Comprehensive Design Review (CDR)

Neptune

Team 16
February 29, 2016

Team 16 Introduction

Frankie Viscusi
EE ’16 - Team Manager
Power System & PCB Design

Hang Do
EE ’16
Alarm & Power System

Scott Powell
EE ’16
Camera & Audio Analysis

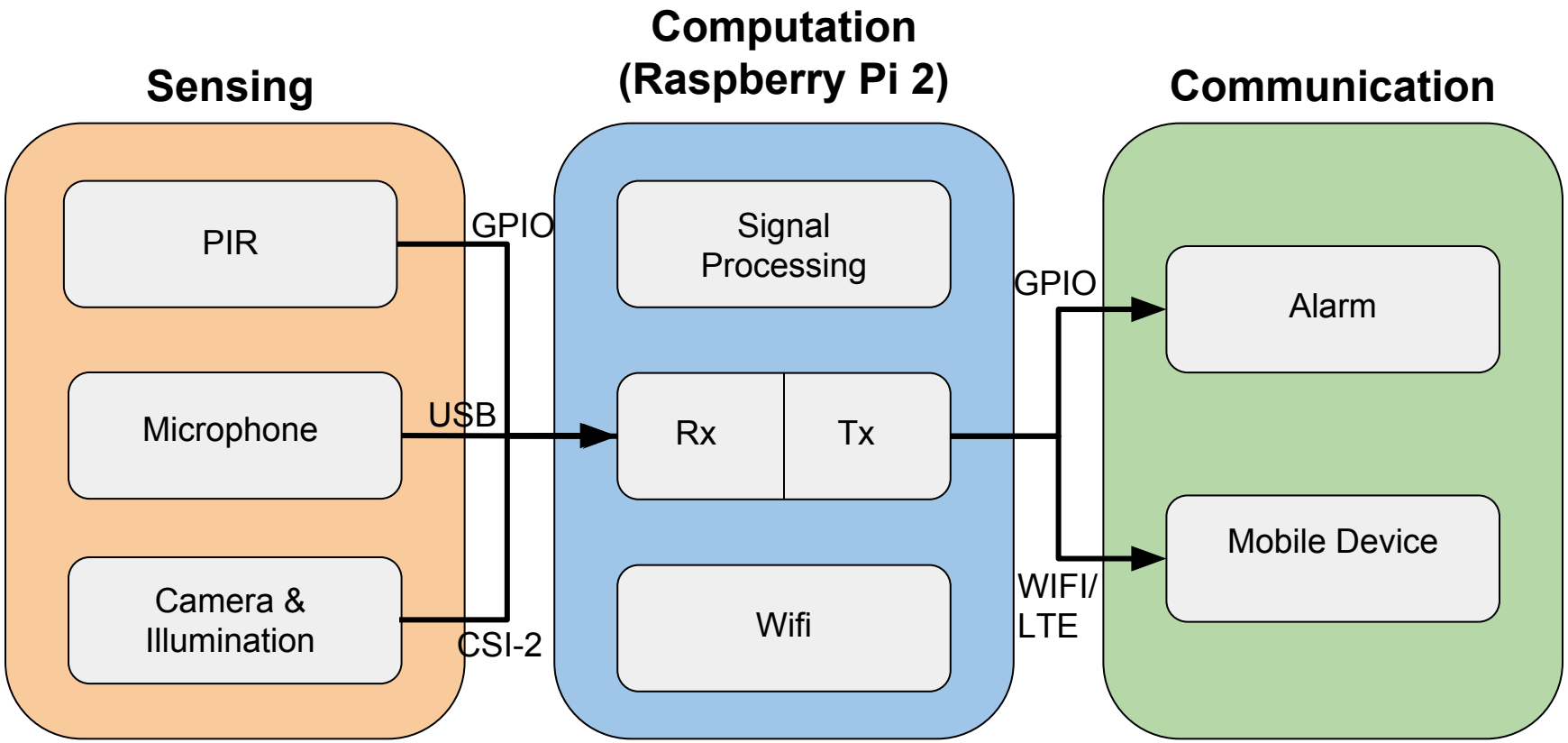
Faculty Advisor: **Daniel Holcomb**

What is Neptune?

