JnJ’s Clockwork

Software and Hardware Specification Sheet

Juan Sebastian Rodriguez, Jordan Pulido, Johnson Dinh

January 24, 2019

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# Declaration of Joint Authorship

We, Juan Rodriguez, Jordan Pulido, and Johnson Dinh, confirm that this work submitted for the project is the joint work of ourselves, and does not infringe upon anyone’s copyright nor violate any proprietary rights. Any uses made with other authors’ ideas, equations, figures, techniques, or any other material from the work of other people included in the project are in accordance with the standard referencing practices. Johnson Dinh has handled the database connection along with the app integration for the hardware, Juan Sebastian Rodriguez created the foundation of the app, along with its features and functionality. Juan also designed the overall structure of the hardwares appearance. Jordan Dave Pulido was responsible for the assembly and functionality of the Amplifier component of the hardware.

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# Proposal

January 17th 2019

***Proposal for the development of JnJ’s Clockwork***

Prepared by Johnson Dinh, Juan Rodriguez, Jordan Pulido  
*Computer Engineering Technology Student*https://github.com/JuanRodriguez19/JnJ-s-Clockwork

**Executive Summary**

As a student in the Computer Engineering Technology program, I will be integrating the knowledge and skills I have learned from our program into this Internet of Things themed capstone project. This proposal requests the approval to build the hardware portion that will connect to a database as well as to a mobile device application. The internet connected hardware will include a custom PCB with the following sensors and actuators: HTU21D-F Humidity/Temp Sensor (0x40), I2S 3W Class D Amplifier Breakout MAX98357, 0.56″ 4-Digit 7-Segment display. The database will store: Username, Password, Timestamp, Temperature Reading, Alarms Saved By Users. The mobile device functionality will include: Alarm Clock, Time Zones, Timers, Stopwatch, Temperature readings, User Information, Customization Features and will be further detailed in the mobile application proposal. I will be collaborating with the following company/department: Humber Prototype Lab. In the winter semester I plan to form a group with the following students, who are also building similar hardware this term and working on the mobile application with me. These are the following group members: Juan Rodriguez, Johnson Dinh, Jordan Pulido. The hardware will be completed in CENG 317 Hardware Production Techniques independently and the application will be completed in CENG 319 Software Project. These will be integrated together in the subsequent term in CENG 355 Computer Systems Project as a member of a 2 or 3 student group.

**Background**

The problem solved by this project is: As a youth, it becomes increasingly difficult to manage and maintain a proper sleeping schedule. The snooze button is used to give the user 5 more minutes to relax and properly wake up, however this is often abused and the user ends up repeatedly hitting the snooze button, which often leads to time wasting. A bit of background about this topic is: This project will consist of an alarm clock application which will link up to a physical hardware element via Bluetooth. The hardware being developed would contain a display where the current time, alarm settings, and local temperature readings would appear. The app is where the user would be able to customize and select what they want to appear on the display. Each sensor in the hardware portion of the project serve their own purpose in conjunction with one another. The Humidity/Temp sensor would give the current readings of the temperature and store them in the database, the Haptic sensor will vibrate the device with an alarm goes off as a time of notification. The display screen will be responsible for displaying the core information requested by the user.

Existing products on the market include Google Home. I have searched for prior art via Humber’s IEEE subscription selecting Institute of Electrical and Electronics Engineers and have found and read A DIY approach to pervasive computing for the Internet of Things: a smart alarm clock which provides insight into similar efforts.

In the Computer Engineering Technology program, we have learned about the following topics from the respective relevant courses:

* Java Docs from CENG 212 Programming Techniques In Java,
* Construction of circuits from CENG 215 Digital And Interfacing Systems,
* Rapid application development and Gantt charts from CENG 216 Intro to Software Engineering,
* Micro computing from CENG 252 Embedded Systems,
* SQL from CENG 254 Database With Java,
* Web access of databases from CENG 256 Internet Scripting; and,
* Wireless protocols such as 802.11 from TECH152 Telecom Networks.

This knowledge and skill set will enable me to build the subsystems and integrate them together as my capstone project.

**Methodology**

This proposal is assigned in the first week of class and is due at the beginning of class in the second week of the fall semester. My coursework will focus on the first two of the 3 phases of this project:  
 Phase 1 Hardware build.  
 Phase 2 System integration.  
 Phase 3 Demonstration to future employers.

*Phase 1 Hardware build*

The hardware build will be completed in the fall term. It will fit within the CENG Project maximum dimensions of 12 13/16" x 6" x 2 7/8" (32.5cm x 15.25cm x 7.25cm) which represents the space below the tray in the parts kit. The highest AC voltage that will be used is 16Vrms from a wall adaptor from which +/- 15V or as high as 45 VDC can be obtained. Maximum power consumption will be 20 Watts.

*Phase 2 System integration*

The system integration will be completed in the fall term.

*Phase 3 Demonstration to future employers*

This project will showcase the knowledge and skills that I have learned to potential employers.

The brief description below provides rough effort and non-labour estimates respectively for each phase. A Gantt chart will be added by week 3 to provide more project schedule details and a more complete budget will be added by week 4. It is important to start tasks as soon as possible to be able to meet deadlines.

Display screen for hardware element required. Materials for creation of the device. Casing for sensors and Raspberry Pi. Additional connectors to link up sensors to one another.

**Concluding remarks**

This proposal presents a plan for providing an IoT solution. The hardware device is a convenient option for those that want to maintain a solid time schedule all while being able to view current temperature readings of the area around them without having to open up external applications. This is an opportunity to integrate the knowledge and skills developed in our program to create a collaborative IoT capstone project demonstrating my ability to learn how to support projects such as the initiative described by [3]. I request approval of this project.

**References**

[1]Google Home. (2016). Retrieved from https://store.google.com/ca/product/google\_home

[2]Institute of Electrical and Electronics Engineers. (2015, August 28). IEEE Xplore Digital Library [Online]. Available: https://ieeexplore.ieee.org/search/advsearch.jsp

[3]Scott, G. and Chin, J. (2013). A DIY approach to pervasive computing for the Internet of Things: A smart alarm clock - IEEE Conference Publication. [online] Ieeexplore.ieee.org. Available at: https://ieeexplore.ieee.org/document/6659445 [Accessed 15 Jan. 2019].

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# Abstract

The purpose of this project is to create a device which alarms the user more effectively for those wanting to be notified on time with ease. It will consist of an alarm clock application which will link up to a physical hardware element via Bluetooth. This technical report will give a thorough analysis of the development process regarding every aspect of the project, ranging from app structure to hardware assembly. Explanations revolving around certain ideals and decisions will be given to provide readers insight on why certain features are present along with their purpose.

Test cases will be examined during development to acknowledge mistakes that were made along the road along with the solutions for said mistakes. Any hardships and difficulties will also be documented for prevention purposes in the future of similar circumstances. Hardware explanation and breakdowns can be located in the Requirement Specification portion of the report.

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# Introduction

JnJ’s Clockwork is an android based alarm mobile application where users are able to set and customize alarms of their choice for daily use. The user will be able to create multiple alarm profiles along with being able to set a timer and utilize a stopwatch. When connected to its corresponding hardware component, the app furthers its capabilities by allowing users the ability to read local temperatures via the sensor included. The project is designed to give users ease of access to anything time related in a simple and clean form factor.

Students can benefit greatly from this product for those that struggle waking up at certain times of day and require an external source for assistance such as the app. It can also be used to set reminders for certain time periods such as deadlines for assignments etc. The temperature readings are an added bonus as it readily displays the current temperature in real time without having the need to open other respective applications for similar purposes.

In order for the app to function as intended, it is linked up with a database known as Firebase. This allows user information such as their own personal accounts, alarm templates and temperature values to be stored in a cloud which is ultimately located in Firebase. A Unique approach we are taking for this project would be the exclusion of a snooze button on the hardware itself which must be manually turned off in the app when alarms are triggered. This would make it harder for users to simply ignore the alarm they set up initially with a simple button press and motivate them to wake up.

