for this system to function.

1.2 Objectives

1.2.1 Goals

The goals of this project are to create an automatic system that will adjust the volume of a stereo based on the distance that the listener is from it to maintain a constant volume level. This system will also allow for multiple speaker systems, so that when the listener walks from one room to another, the speakers in the previous room will turn off and the new speakers turn on.

1.2.2 Functions

This will all be accomplished through a portable active device that the listener would carry, such as a smart phone. The device would emit a high frequency tone out of the range of hearing which would allow ultrasonic sensors to know how far away it is from them, and with that information the volume levels of the speakers would be adjusted.

1.2.3 Benefits

- Move within room while maintaining “normal” audio volume
- transition from room to room while maintaining “normal” audio volume

1.2.4 Product Features

- multiple volume controlled speakers that can be in different rooms
- transmitter is an app that can be downloaded from google apps or the apple app store for free, so the system will work with any smartphone

2.0 Design

2.1 Block Diagrams

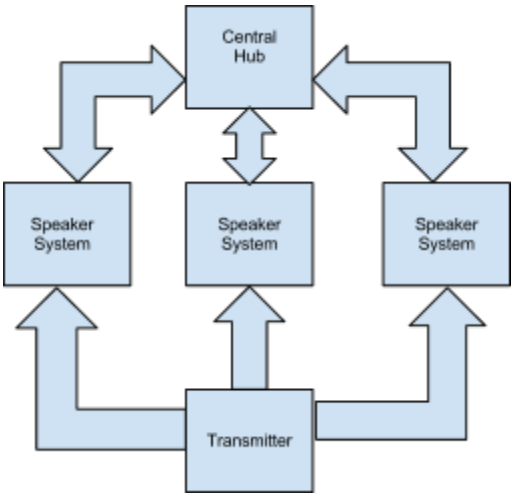

Figure 1 (High Level Block Diagram)

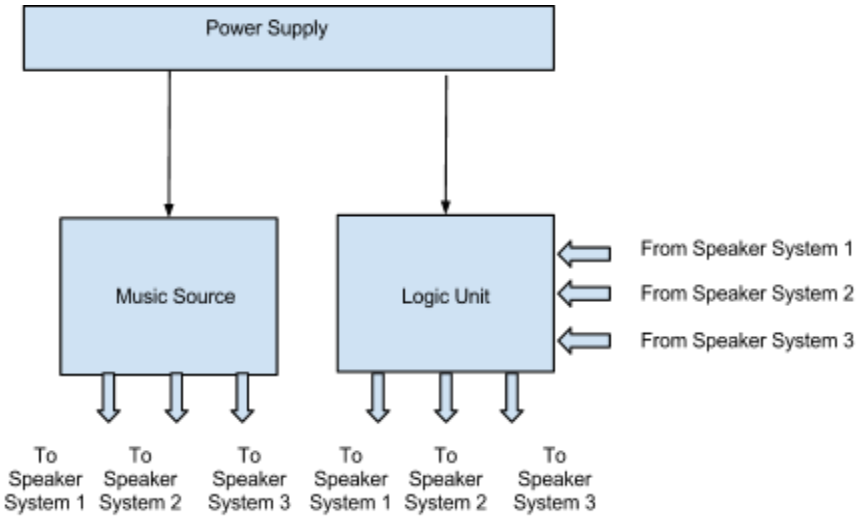

Figure 2 (Central Hub Diagram)

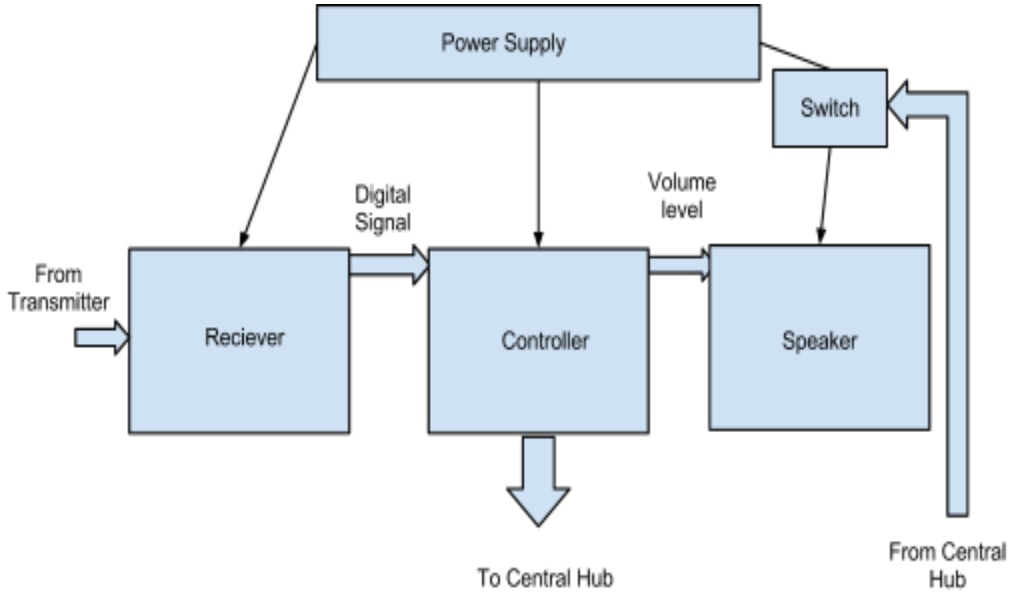

Figure 3 (Speaker System Diagram)