- Drowning Prevention and Pool Security System
- Uses a PIR sensor to detect movement in combination with audio analysis to detect splashes
- Alerts those nearby with audible alarm located poolside
- Contacts the person in charge by messaging MMS picture

Block Diagram - Neptune

Scott



Deliverables for CDR

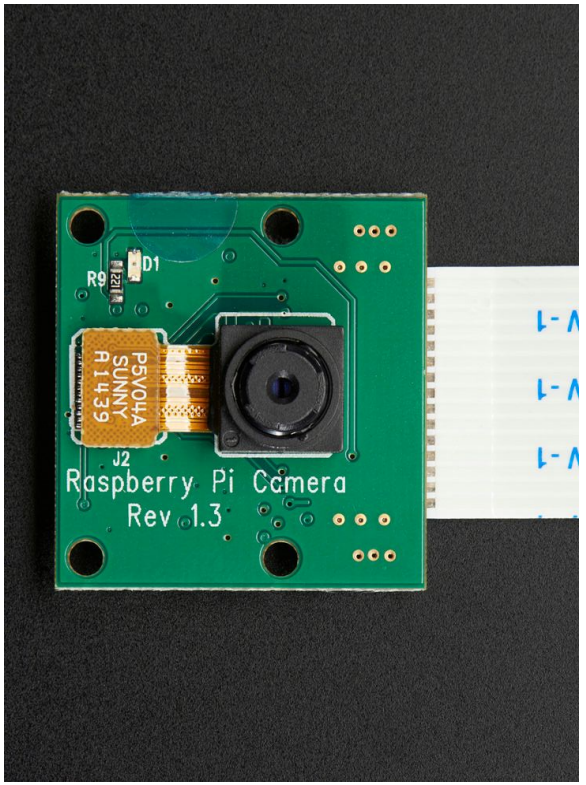
Scott

- ✓ Analyze audio coming from the microphone and determine whether or not a splash occurs
- ✓ Capture a picture once both the motion is detected by PIR and an audio signal of a disturbance is received
- ✓ Determine the appropriate "risk threshold" based upon the PIR and microphone performance
- ✓ Activate the alarm once the "risk threshold" is exceeded
- ✓ Design a circuit that provides power efficiently for the Neptune system
- ✓ Increase the decibel level of the alarm system

PIR & Camera with Floodlight

Scott

- Raspberry Pi Camera to take pictures of pool environment when PIR sensor detects movement and audio analysis indicates splash
- RPi Camera is the best choice to interact with the Pi because it is compatible, there is a dedicated RPi ribbon port on the board, and is perfectly integrated into Python
- A floodlight will be used to illuminate the pool area in the event of nighttime intrusion



Current Audio Analysis Method

Scott

- Python
  - PyAudio for live audio capture
  - *Numpy:* audio processing library; data organization
  - QT for plotting
- Currently we are tracking audio at all times and performing a FFT as it is received in order to analyze in terms of amplitude and frequency
- Requires a hard-coded algorithm to determine if incoming audio is a "splash sound"
- Due to the inconsistent performance and false alarms this could provide, one of our FDR goals is to use Matlab to incorporate a form of machine learning.