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# Project Description

## Requirement Specifications

### Hardware

The hardware portion of this project will be a joint effort between each member of the group as there are many responsibilities in order for everything to function as intended. In terms of the hardware design and enclosure, it will be handled by Juan. The functionality of each sensor will be tested and operational mainly by Jordan with help from Johnson when required. Connections between sensors and the Raspberry Pi will be accomplished by Johnson. The Integration of components may require additional help from every member due to problems that may occur during development.

The project utilizes many hardware components such as the Raspberry Pi 3B+, HTU21D-F Humidity/Temp Sensor (0x40), and a Display screen. These sensors will be enclosed using 3D printed materials with a maximum dimension size of: 12 13/16” x 6” x 2 7/8”. The Humidity and Haptic sensor are ready for integration with one another as they were already completed last semester. The new inclusion for the project is the Display Screen as it is crucial to display the time and temperature from the application. The android smartphone’s role will act as the device’s remote as it can communicate with the clockwork through Bluetooth. An 8GB micro SD card will be used as storage as it can store the installation of the Raspbian OS, and reading and writing values from the Clockwork. The PCB (printed circuit board) acts as the structure and support of the system for sensor connections.

### Software

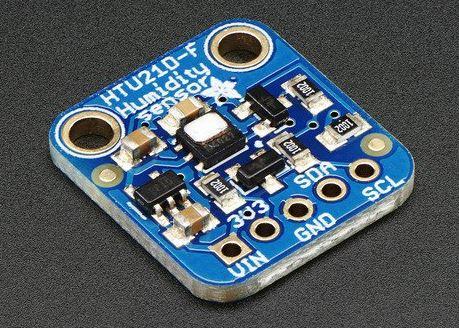
The android application will be developed and maintained by Juan and Johnson. Add ons and additional functionality will be incorporated with the help from Jordan. The app is mostly complete in its current state. The only things that are left to work on is Bluetooth functionality and debugging. The app needs to respond to the hardware in order to display desired information from the application.

The project utilizes a smartphone capable of running Android API 21 or higher. An up to date version of Android Studio was used to build the mobile application. A Raspberry Pi 3 was implemented with connection between the hardware and application. Updating the Raspbian OS to its newest version was used throughout the project. The mobile application will be used to work alongside the hardware components. Firebase real-time readings is going to be used for communication such as storing user and temperature readings.

### Database

The database will be designed, created and upheld by Juan and Johnson. The database connection is established and connected to the mobile application. Reading and writing from the sensor to the database are also required. The database utilizes user-authentication to allow maximum security and protection for the user’s information. In order to read and write temperature, the user must be registered using a username and password through authentication processing. Offline mode allows access to the app, without the need to register and login. Offline mode skips user-authentication, and moves the user to the actual app. In offline mode, there will be no form of communications to the database. Therefore, the user is unable to read/write temperature to the database.

# Build Instructions



The HTU21D-F Temperature/Humidity sensor uses the ratio of air moisture to be able to measure and read both temperature and humidity. In this tutorial, the goal is to able to activate the senor and have it display readings of the temperature and humidity. It has a typical accuracy of ±2% with an operating range that's optimized from 5% to 95% RH.

Figure - HTU21D-F Temperature/Humidity Sensor(0x40)

This sensor is a 4 digit - 7 segment numeric display

Figure - 0.56″ 4-Digit 7-Segment display

which utilizes many LEDS built into the display. The screen is accompanied by a backpack which does all the heavy lifting. Includes a built-in clock to multiplex the display and current drivers for bright/vivid colors for the LEDS.

### C:\Users\n01164181\AppData\Local\Microsoft\Windows\INetCache\Content.Word\Amplifier.JPG

The I2S 3W Class D Amplifier Breakout MAX98357 is a sensor which amplifies audio for digital sounds files. It takes standard I2S digital audio input and decodes it into analog, which also amplifies it directly into a speaker. The small mono amplifier is capable to deliver 3.2 Watts of power into a 4-ohm impedance speaker. Inside the chip is a class D controller, able to run from 2.7V-5.5VDC making it extremely efficient.

Figure - I2S 3W Class D Amplifier Breakout MAX98357

### Introduction

JnJ’s Clockwork is an android based alarm mobile application where users are able to set and customize alarms of their choice for daily use. The user will be able to create alarm profiles along with being able to set timers and stopwatches. When connected to its corresponding hardware component, the app furthers its capabilities by allowing users the ability to read local temperatures via the sensor included. The project is designed to give users ease of access to anything time related in a simple and clean form factor.   
This project consists of the HTU21D-F Temperature/Humidity Sensor for reading local temperature values, a 1.2″ 4-Digit 7-Segment display for displaying current time and temperature readings, and a I2S 3W Class D Amplifier Breakout MAX98357 for audio when an alarm goes off.

### Budget for Materials Required

The required materials and budget for this project can be found in the documentation folder in the repository.

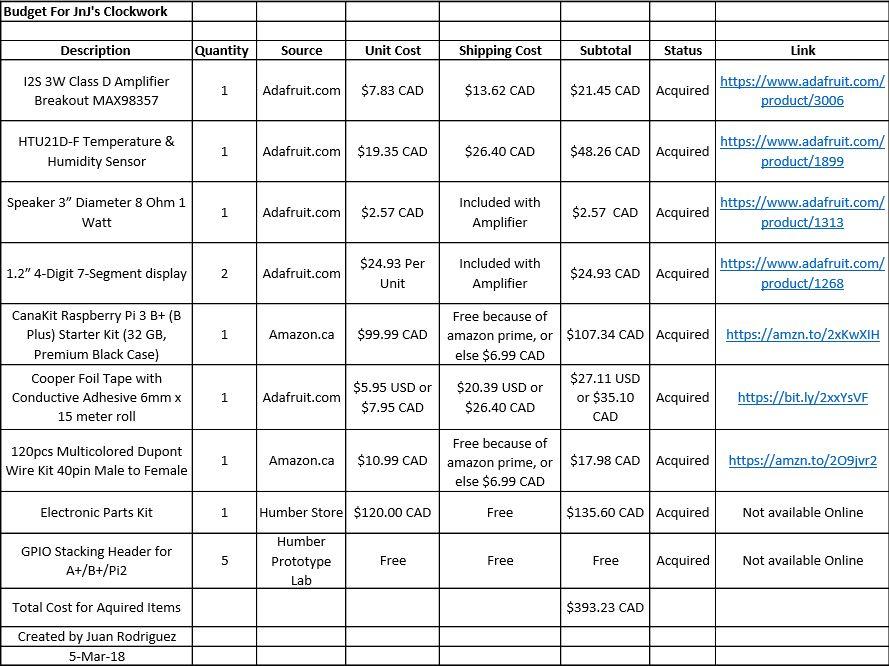
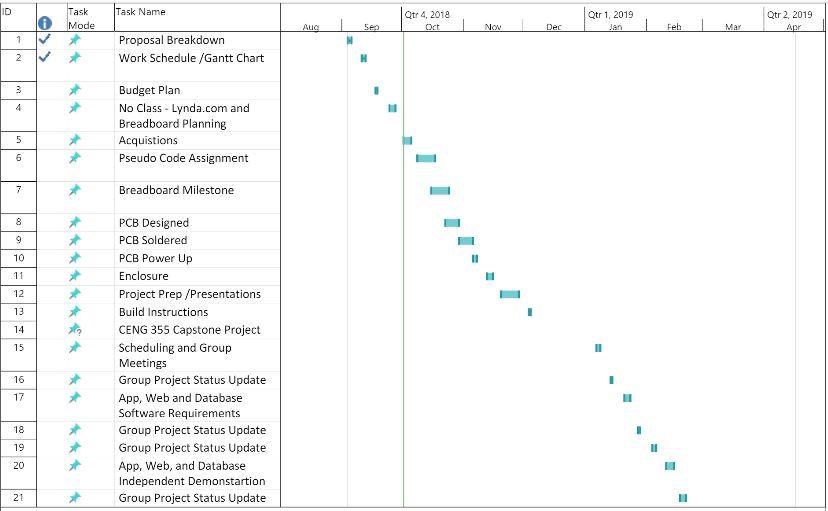


Figure - Budget

### Time Schedule

Realistically, this project should take around 3-4 weeks to complete if all materials and facilities are available to you. The materials themselves might take a week to arrive due to shipping, but the actual process of assembling and programming should not take longer than a week if proper time is given. A couple of hours each day can be dedicated towards the different aspects of the project to make time usage more efficient and effective. For us, this project took around 2 whole semesters (8 months) to finish along with an average work time of around 2.5 hours a week. Here is the time schedule we followed:



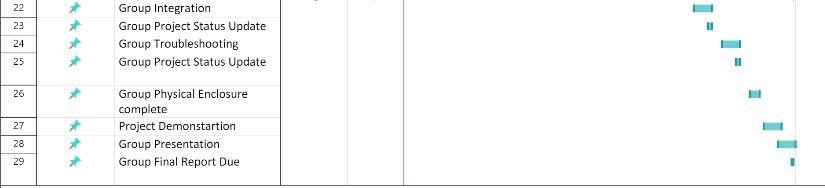


Figure - Schedule

### Assembly of Pi

These steps will cover how to set up the Raspberry Pi 3 B+ properly so that you have the ability to log in and test your sensors capabilities.