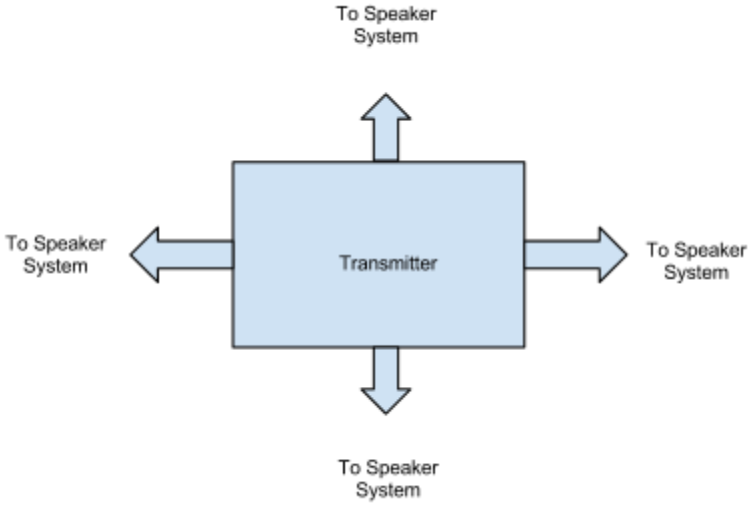

Figure 4 (Transmitter Diagram)

2.2 Block Descriptions

2.2.1 Central Hub

Overall Summary:

The purpose of this component is to play the music desired, sending the signal to the speakers, and to decide which speaker will be on. It receives and sends information from the speaker system. The information it receives from each speaker system is the distance the person is from that speaker system. The information it sends to each speaker system is whether to turn that system on or off. It is composed of a music source and a logic unit.

Case Design:

The Central Hub will consist of a music source and a portable logic unit. The music source, such as a portable laptop or stereo, will be powered by a battery charger. The portable logic unit will be powered by the music source as well.

Music Source:

The music source will consist of a laptop (stereo) that will take a sound file (MP3, .wav,itunes, windows media player) as the desired music to be played and will then send this information to the speakers via audio cables.

Logic Unit:

The logic unit consists of 2 comparators. It takes in the signal intensity, which is the distance information where a greater intensity means a shorter distance, from speaker system 1 and compares it to the signal intensity from speaker system 2. The greater of these values is then compared to the signal intensity from speaker system 3. Once the greatest signal intensity is determined, that speaker system is sent a signal to turn on or leave on the speaker and the other two speaker systems are sent signals to turn off or leave off the speakers. This way, only the closest speaker will be playing the music.

2.2.2 Speaker System

Overall Summary:

The purpose of this component is to play the music at a normal volume. It is composed of five parts: switch, receiver, controller, speakers, and power supply.

Case Design:

This component will consist of a case to be set on top of the speakers. Inside the case will be the controller and reciever. The case is powered by the speakers which are powered by a power cable. The case will be connected to the speakers such that it will tell the speakers what to play and the volume to be played at.

Switch:

This component takes a signal from the Central Hub. When it receives an on signal, it supplies power to the speaker. Otherwise, the speaker does not receive power and remains off.

Receiver:

This block consists of a transducer that detects the audio frequency transmitted by the receiver. It then turns this audio signal into an electrical signal describing the intensity of the audio frequency.

Controller:

This block receives a signal from the receiver. It takes the signal intensity and sends it to the Central Hub to compare against the signal intensity at other speakers. It also takes the signal intensity and after consulting a look up table it will send a signal to the speaker to turn up or down the volume.

Speakers:

The speakers receive a signal form the controller to turn up or down the volume to transmit the desired sound at a normal volume.

Power Supply:

The power supply makes sure that all of these components are receiving the power that they need.

2.2.3 Transmitter

Overall Summary:

The purpose of this component is to emit a high frequency signal in the form of a ultrasonic pulse. This will be done by using a customized "Ultrasonic" app that can be uploaded to a smart phone. This frequency will be received at all speakers.

Case Design:

The Transmitter is a Galaxy S II SPH-D710 with Android Version 4.0.4. The app used is "Ultrasonic Ringtones and Sounds" by RayJayFro.

Transmitter:

The transmitter will be set at a specific frequency 80kHZ this frequency was chosen to avoid the range of humans and animals, but also use as low a frequency as possible to transmit the signal as far as possible.

3.0 REQUIREMENTS AND VERIFICATION

3.1 Requirements and Verification

This section lists the requirements and verification methods for each major component in the High level block diagram (see figure 1 “High Level Block Diagram”).