Audio Analysis Goal: Machine Learning

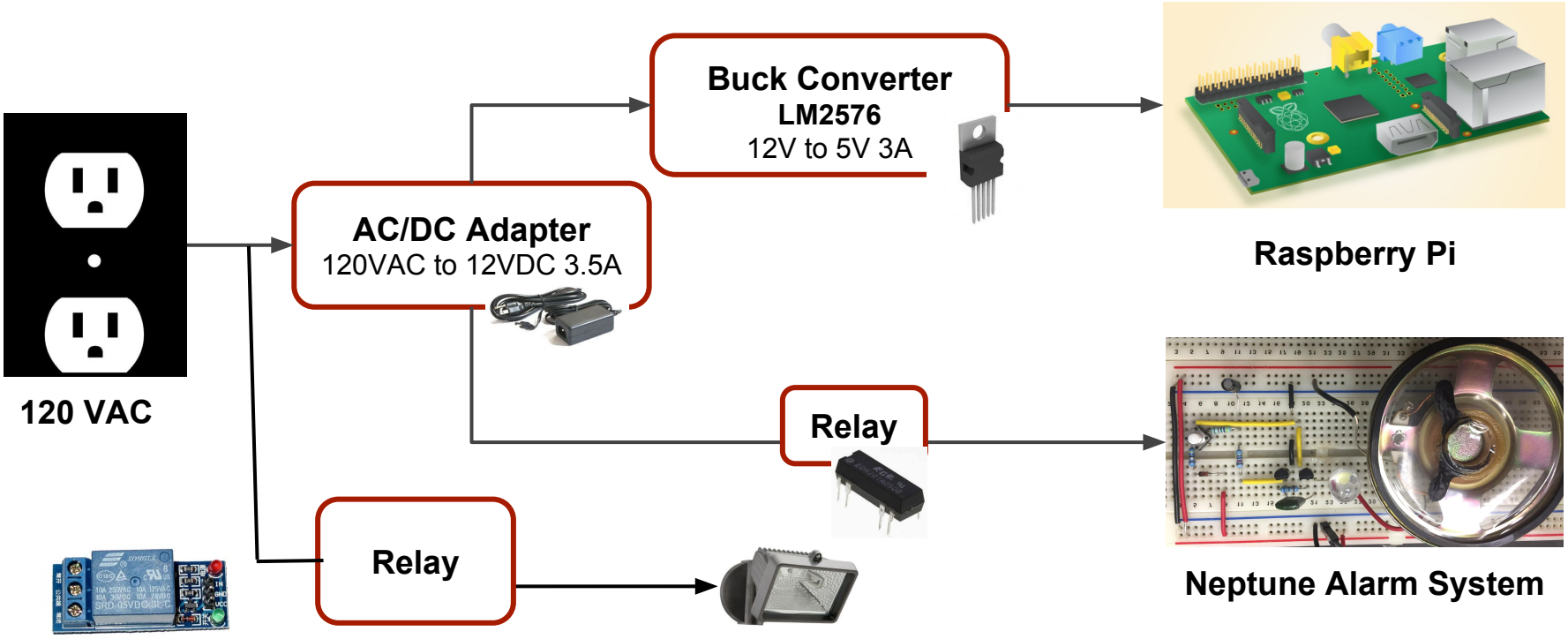
Scott

- Matlab on Raspberry Pi via simulink
- Train a classifier that utilizes a database of known splash/non-splash sounds to which newly captured audio will be compared and determined to contain a splash
- We evaluating the MIR toolbox library to do this processing as it contains the means to classify in addition to onboard machine learning algorithms
- This will provide a more efficient and accurate way of detecting audio disturbances

Power System Requirement

Frankie

- Provides 12V-3A to supply the alarm system
- Provides 5V-2A to power the Raspberry Pi