1. Format an SD card with a minimum of 8GB to be used for the OS of the Pi. You can use the following link to download a SD card formatting software: https://www.sdcard.org/downloads/formatter\_4/index.html
2. Download and unzip the latest version of the OS for the Raspberry Pi to your SD card. Download NOOBS in the link as that will ensure that you will have almost everything required when starting: https://www.raspberrypi.org/downloads/noobs/
3. Once the image is on the SD card, remove it from the pc and insert it in the Pi. Now plug in a separate monitor, mouse, keyboard, HDMI, Ethernet cable, and power supply to the Pi in their corresponding ports. The Pi turns on automatically when the power is plugged in.
4. Upon the boot up session, select Raspbian as the operating system for the Pi and follow the instructions as they appear. You may also change the keyboard layout on the bottom during initial boot. The US layout is highly recommended.
5. Once installation is completed, you should be brought to the desktop. Connect yourself to either Wifi or wired connection in order to perform the next few steps.
6. Open the terminal in the top left corner of the screen and input the following lines (this takes quite a long time): Shell wget https://raw.githubusercontent.com/six0four/StudentSenseHat/master/firmware/hshcribv01.sh \ -O /home/pi/hshcribv01.sh chmod u+x /home/pi/hshcribv01.sh /home/pi/hshcribv01.sh
7. Now it is time to set up a VNC connection so that you can access your Pi on any computer screen. From the Start Menu, go -> Preferences->Raspberry Pi Configuration->Interfaces, then set VNC to Enabled. Now on the desktop in the top right corner, you should see a VNC logo. When you click it you should see an IP address for your Pi which will be used to connect it via the VNC software. Download the software on any computer you wish to communicate with the Pi: https://www.realvnc.com/en/connect/download/vnc/
8. Once the software is installed, connect the Ethernet cable from the Pi to your computer of choice to have a direct connection. Now you can simply input the same address you found in the Pi in the VNC software and it should connect.
9. To turn off the Pi, type sudo power down in the terminal.

If you are still unsure or struggling with a part in particular, this video provides a step by step explanation for everything required: <https://www.youtube.com/watch?v=xBlxuf_LSCM>

### Wiring

Before wiring each sensor to the breadboard, it is important to solder the pins that come included to the sensors corresponding pin layouts. Additionally, make sure to cut the excess pins that come included that will not be required for each sensor.   
   
When soldering, make sure you have safety glasses equipped along with having proper ventilation that contains an extractor arm for the fumes. A soldering toolkit is also required which is available in most labs. Here is a great soldering tutorial to help with those unsure.  
 https://www.youtube.com/watch?v=3230nCz3XQA

You can wire the sensors to the Raspberry Pi using the following charts:

**HTU21D-F Temperature/Humidity Sensor (0x40).**

|  |  |
| --- | --- |
| Device Pin | Pi |
| 1 (VIN) | [5.0v] |
| 2 (3.3v) | [3.3v] |
| 3 (GND) | [GND] |
| 4 (SDA) | [GPIO 2] |
| 5 (SCI) | [GPIO 3] |

**0.56″ 4-Digit 7-Segment display.**

The IO pin only needs to be connected if you are working with the 1.2" display which has the same pinouts as the 0.56" one.

|  |  |
| --- | --- |
| Device Pin | Pi |
| 1 (D) | [SDA] |
| 2 (C) | [SCL] |
| 3 (+) | [5.0v] |
| 4 (-) | [GND] |
| 5 (IO) | [3.3v] |

**I2S 3W Class D Amplifier Breakout MAX98357.**

|  |  |
| --- | --- |
| Device Pin | Pi |
| 1 (VIN) | [5.0v] |
| 2 (GND) | [GND] |
| 3 (DIN) | [GPIO21] |
| 4 (BCLK) | [GPIO18] |
| 5 (LRCLK) | [GPIO19] |

This is the layout for the pins of the Raspberry pi for guidance on where certain pins are located:

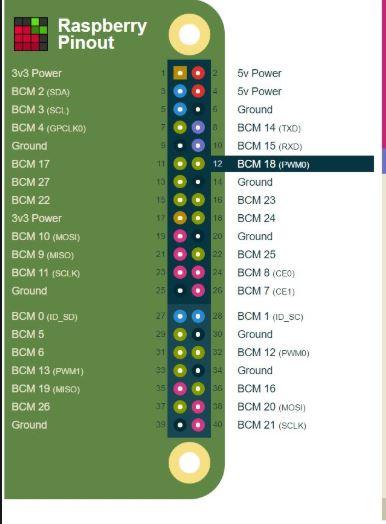


Figure - Raspberry Pi 3 B+ Pinouts

### PCB Design Files

In order to develop the PCB design files, the application Fritzing is required along with the Corresponding sensors file which must be added to the application under MyParts. The files can be located here: https://github.com/adafruit/Fritzing-Library/tree/master/parts   
 Once the Sensor is added to parts, you can create a fritzing diagram for the wiring of the pi and sensor. It should look similar to this.

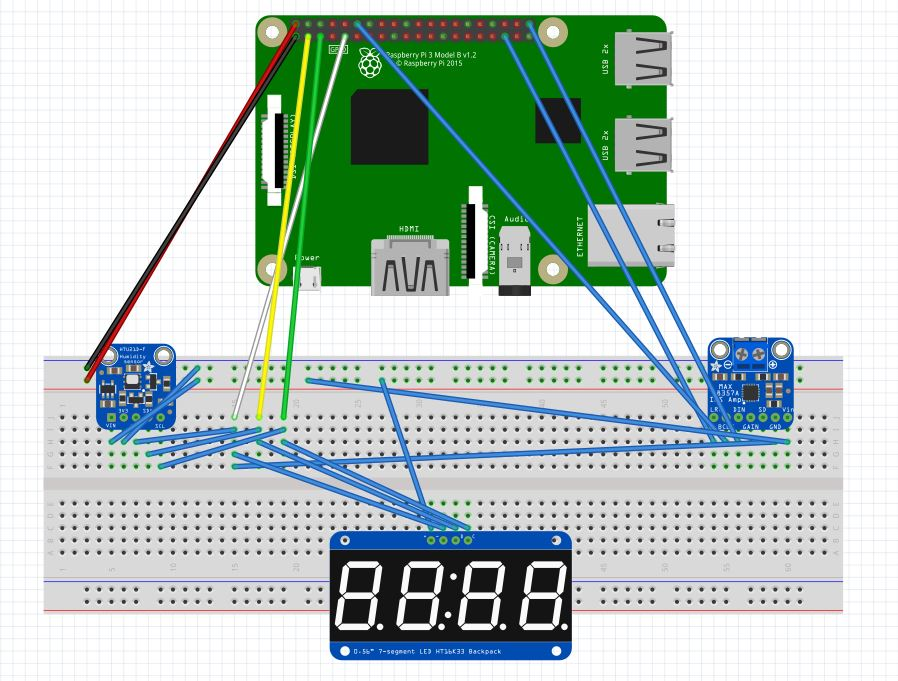


Figure - Breadboard Layout

From here you can create the PCB design from the wiring you just designed. The PCB layout should look similar to this. Reminder, the IO pin is only connected to 3.3v for the 1.2” screen.

