Smart Pillow

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Team 50

The Team

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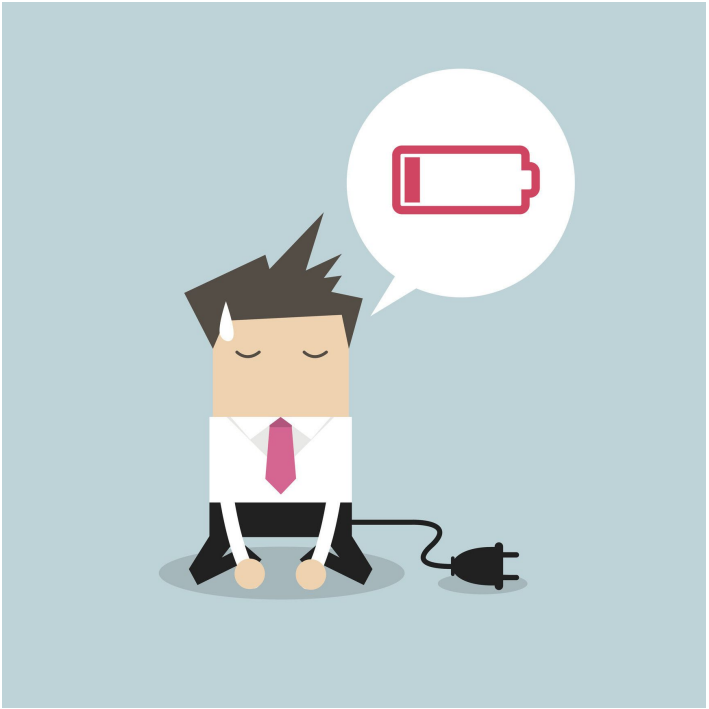
Problem Statement

- Recent deterioration in sleep quality
- Increasing fatigue
- Signs - Snoring, moving
- Inadequate current solutions

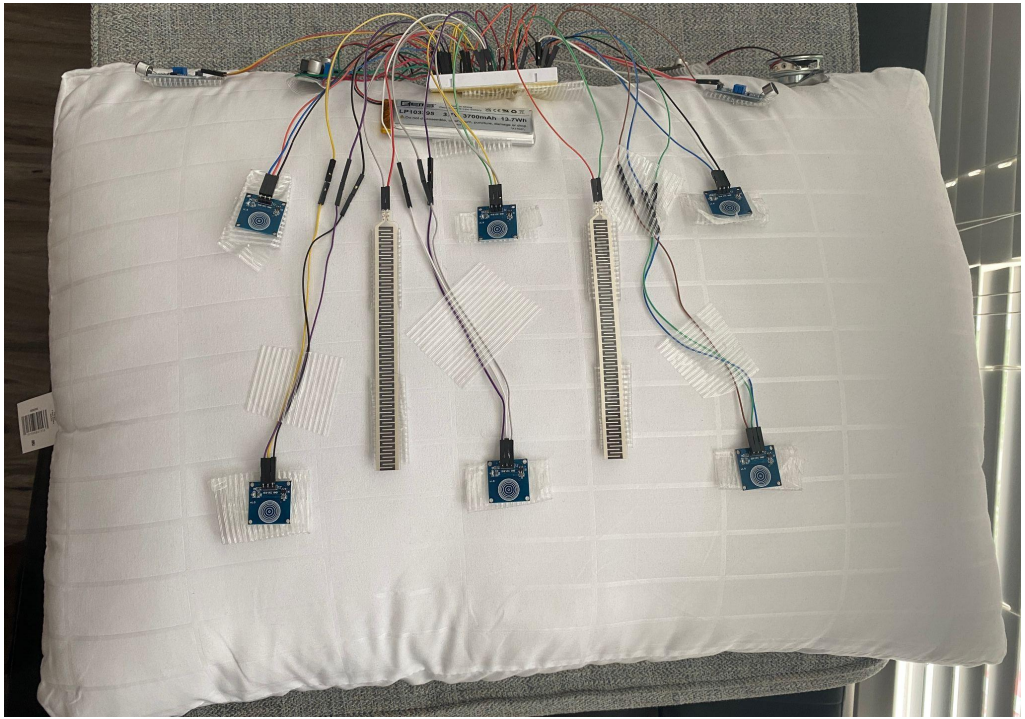


Proposed Solution

“SMART PILLOW”