3.1.1 Central Hub

Requirements:	Verification:
Send music signal to speakers	Is the correct music being played when the switch is on?
Send the correct control signal to the speaker system switches	Is only one speaker playing? Is it the correct speaker?
Receive signals from controller of speaker systems	The logic unit receives different signals as the distance changes

3.1.2 Speaker System

Requirements:	Verification:
Volume changes with distance	Volume changes when the person with the device moves
Speakers turn on and off correctly	Person with device walks from one speaker to another, the former speaker turns off and the new speaker turns on in the middle
Receiver detects the distance signal	Receiver’s data is consistent with transmitted signal
Controller sends signal to control hub	Controller sends clear signal corresponding to the signal received by the receiver
“Normal” volume changes when adjusting the regular music source volume	At the same distance, by changing the volume of the music source, the volume changes and changes accordingly from that “normal” level when distance changes again
All speakers should be synced	No lag times when switching between speakers

3.1.3 Transmitter

Requirements:	Verification:
Sends a high frequency signal	Humans and animals can’t hear it, at least 80kHz
Transmitter uses low power	Using the transmitter application is not a significant drain on the battery life of a smart phone, no more than 10% in 30 minutes
Synchronized clock with the receiver	Must be synced to within 5ms

3.2 Tolerance Analysis

The system must distinguish distances very accurately in order to cleanly transition from one speaker set to another, especially since the listener might be walking fast from one room to another. When between two speakers, the transition should take place within 2 feet of the midpoint between the two speakers. The speakers should also turn on and off quickly, within 100ms.

The system must distinguish distances very accurately in order to change the volume smoothly and consistently with distance. With every 5 feet, the volume level should change either higher or lower.

4.0 Cost and Schedule

4.1 Cost Analysis

4.1.1 Labor Costs

Name	**Hourly Rate ($)**	**Total Invested Hours**	**Total = Hourly Rate x 2.5 x Total Hours Invested**
Eric Davila	42	150	15750
Chris Goulet	42	150	15750
Roland Legrand	42	150	15750

Total Hours: 450 hrs
Total Labor Cost: $47250.00

4.1.2 Parts Cost

Item	**Quantity**	**Cost/Unit ($)**	**Total Cost ($)**
A520S V7 Speakers	3	7.24	21.72
SensComp Series 600 Ultrasonic Sensor	3	27.00	81.00
PCBs	4	15.00	60.00
PIC16F1459 Microcontroller	5	1.82	9.10
TI CSD18531Q5A MOSFETs	10	1.62	16.20
Resistors	20	0.09	1.80
Capacitors	20	0.08	1.60
Inductors	20	0.39	7.80

Total Parts Cost: $199.22

4.1.3 Grand Total

Section	**Total**
Labor	$47250.00
Parts	$199.22
Total	**$47,449.22**

4.2 Schedule

Week Of	**Task**	**Person Responsible**
Feb 4	Prepare introduction for proposal	Chris Goulet
	Prepare block diagram and design overview for proposal	Roland Le Grand
	Prepare cost and scheduling for proposal	Eric Davila
	Finalize proposal	All
Feb 11	Design logic unit for hub	Eric Davila
	Research and design power supply for speakers and hub	Chris Goulet
	Research communication between transmitter and receiver	Roland Le Grand
Feb 18	Design control scheme for speakers	Eric Davila
	Research the dynamics of the speaker	Chris Goulet
	Simulate logic unit and power supply using PSpice	Roland Le Grand
	Sign up for Design Review	All
Feb 25	Learn software for PIC microcontroller	Eric Davila
	Prepare presentation for Design Review	Chris Goulet
	Layout PCB for hub and speakers	Roland Le Grand
Mar 4	Adjust design using suggestions from Design Review	Roland Le Grand
	Program PIC microcontroller	Eric Davila
	Order the PCBs and parts from parts list	Chris Goulet

Mar 11	Prepare Individual Progress Report	All
	Verify microcontroller design	Eric Davila
	Test ultrasonic sensor and microcontroller	Roland Le Grand
	Assemble stereo assembly	Chris Goulet
Mar 18	*Spring Break*	
Mar 25	Sauder components into PCBs	Chris Goulet
	Prepare presentation for mock presentation	Eric Davila
	Assemble hub and set up system for testing	Roland Le Grand
April 1	Test connections	Roland Le Grand
	Perform initial tolerance analysis	Chris Goulet
	Adjust presentation using suggestions from mock presentation	Eric Davila
April 8	Test assembled system	Roland Le Grand
	Debug remaining issues facing system	Eric Davila
	Perform remaining tolerance analysis	Chris Goulet
April 15	Verify specifications and fix any remaining bugs	Eric Davila
	Prepare presentation, using suggestions from mock presentation	Roland Le Grand
	Outline Final Paper	Chris Goulet
April 22	Demo and Presentation	All
	Final Paper write-up	All
April 29	Final Presentation and Check-in	All