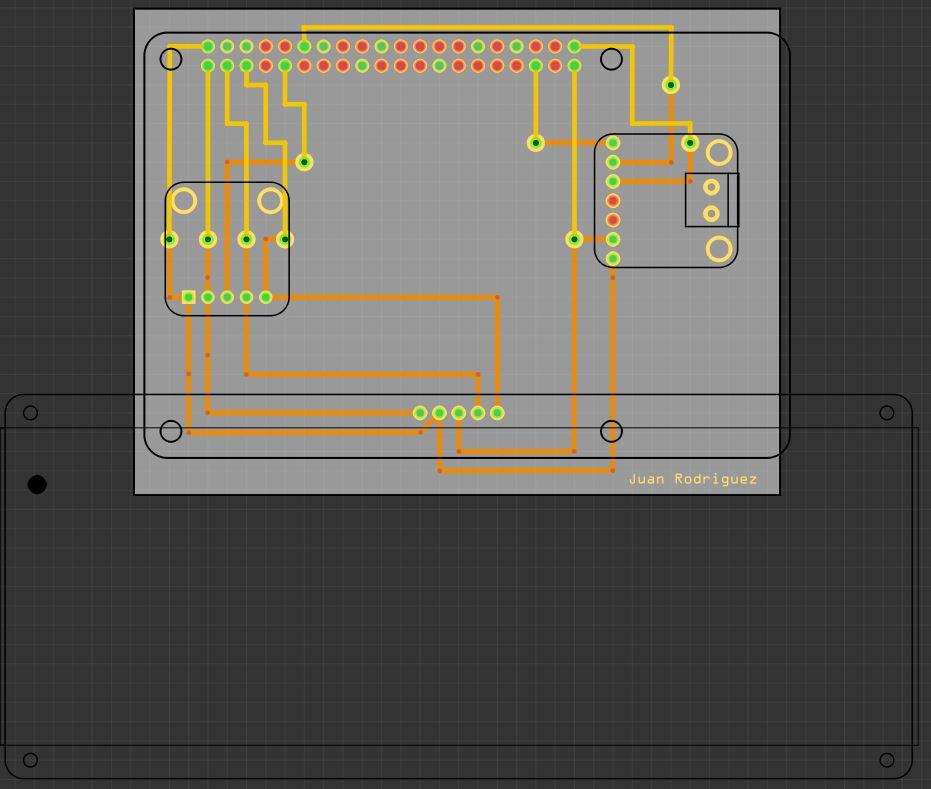


Figure - PCB Design

With these now ready, you can put together your Gerber files and create your PCB using a laser cutter machine. The Gerber files are located and can be downloaded Here

### PCB Soldering

Using the same rules as when soldering the Sensors, solder pieces of wire in between the vias on the PCB board. Once that's done, solder the 20 pin socket to the PCB board to the corresponding holes for where the pi would connect. For the remaining pin sockets you have, solder in the respective headers for each sensor in the appropriate locations. Your final board should look similar to this.

Top view:

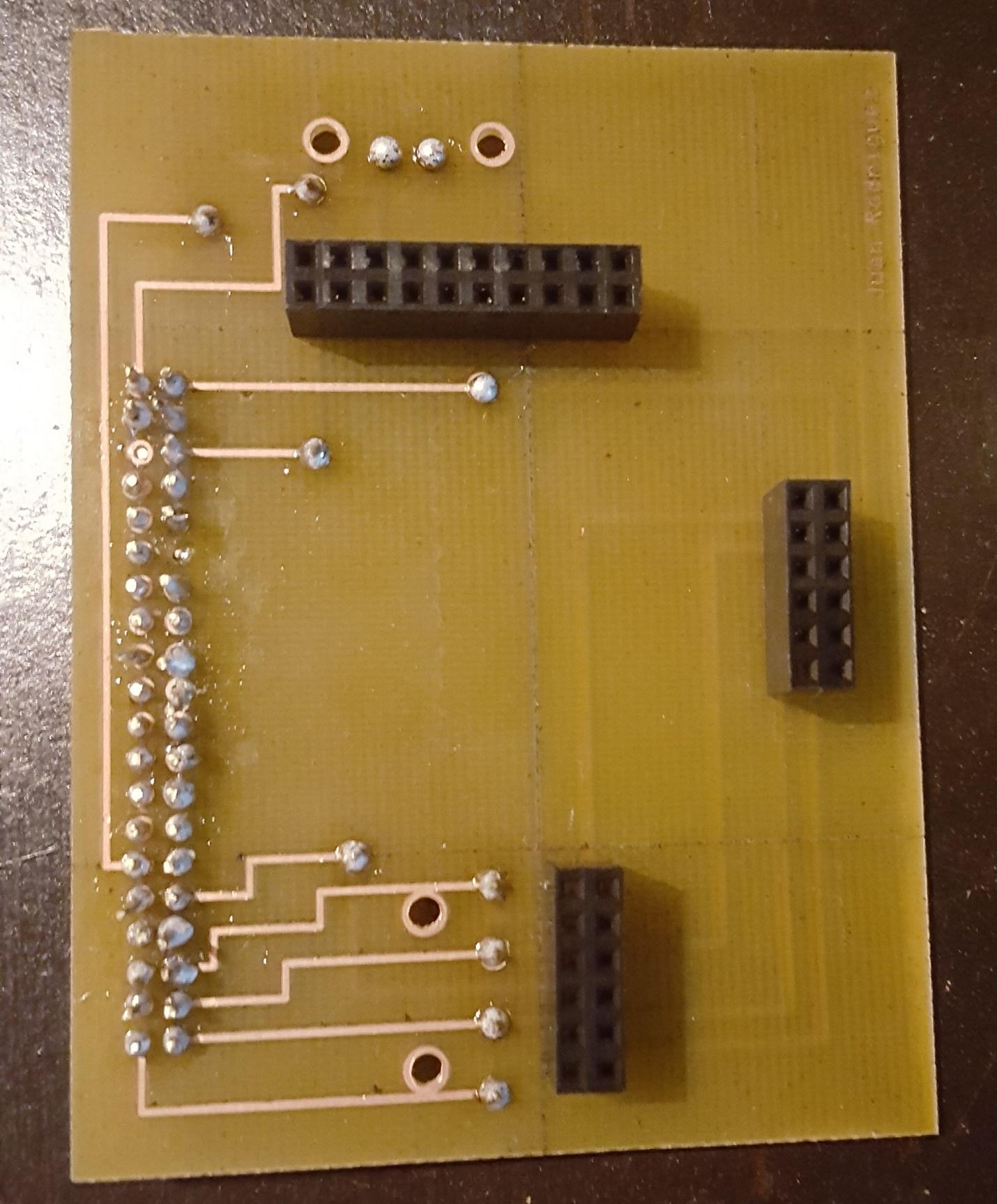


Figure - PCB Top View

Bottom view:

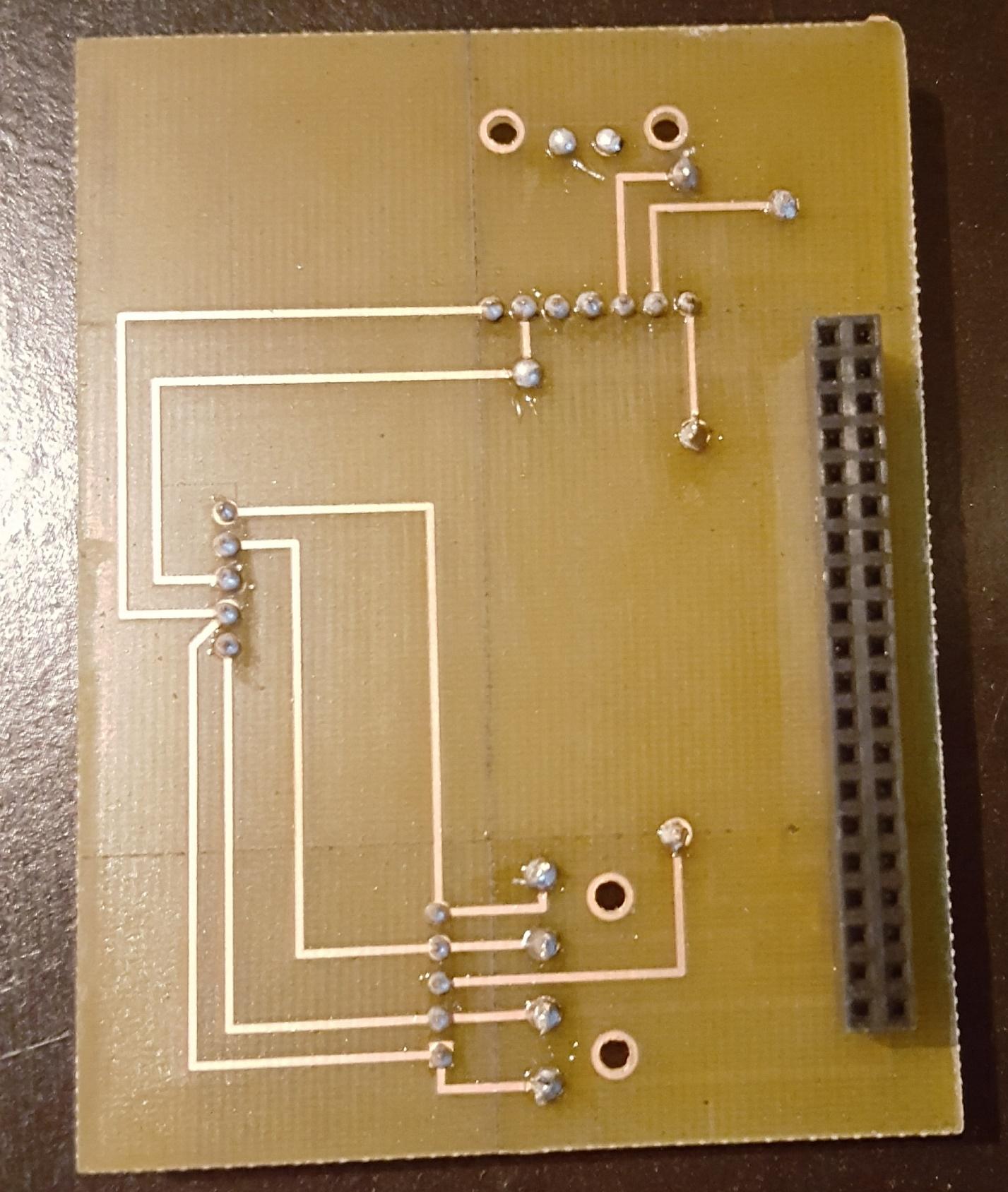


Figure - PCB Bottom View

### Power Up

In this section, we will now see if everything works, this works on whether you have soldered your PCB or you normally wired it onto your circuit board. Once connected boot up the Raspberry Pi, open the terminal window and follow these steps:

1. This will bring you into the configuration tool

sudo rasp-config

1. Use your arrows keys to go down and select "Interfacing Options"

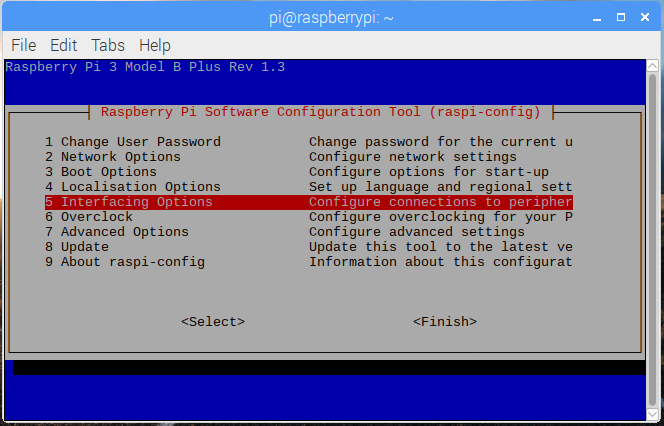
* 

Figure - Interfacing Menu

1. Select I2C and submit yes. It should display ARM I2C is enabled.

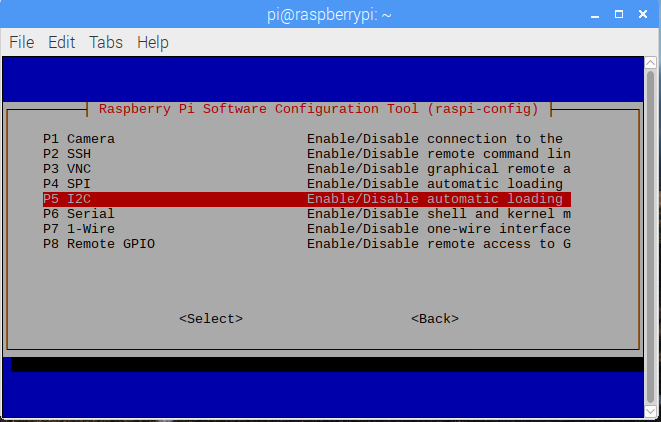


Figure - I2C Option

1. Exit by selecting the finish option. By using the command below it should your address for the sensors being (0x40) and (0x70).

sudo i2cdetect -y 1

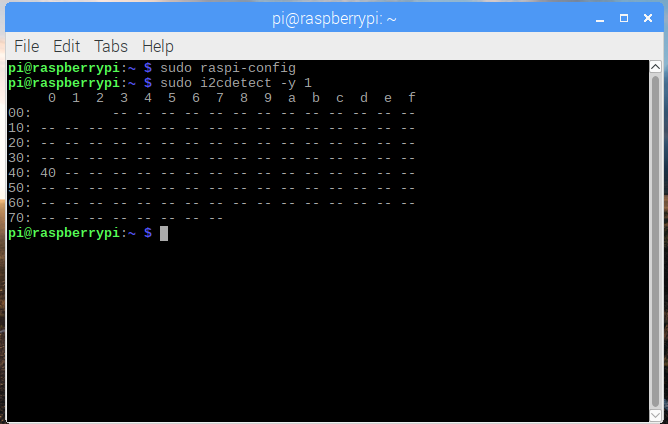


Figure - I2C Addresses

### Case Design

The case was created using CorelDRAW software. The file can be located in the repository linked above. Each case side was carefully measured to ensure everything fit in their corresponding locations. It should look like this:

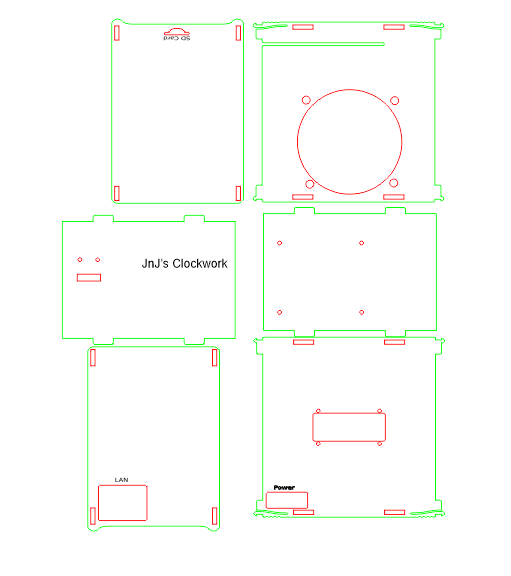


Figure - Case Design

### Assembly for Hardware

The finished product should look like this when assembled:

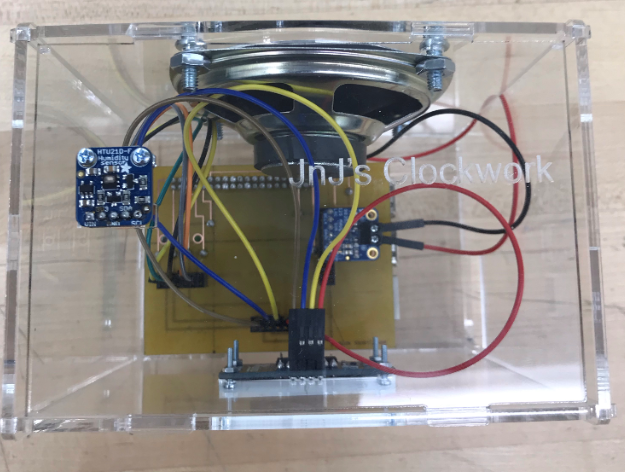


Figure - Top View

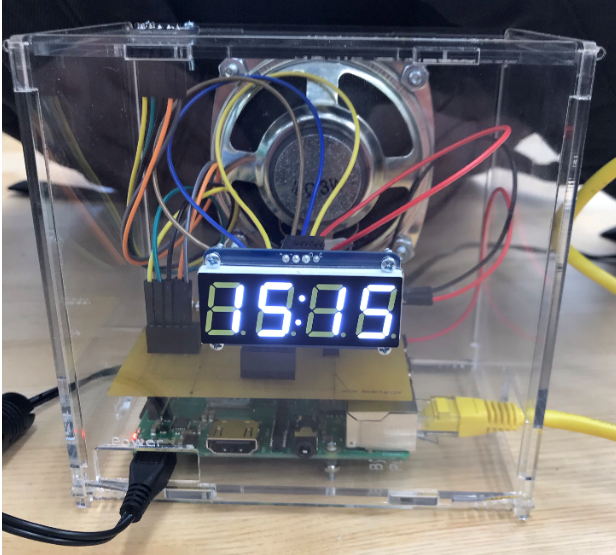


Figure - Front View

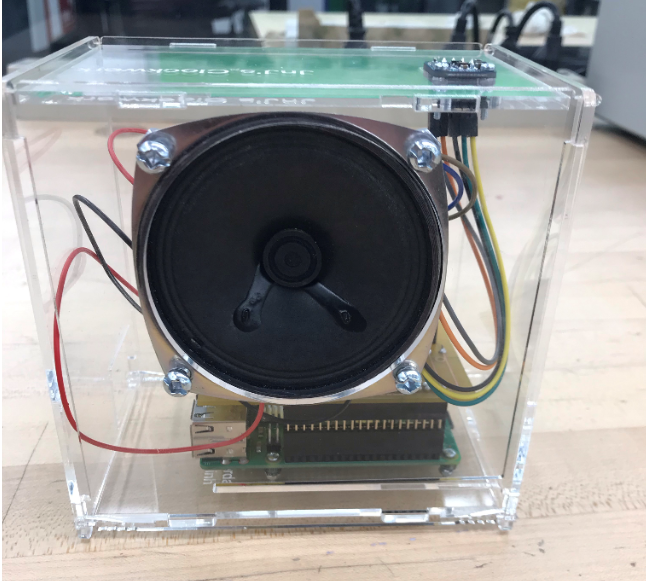


Figure - Back View

### Installing CircuitPython

For this project alot of code will be used with Circuit Python so here is the installation process for it.

The following tests were experimented using Adafruit:

1. Run the update commands for the Raspberry Pi.  
 sudo apt-get upgrade

2. When done installing, run the command line for the python tools

sudo pip3 install --upgrade setuptools

3. Verify you have I2C Enabled

ls /dev/i2c\*



Figure – Verification

4. Begin to install the Python Libraries

pip3 install RPI.GPIO

5. Use the following command to install adafruit-blinka:

pip3 install adafruit-blinka

To test if Python works, open python in the Raspberry Pi (it should be installed at this point), and write an example file to sample output.

import board  
import digitalio  
import busio  
   
print("Hello blinka!")  
   
# Try to great a Digital input  
pin = digitalio.DigitalInOut(board.D4)  
print("Digital IO ok!")  
   
# Try to create an I2C device  
i2c = busio.I2C(board.SCL, board.SDA)  
print("I2C ok!")  
   
# Try to create an SPI device  
spi = busio.SPI(board.SCLK, board.MOSI, board.MISO)  
print("SPI ok!")  
   
print("done!")

Save it, then run it on the command line by typing

python3 blinkatest.py

The following should be seen

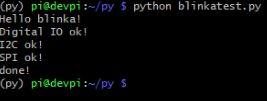


Figure - Blinatest Output

### Code for Sensors

HTU21D-F Temperature/Humidity Sensor:

With the code provided in this repository, this test code should get your sensor to read and write temperature/humidity.

Firstly, though assuming you installed circuit python, all that is required is to run the command line to install HTU21D libraries.