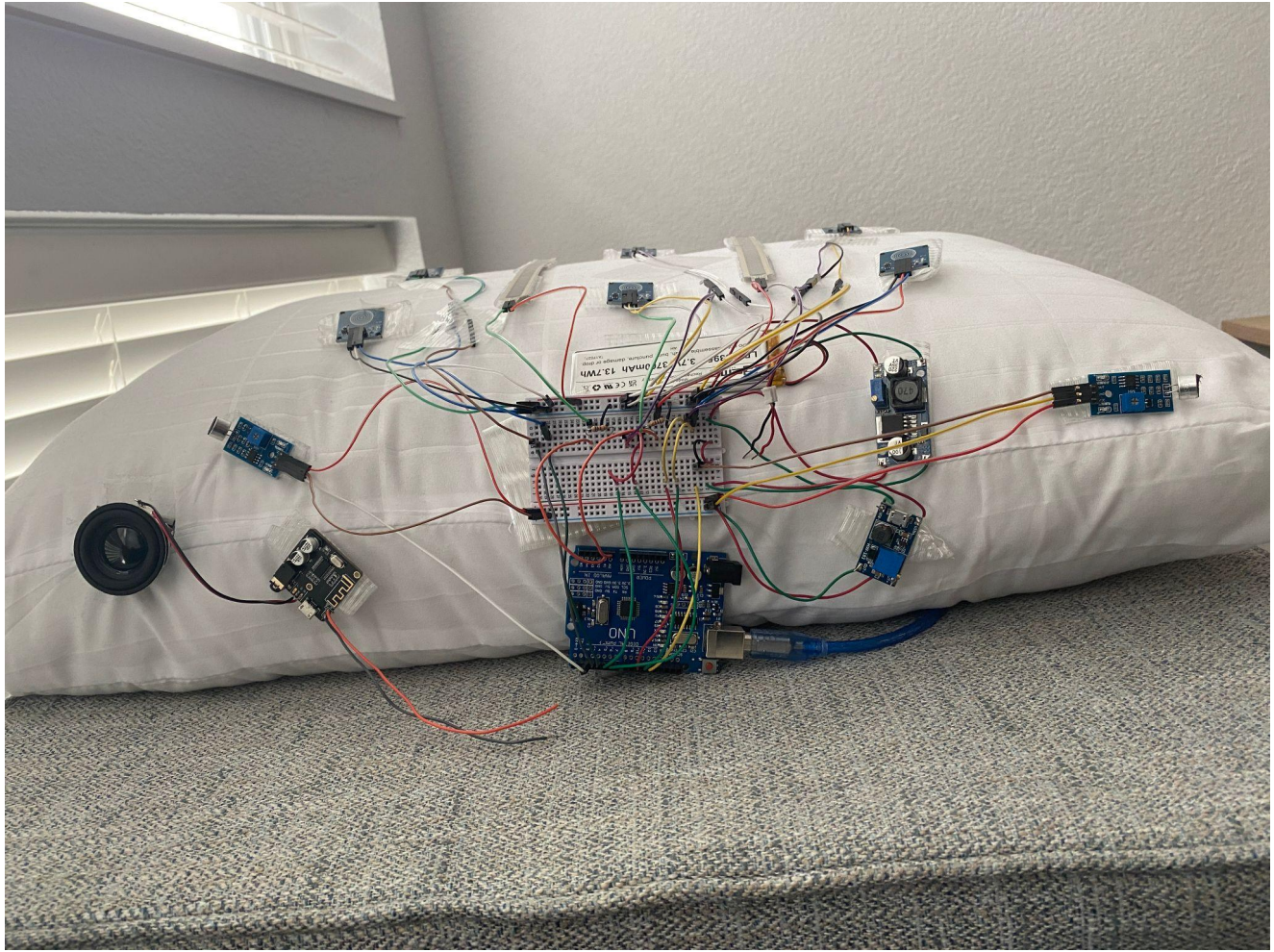
Aims to detect:

- Position
- Motion
- Snoring

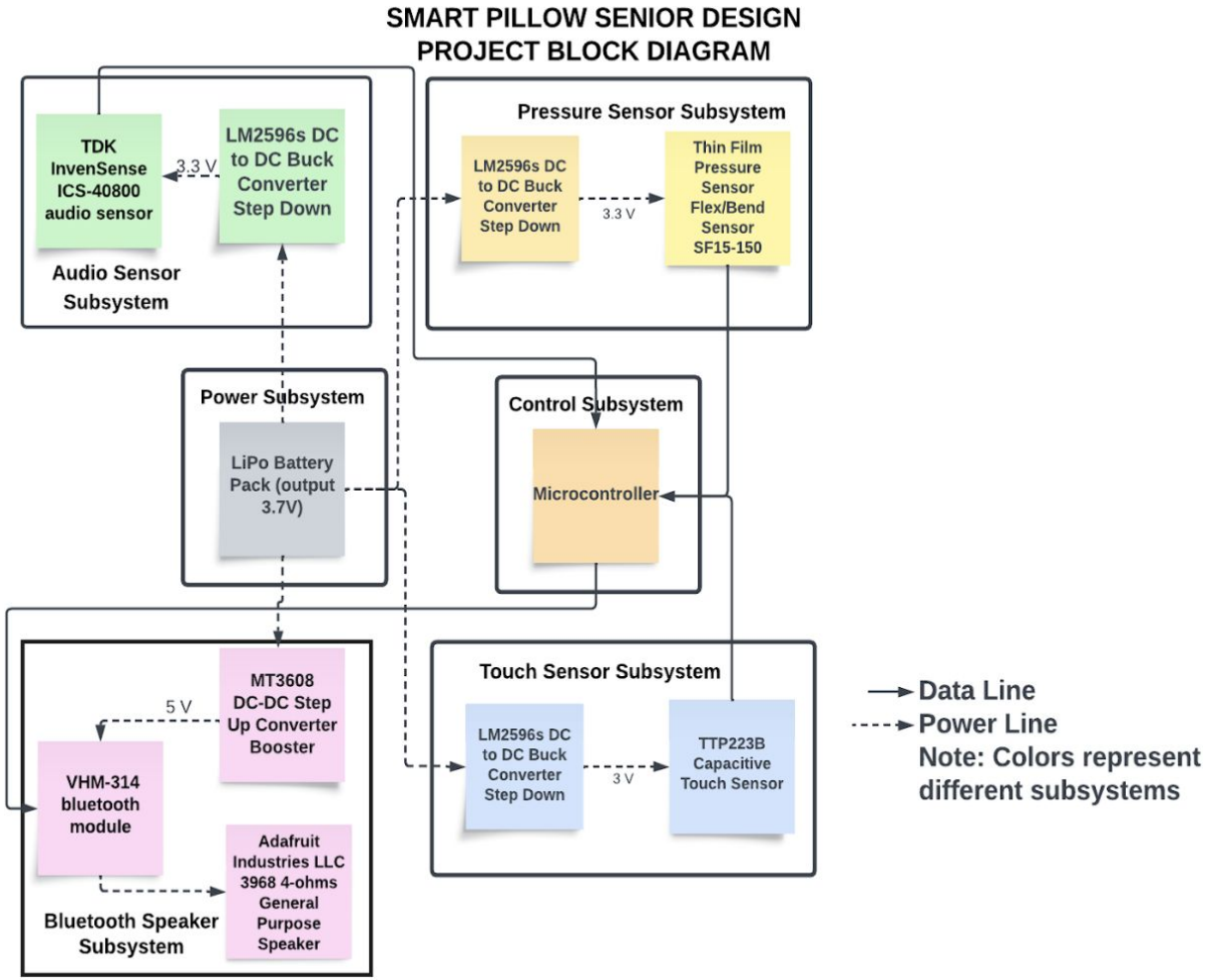


High-Level Requirements

1. The pillow should be **able to detect motion when the person is in contact** with the surface of the pillow.
2. There should be **no interference in the data** collected by the sensors from other components of the pillow.
3. The pillow **should be comfortable**, which means that the user should not be able to feel the sensors when they touch their head to the top of the pillow
4. The **front and back of the pillow should be clearly differentiated** so the data from the pillow is actually usable.