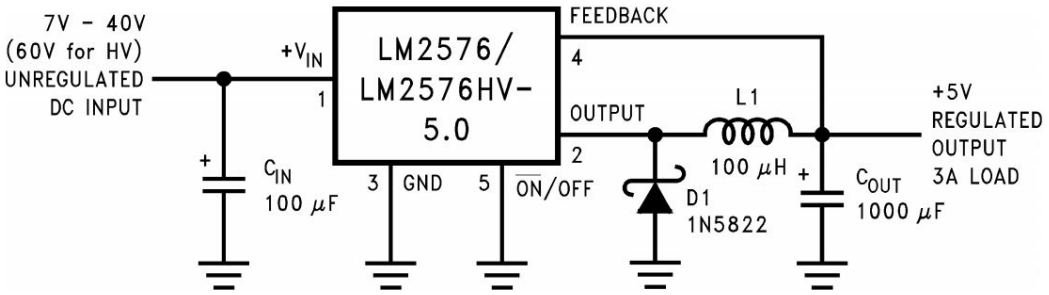


Power System Choices

Frankie

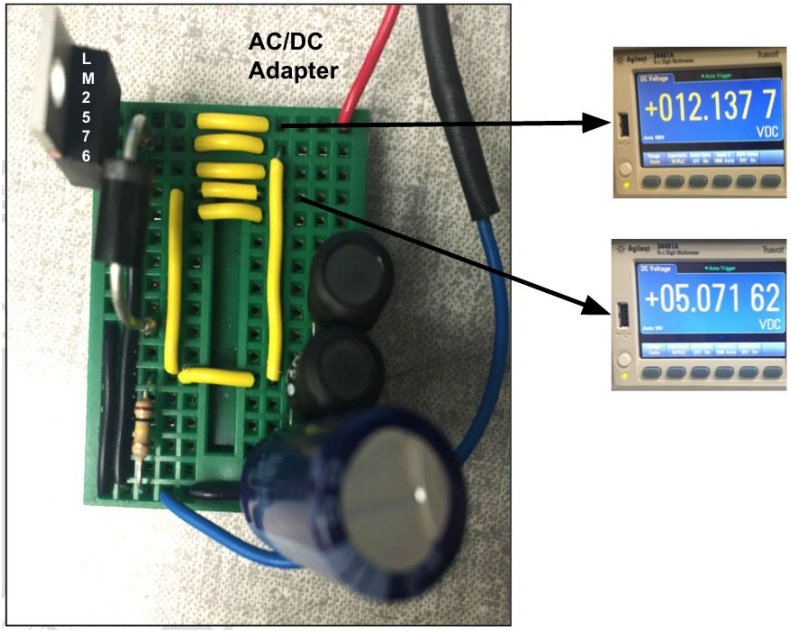
- 12V 3.5A DC Power Supply Adapter

- LM2576 3A Step-Down Voltage Regulator
  - 75% efficiency for V_{in} = 12V and I_{load} = 3A

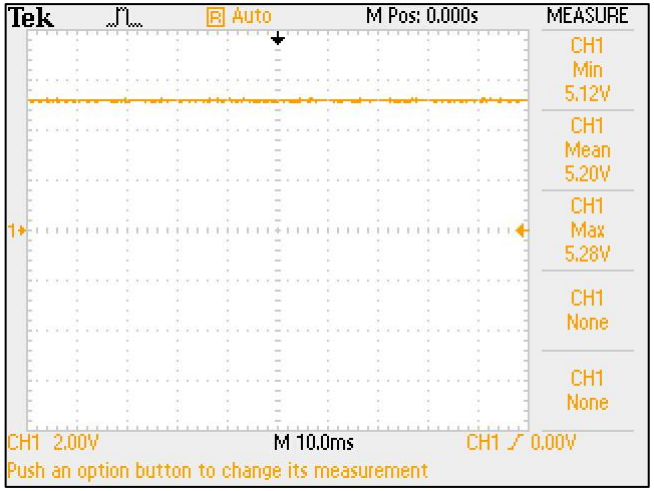


Power System Results

Frankie



AD/DC Adapter and LM2576 Voltage Regulator Results shown in Digital Multimeter



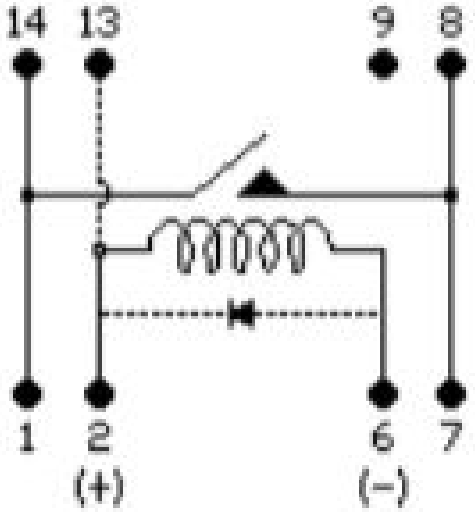
LM2576 Voltage Regulator Result shown in Oscilloscope