sudo pip3 install adafruit-circuitpython-htu21d

You can copy this code and run it.

```import time import board import busio from adafruit\_htu21d import HTU21D

### Create library object using our Bus I2C port

i2c = busio.I2C(board.SCL, board.SDA) sensor = HTU21D(i2c)

while True: print(": %0.1f C" % sensor.temperature) print("Humidity: %0.1f %%" % sensor.relative\_humidity) time.sleep(2)

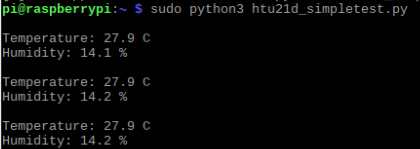
Your output should look like this.  


Figure - Temperature Readings

**0.56″ 4-Digit 7-Segment display:**  
  
For this sensor we want to be able to display the current time. With that python and its libraries need to be installed:

sudo apt-get update sudo apt-get install build-essential python-dev

You would also need python smbus and python-imaging library:

sudo apt-get install python-smbus python-imaging

Clone the url onto your pi and move into it:

git clone https://github.com/adafruit/Adafruit\_Python\_LED\_Backpack cd Adafruit\_Python\_LED\_Backpack

This is the last library you need to install:

sudo python setup.py install

Now go into your file named examples:

cd examples

There are alot of test codes we can use here, but in case we just need our sensor to display the time:

sudo python ex\_7segment\_clock.py

**I2S 3W Class D Amplifier Breakout MAX98357:**  
  
For testing the sensor, the following line was used with the help of internet connectivity within the Raspberry Pi.

curl -sS https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-Scripts/master/i2samp.sh | bash

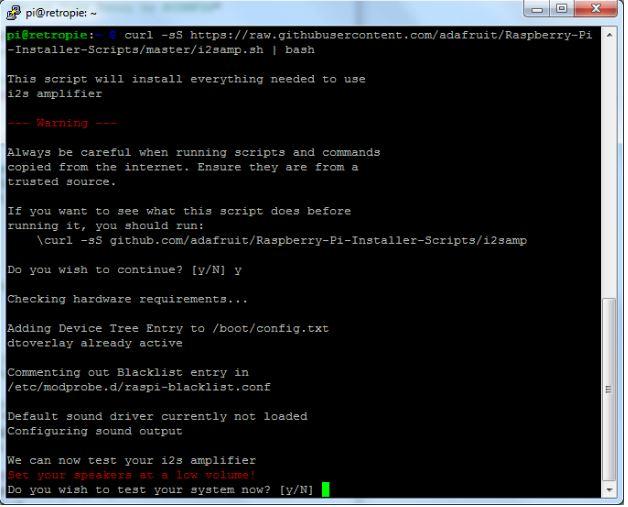
Select yes for the following questions the file asks by typing "y".  


Figure - Permission Screen

The file will ask to reboot. Type "y" again to reboot the Raspberry Pi. When the device is rebooted, type in the same command

curl -sS https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-Scripts/master/i2samp.sh | bash

The script should recognize the device at this point and noise should be coming out of the speaker. To adjust the volume, Alsamixer was used within the terminal. The recommended volume is 50 within Alsamixer.

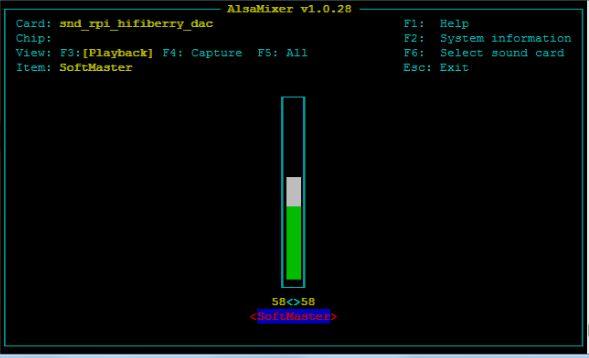


Figure - Alsamixer Volume Screen

Press "ESC" to exit Alsamixer. To actually save the volume settings THE PI MUST BE REBOOTED TWICE, type in the following to reboot the system.

sudo reboot

Start up the Raspberry Pi, type in the following to generate a white noise coming out of the speaker

speaker-test -c2

If real sound wants to be heard, here is a demo

sudo apt-get install -y mpg123 mpg123 http://ice1.somafm.com/u80s-128-mp3 ```

Open another terminal window to access Alsamixer to adjust volume of the speaker.

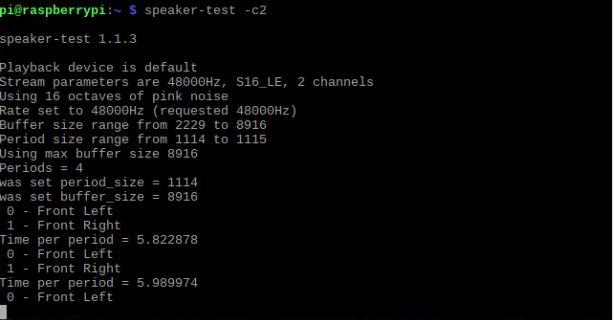


Figure - Speaker Test Output Screen

If errors occur, refer to Adafruit's manual setup:

https://learn.adafruit.com/adafruit-max98357-i2s-class-d-mono-amp/raspberry-pi-usage

### Database Design

The database connection is established and connected to the mobile application. Reading and writing from the sensor to the database are also required. The database utilizes user-authentication to allow maximum security and protection for the user’s information. In order to read and write temperature, the user must be registered using a username and password through authentication processing. Offline mode allows access to the app, without the need to register and login. Offline mode skips user-authentication, and moves the user to the actual app. In offline mode, there will be no form of communications to the database. Therefore, the user is unable to read/write temperature to the database. The database connection works in conjunction with firebase.

### Mobile Application

The mobile application upon startup will provide the login screen. Through user authentication, the application will transfer to the main menu. We designed the user interface to be clean and simple so that it would feel inviting for the user rather than being complex and intimidating. Having the 3 main features of the app (Clock, Alarm, Timer) on the homepage via tab fragments would make it quick and easy for the user to traverse without having to flip through various menus and options. The data that the app uses such as different time zones, alarms, and stopwatch count would be provided by user input so that they could choose whatever they desire. The mobile app also includes a section where it connects to the firebase where it has the temperature readings. In terms of hardware connectivity, the user will be able to set an alarm from the app and that information will then be sent to the database. The alarm data will then be sent to the hardware component, which will ultimately trigger the hardware to go off.

**Test Cases**

Authentication:

This is important as it gives the user access to the database. The first thing they will see is if they can login, for new users they would have to register. If the user attempts to login without registering, a message will appear noting that the account is not registered. The register page consists of an email and password. When the user inputs a incorrect email address such as @email.com, it would not work due to the authentication recognizing that this is not a proper email address. Therefore, the user would have to use either Gmail, Hotmail, Yahoo, etc. Once everything is met, the account is now registered and saved onto the firebase authentication. They can now log in, if any mistakes are made a warning will appear prompting the user that there is a mistake. A successful login message will appear, if they meet all the necessary credentials and they will move on the to the clock screen.

Firebase Read/Write:

In order to read and write to the database, the user first has to be logged in. If the user is in offline mode, they will not be able to read or write to the database. The database is structured so that it will always use the UID as the primary key and then the temperature and timestamp under it. So if a new user saves a temperature, a new structure of their UID, temperature readings, and timestamp will be displayed on the database. This in turn can always have accurate reads of timestamp and temperature for different selected users. When the user creates an alarm profile, it will be saved to the database under their user id along with their temperature values. This then allows the amplifier to receive the database data and act accordingly, in this case having audio play with the alarm condition is met.

Clock Screen Test:

This fragment is shown right after someone logs in, or go in offline mode. You can access this page anytime by clicking the Tab that has a label “Clock” on it. To test the app there are textViews displaying the current time, and the time of the selected time zone. Select a time zone by pressing the spinner, it will show a list of all the available time zones in standard time. Once you pick a time zone, the textView for the selected time should change to the appropriate time. Changing to landscape mode changes the layout design to fit appropriately.

Alarm Screen Test:

You can get to this Fragment by clicking the second tab labeled “Alarm”. At first it should show the text “No Alarm Set” clicking the set alarm button will open up a TimePickerDialog that, on default, should be on the exact time you click the button, you can set the time by picking the hour then selecting the minutes. Or you can change to a different mode to change the alarm manually. After selecting the time, the text view should show “alarm set for \_\_\_” and will send a notification once it reaches the time selected. To cancel the alarm, click the cancel button and the text should change to “alarm canceled”. Changing to landscape mode will retain an appropriate layout design. There is a button at the bottom of the page called hardware which sets an alarm that will communicate with the database and the hardware component, not solely the mobile phone. This will make so the audio that hits when the alarm goes off comes from the amplifier and speaker from the raspberry pi, not the phone.

Stopwatch Screen Test:

The stopwatch can be accessed by clicking the third tab Fragment labeled Stopwatch. In this screen it displays a chronometer for minutes and seconds. If you press the start button it will start to count up. If you press the pause button it will pause the stopwatch at the time, pressing start again will resume the stopwatch. Reset button will reset the time displayed back to 0. landscape has an appropriate design layout.

**Android Components**

Many android components and libraries are used during development of the app, each with their own specific purpose.

Major methods used for general overall use:

* **Intent (this, MainActivity.class)** - this method is often called when switching between screens (Often used with buttons or TextView links)
* **findViewById (int id)** - this method is used frequently to locate and interact with views found from layout resource files that are attached to the current activity
* **toastmakeTest(applicationContext, text, duration) -** this method is used often to send feedback to the user when they do a certain task like logging in.

Main methods for user authentication:

* **signInWithEmailAndPassword -** this method is called when the user gains access to their respective account once the proper email and password are entered
* **getCurrentUser() -** this method retrieves the data from the current user logged into the server, thereby accumulating further input they enter and save to the database

Main methods of Clock Fragment:

* **SimpleDateFormat** - allows you to set and use your own custom date format. Allows you to set the timezone format.
* **Calendar** - It's a abstract class with methods that allow you to set calendar fields such as Year. Month, Day of month, Hour.
* **TimeZone** - represents a timezone offset, you can use getavailableIds to set the spinner widget to display all the time zones.

Main methods of Alarm Fragment:

* **TimePicker** - A widget that allows you to pick a date and time 24h AM/PM, using TimerPickerDialog that displays a dialog to the user to set the time.
* **AlarmManager** - This allows you to schedule your application to be run at some point in the future, using intents to broadcast it. It retains the application when the device is asleep.
* **NotificationManager -** Class to notify the user of events that happen. This is how you tell the user that an alarm has been triggered in the background. You can set vibration, lights, sound, descriptions and the icon. You can also put default intensity settings for vibration or sounds.

Main methods of Stopwatch Fragment:

* **Chronometer** - A class that implements a timer. You can set when the timer should start counting and also change it to a countdown timer.
* **SystemClock** - has access to all timekeeping facilities. The use of this method was to set the chronometer to 0 when you start it, so it started on the system clock time.