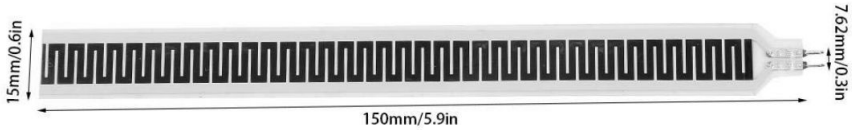

UNO

Subsystem Overview



Pressure Subsystem

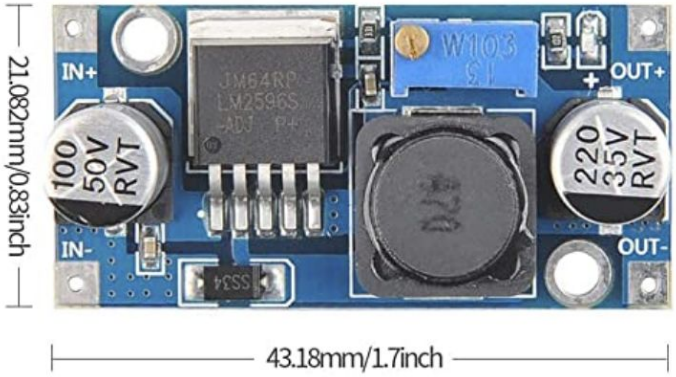
- Used to detect high head pressure indicating poor sleep/change in position



Thin Film Pressure Sensor

- Consists of 2 thin film pressure sensors and a DC to DC step down Buck converter

- Step down converter to convert 3.7V to 3V



DC to DC step down Buck converter

Requirement and Verification

Requirement	Verification
The thickness of the sensor should not exceed more than 7.62mm to ensure comfort while sleeping	Thin film pressure sensors were used
The distance between each pressure sensor should be 120.11 mm to ensure accurate reading of the head position	Distance between the pressure sensor was recorded and placed accordingly

Power Subsystem

- Consists of a Lithium Polymer battery
- Supplies 3.7V to the remaining subsystems
- LiPo batteries are commonly used in medical devices due to their lightweight and safety

Lithium Polymer Battery

Requirement and Verification

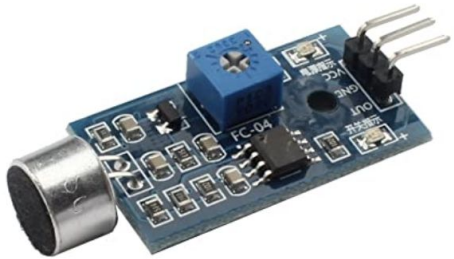
Requirement	Verification
Must supply 3.7 Volts	Measure the output voltage of the DC power using Multimeter
To ensure comfort, the dimensions should be 35x100x15 mm and should weigh less than 80g.	Lithium Polymer battery pack was used after looking at the dimensions and the weight: 33.5x96x10.3 mm and weighs 74g.

Audio Subsystem

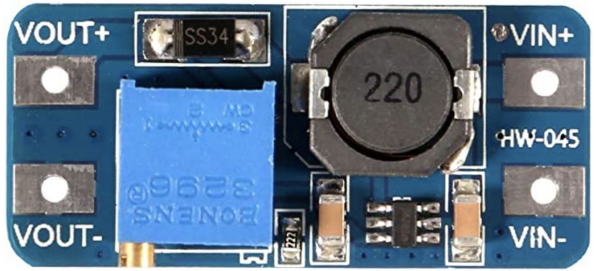
- Made up of two high sensitivity audio sensors and a DC-DC voltage step up converter.

- Used to detect sounds such as snoring from the user

- Step up converter is used to step up 3.7V to 5V



High Sensitivity Audio Sensor



DC-DC voltage step up converter

Requirements and verification

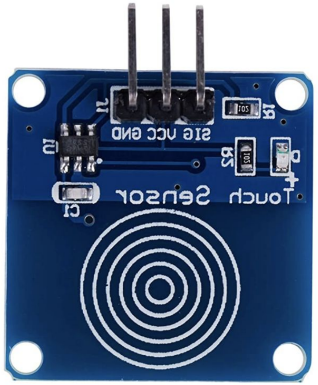
Requirement	Verification
Dimensions of each sensor should be within the following: 5x5x1 inches and weigh less than 1 ounce.	2 High Sensitivity Sound Microphone Sensor which have the following dimensions: 4 x 4 x 0.5 inches and weighs 0.63 Ounces
Speaker doesn't interfere with the audio sensor	10 s delay between noise and next data collection