Relays

Frankie

EDR201A0500

- Simple relay to activate alarm circuit
- 3.3V from GPIO pin on the RPi will close relay



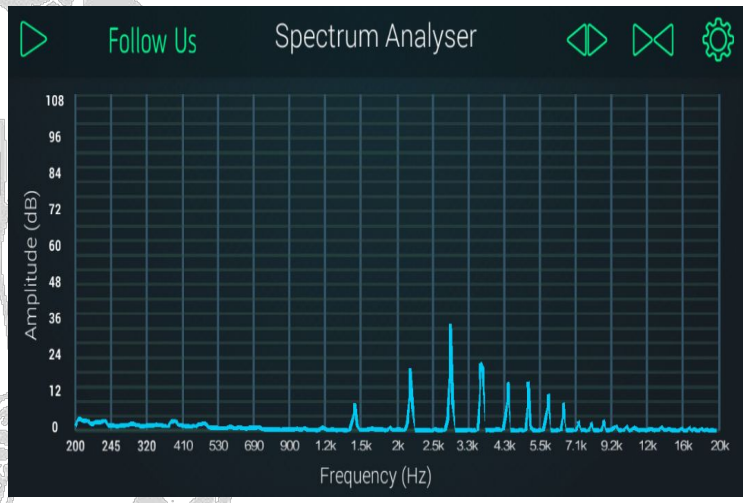
RPi Relay Module 250V/10A

- Relay module chosen which will be used to switch on 120V floodlight with 3.3V output from a GPIO pin on the RPi
- Relay module requires 5V to power itself

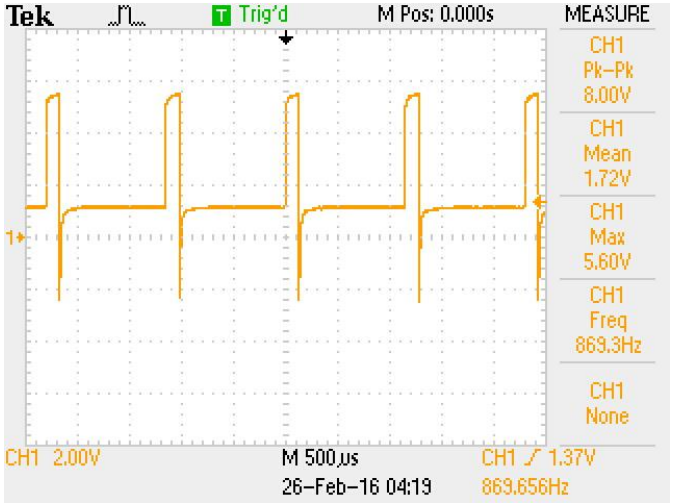
Alarm System (Previous)

Hang

- Once both the motion and splash are detected, the Raspberry Pi will trigger the EDR201A0500 relay to activate the alarm system
- The amplitude produced by this alarm is up to 32 dB within ~15 cm using the Spectrum Analyser application



Alarm System Frequency vs. Amplitude Plot



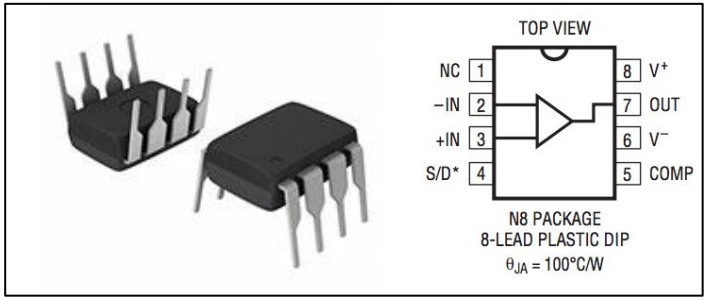
Alarm System Result shown in Oscilloscope

Alarm System Changes

Hang

- CDR Goal: Increase the decibel level of the alarm system
- Solution:
  - Utilize PH-180Q 8Ω Speaker Horn and Loudspeaker that handles up to 15W
  - Utilize LT1206 Current Feedback to amplify the current from 20mA to 1.2A