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# Status Reports

**Status Report 1:**

Dear Kristian,

The following is the status report for JnJ’s Clockwork:

**Physical Format**

The product will take on a box form factor in the end as it is supposed to replicate a alarm clock that would be on a typical nightstand. The current dimensions of the project are unknown however the max would be 12 13/16" x 6" x 2 7/8" = 32.5cm x 15.25cm x 7.25cm.

**Recent and Current Progress**

Johnson

Fixed few bugs in the application that were still present from last semester. Currently researching how to integrate bluetooth connectivity with the Hardware portion.

Jordan

Recently purchased 2 display screens which we plan on using for the Hardware, 20×4 RGB Backlit LCD display and 1.2″ 4-Digit 7-Segment display. When the products arrive, Jordan will start to work on how to integrate them with the other sensors.

Juan

Created rough schematic and layout for how the hardware device should appear and function. Assisted Johnson in fixing database errors from last semester in the application. Next step is to design the internal layout of the project to determine locations for sensors and wiring.

**Problems and Hyperlinks**

Some problems we have encountered has to deal with the application itself in terms of how to actually display what we want to the screens purchased. Johnson and I are not quite sure what code to implement that would allow such a process to occur. Research is still ongoing so that once the displays arrive, we may attempt a few theories we currently have.

**Financial**

The price for the 2 display screens we recently purchased are as follows:

20×4 RGB Backlit LCD - $32.83 CAD

1.2″ 4-Digit 7-Segment display - $24.93 CAD

More components may be purchased in the future depending on current circumstances.

**Status Report 2:**

Dear Kristian,

The following is the status report for JnJ’s Clockwork:

**Recent and Current Progress**

Johnson

Attempted to connect the temperature sensor to the database. I have proper C code working however in order to simply things, I am trying to get python code to upload to the database. While also displaying a real-time clock on the 7-Segment sensor.

Jordan

Worked with the amplifier and speaker, managed to produce white noise, and is now working on emitting an alarm sound.

Juan

Soldered all the sensors, and has completed all designs for the fritzing diagram. His next step is to print out the PCB, solder, and test it with all connected sensors. Once that is complete, he can move onto creating the casing for the combined hardware.

**Problems and Hyperlinks**

One issue occurred when testing the 7-Segment display, we learned that the display can only take in 3.3v rather than 5v. Because of this the original display screen was short-circuited and a new one had to be purchased. An issue that was discovered with the raspberry pi was it required an amplifier and a speaker in order to emit sound.

**Financial**

The price for the 2 display screens we recently purchased are as follows:

I2S 3W Class D Amplifier Breakout MAX98357- $7.83 CAD

Speaker 3” Diameter 8 Ohm 1 Watt - $2.57 CAD

1.2″ 4-Digit 7-Segment display - $24.93 CAD

More components may be purchased in the future depending on current circumstances.

**Status Report 3**

Dear Kristian,

The following is the status report for JnJ’s Clockwork:

**Recent and Current Progress**

Juan

Printed out the PCB, soldered, and tested with all connected sensors. The next step is to create a case given that the PCB and sensors are all connected to the Pi, and finding dimensions for the alarm case. The dimensions of the alarm box are not yet determined, but will fall under the maximum dimensions of 12 13/16" x 6" x 2 7/8" = 32.5cm x 15.25cm x 7.25cm.

Johnson

Got the temperature sensor to connect with the database. He is now managing to add more python code into the data. Johnson is now working on displaying the temperature readings that are stored in the database to the application itself and also sending timer instructions to the raspberry pi.

Jordan

I got actual sound coming out of the speaker through the amplifier. An alarm sound has been emitted . Currently working with Johnson on triggering the alarm sound from data taken through the database by using python.

**Problems and Hyperlinks**

A problem occurred while soldering the PCB. We were measuring each pin and via with an ohm meter to identify its connection, and we came upon some vias that were not soldered accordingly. Another PCB had to be printed and soldered, while acquiring more pin sockets from the prototype lab. When the 7-Segment digital display was connected to the PCB, a problem occurred where the i2c would detect every single address from the sensor. A 4.7k ohm resistor was implemented into the IO slot to acquire the specified address. However, the same situation applies where the sensor displays every single address from the sensor; this only happens for the display screen and not the other sensors.

**Financial**

Nothing has been purchased lately as we retrieved pin sockets from the prototype lab.

More components may be purchased in the future depending on current circumstances.

**Status Report 4:**

Dear Kristian,

The following is the status report for JnJ’s Clockwork:

**Recent and Current Progress**

Johnson

Has full database connections with the temperature sensor and is able to get its readings from firebase to the android app. Also assisted Jordan with alarm functionality. Currently is researching on how to get the pi to start up and have its applications run automatically.

Jordan

Created an activity in the android app to get the user to send its alarm settings to firebase, the hardware is able to detect and read the set alarm. He will also attempt to implement multiple alarm ringtones and volume control from the android app.

Juan

Updated the GitHub to provide its current version of android code. Is still working on the enclosure. He continues to work on the report in terms of the app build details and has included the build instruction, status reports, and illustration to the report.

**Problems and Hyperlinks**

One of the issue we encountered was with the display screen. When we originally used the PCB to connect the display screen, the screen would output all i2c numbers and would no longer run. We had this issue with 2 screens that we purchased prior. As a solution we decided to get a 0.56” 7-segment display screen instead of a 1.2”. Thankfully the 0.56” had the exact same pins as the 1.2” except for the IO pin and also was on Amazon so it came in fast. In terms of the amplifier, Jordan encountered an issue where the amplifier was unable to output sound when the alarm is supposed to go off. Jordan is still working on this issue and will hopefully have this issue resolved by the weekend.

**Financial**

The price for the display screen we recently purchased are as follows:

Adafruit 0.56" 4-Digit 7-Segment Display w/I2C Backpack White [ADA1002] - $30 CAD

More components may be purchased in the future depending on current circumstances.

**Status Report 5:**

TBD

## Problems Encountered

During the development of this project, we ran into many problems and roadblocks which halted progression and created extra hurdles for us to overcome. These ranged from database communication errors to hardware malfunctions.

In terms of hardware failure, we initially wanted to work with a 1.2” 4 -digit 7-segment display from adafruit. The display used the same pins as the 0.56” model besides an IO pin which is required to be plugged into either 3.3v or 5v depending on the processor being used, in this case being a raspberry pi 3 B+. We purchased the display and got it to output the current time as desired, however upon second boot up, the display stopped being recognised and no longer functioned. Upon checking for the failure point, we came to the conclusion that the display short circuited due to the IO pin being plugged into 5v rather than 3.3v. 5v only works for processors such as arduinos, and not really stable with raspberry pi’s. With this knowledge, we purchased the same display and used used the 3.3v pin instead, however it resulted in the same conclusion. The display appeared to short circuit again. We could not figure out the reasoning behind it and could not afford to waste time ordering a new one. We also encountered issues with the PCB board that was created in terms of soldering, where the pins connecting the Pi to the board (20xpins) were improperly soldered, resulting in the the sensors not receiving any current.

When it comes to the database, one issue we encountered was that we weren’t able to get the temperature readings to send to the firebase. This is due to the rules of firebase that are automatically implemented when starting a project. The rules of read/write are set to where authentication is required. The problem lies where we weren’t aware of this ruling and therefore was unable to send any sort of data to the firebase.

When working with the application itself, there were many instances where a (R.) error code occurred in android studio. This had to do with strings that were created upon making new xml and java pages that had similar or identical ids.

## Solution

For hardware, we decided to purchase a similar display to the one that kept malfunctioning, the 0.56” model which lacks an IO pin as that seemed to be the issue with the bigger variant. All other pins are the same which made readjustments simple. This completely fixed the issue and we were able to have the sensor display the time without it short circuiting. In terms of PCB, we needed to remake and solder the board as the old one was well beyond repair.

The database issue was resolved by setting the rules to true. This allowed all access to read and write to firebase. This was not clearly evident at the start, hence why it took longer than anticipated.

In order to fix the (R.) issue, we need to navigate to the strings.xml file and check change string ids that were the same. This did not always fix the error initially however, a successful reboot would clear the errors that were still present.

# Conclusion

In Conclusion, JnJ’s Clockwork is a android based project designed to give users ease of access to anything time related in a simple and clean form factor. The project consists of mainly layers in order to function as designed. It utilizes 3 distinct sensors being the 4-digit, 7 segment display, Humidity/Temperature sensor, and audio amplifier. All sensors communicate with our database in firebase which allow interactivity with the android app. Users have the ability to create alarm profiles, set different time zones, create stopwatches, and view/save local temperature readings all in one condensed form factor.

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# Recommendations

# Bibliography