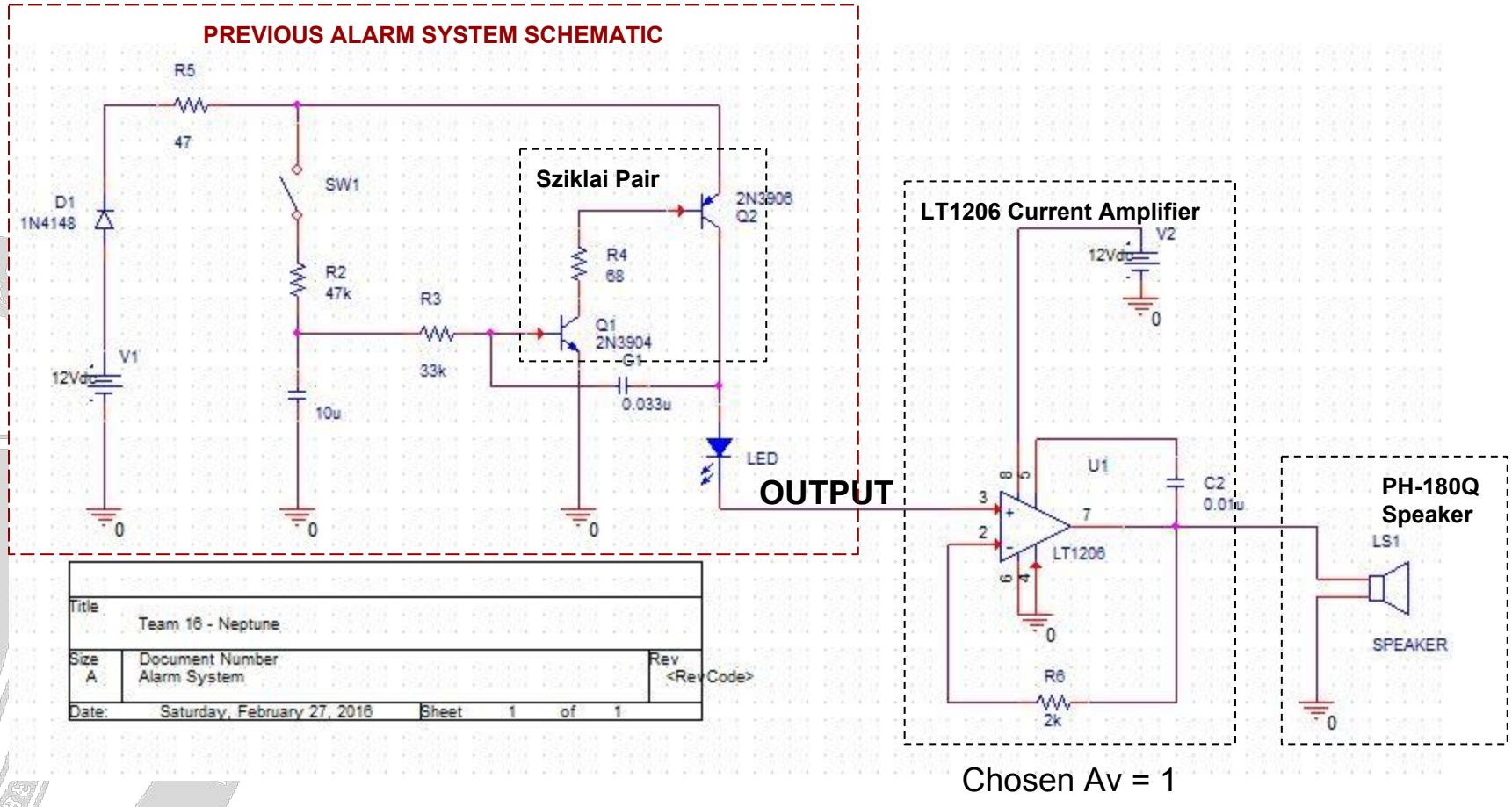
PH-180Q Speaker Horn



LT1206 Current Amplifier

Alarm System Schematic

Hang

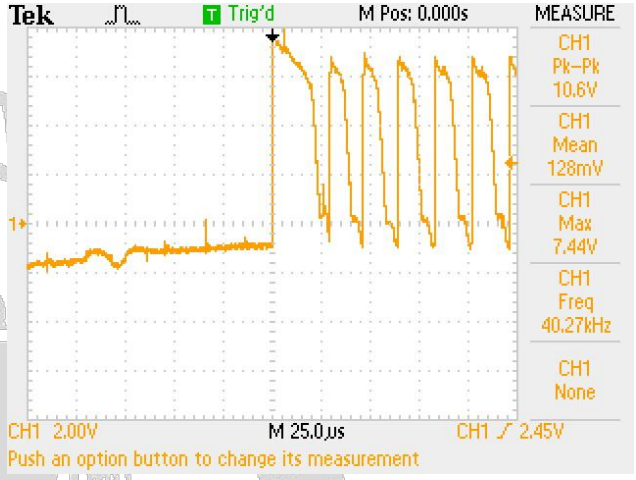


Chosen Av = 1

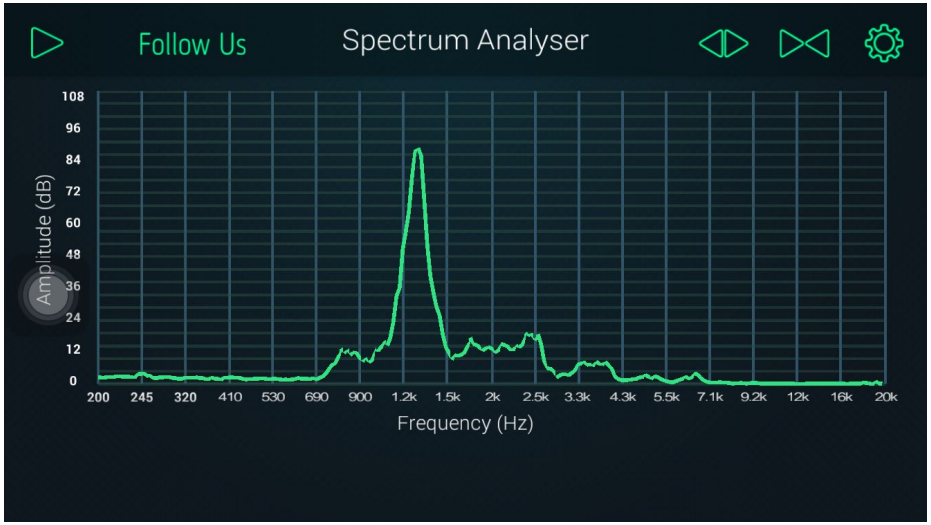
Alarm System Result

Hang

- Produces up to 70 dB with 12V supply



Alarm System Result shown in Oscilloscope

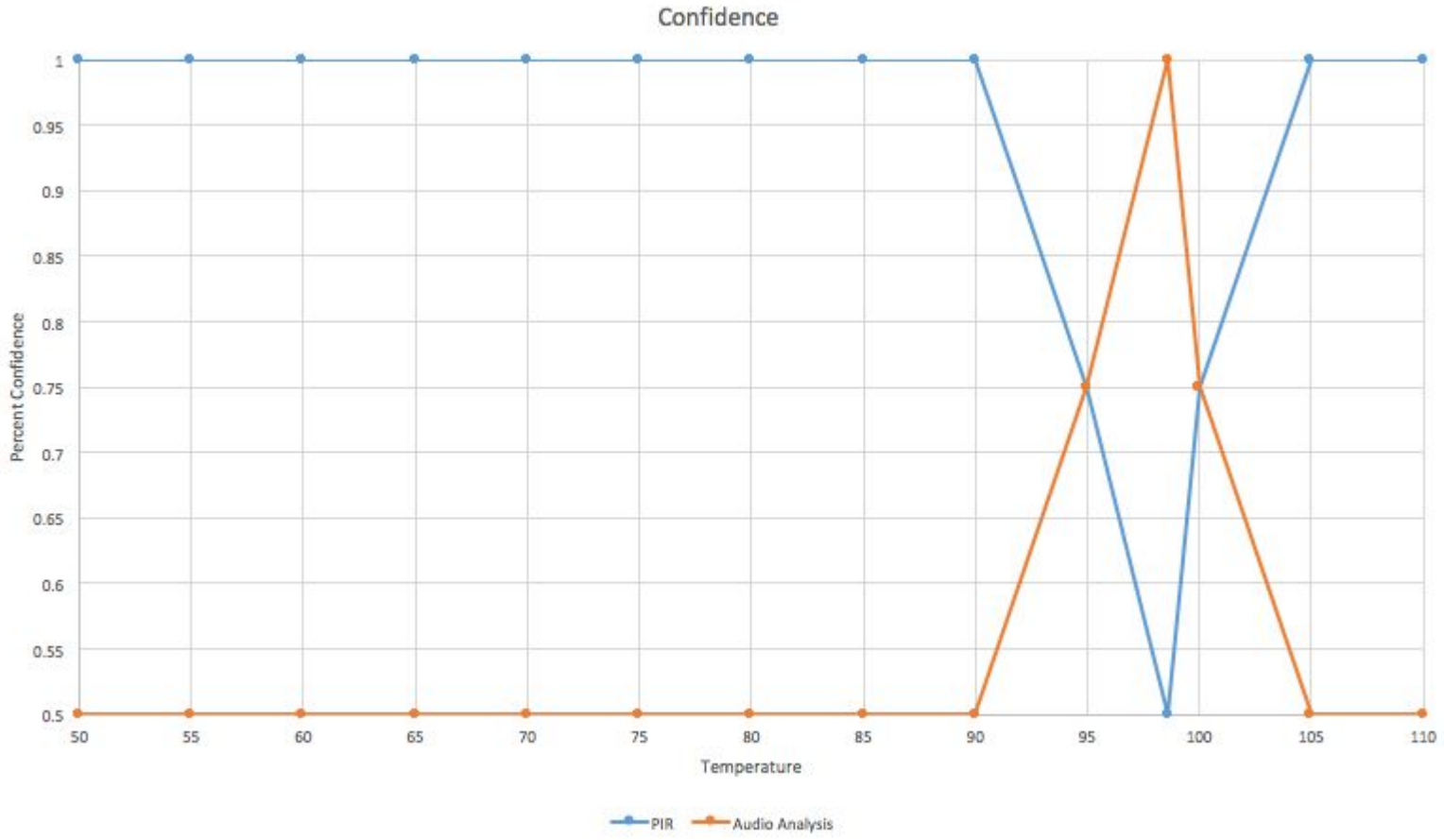


Alarm System Frequency vs. Amplitude Plot

Problems Encountered

Frankie

- PIR Functionality around 98.6°F



Cost Breakdown

Part	Cost
Speaker	$11.29
Current Amplifier	$6.28
Voltage Regulator	$2.68
USB Microphone	$32.99
USB Wifi Adapter	$8.50
PIR Sensor	$9.95
Camera	$26.65
Raspberry Pi 2	$35.00
Flood Light	$12.97
12V 3.5A AC/DC Converter	$7.48
Total Cost	$153.79

FDR Goals

Frankie

- Design and implement PCB for Neptune system
- Refine tone of audible alarm
- Implement Simulink on the Raspberry Pi for audio analysis
- Fabricate enclosure for the Neptune system
- Test system in a real pool environment

Upcoming Demo…

Scott

- Use our designed power system to demonstrate an accurate flow of power
- Simulate someone walking into the pool shortly before a "splash sound" occurs (could be any loud sound in the frequency range)
  - At this point picture message will be sent, loud alarm will go off , and LED will illuminate
- We encountered problems with relay switch so floodlight will be incorporated by FDR

DEMO