Touch Subsystem

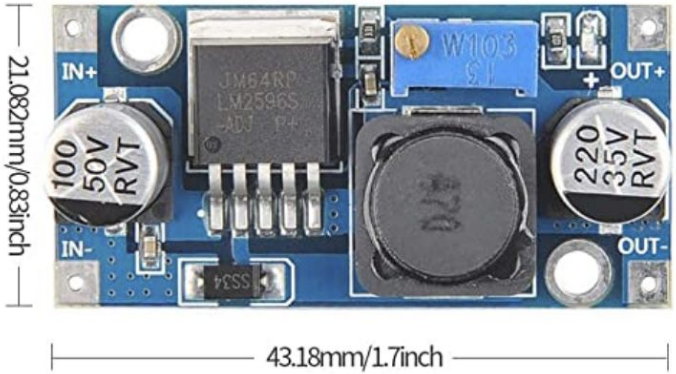
- Consists of six HiLetgo touch sensors and a DC to DC step down Buck converter

- Used to determine the various head positions of the user

- Step down converter to convert 3.7V to 3V



HiLetgo Capacitive Touch Sensor



DC to DC step down Buck converter

Requirements and Verification

Requirement	Verification
Dimensions of each sensor should be within the following: 24x24x7.2 mm	To ensure the size of the sensors, we compared the thickness and dimensions of different types of touch sensors available and decided to go with the touch sensors that match our requirements.
Must be at equal distance from a pressure sensor on either side: must at 60 mm from a pressure sensor	Distance was measured and sensor was placed accordingly
The 6 sensors should detect sleeping positions	Determined by checking how many and which sensors are turned on depending on the head position

Speaker and Bluetooth Subsystem

- Consists of the bluetooth board, speaker and a DC-DC voltage step up converter

- The speaker is used to play white noise

Adafruit industries 3968 speaker

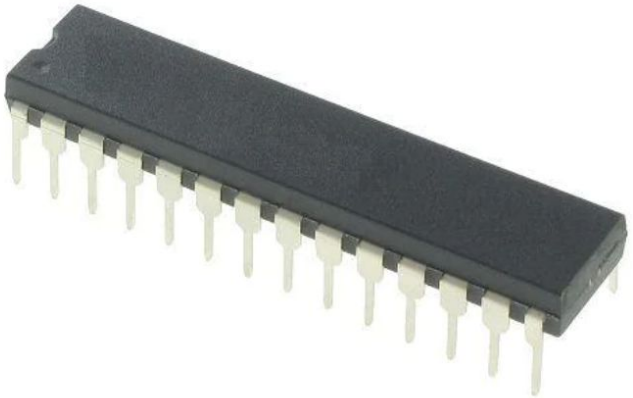
VHM-314 Bluetooth Board

Requirements and verification

Requirement	Verification
Limited to the sum of size dimensions 45x45x40mm	The speaker is just 36x17x14mm, the VHM-314 is 3x3cm
Ability to work with the audio sensor, switching it off within 1 minute of the audio sensors being used	We were able to ensure this was the case through our code
Cross device connectivity enabled by Bluetooth 5.0	VHM-314 offers Bluetooth 5.0 connectivity

Control Subsystem

- ATmega328P microprocessor: Responsible for collecting data regarding head positions, head pressure, and snoring.



ATMEGA328P Microprocessor

- Data processed to determine bad sleep

- Triggers bluetooth speaker

Requirements and verification

Requirement	Verification
Must be able to determine if the user is snoring	If the sensor value is 1 or more then the user is determined to be snoring.
Must be able to determine if the user is changing positions every 30 seconds	If we receive data from all touch sensors, the person is determined to be changing positions.
Must be able to determine if the user isis applying high pressure on the pillow	If the pressure detected is above 1100, this implies high pressure on the pillow.

Data Reading Code

```
6   current_time = datetime.now()
7   print("The current date and time is:", current_time)
8
9   arduino_port = "COM3" #serial port of Arduino
10  baud = 9600 #arduino uno runs at 9600 baud
11  fileName="analog-data3.csv" #name of the CSV file generated
12
13  ser = serial.Serial(arduino_port, baud)
14  print("Connected to Arduino port:" + arduino_port)
15  file = open(fileName, "a")
16  print("Created file")
17
18  #display the data to the terminal
19  getData=ser.readline()
20  dataString = getData.decode('utf-8')
21  data=dataString[0:][:-2]
22  print(data)
```

Obtaining Real Time Value

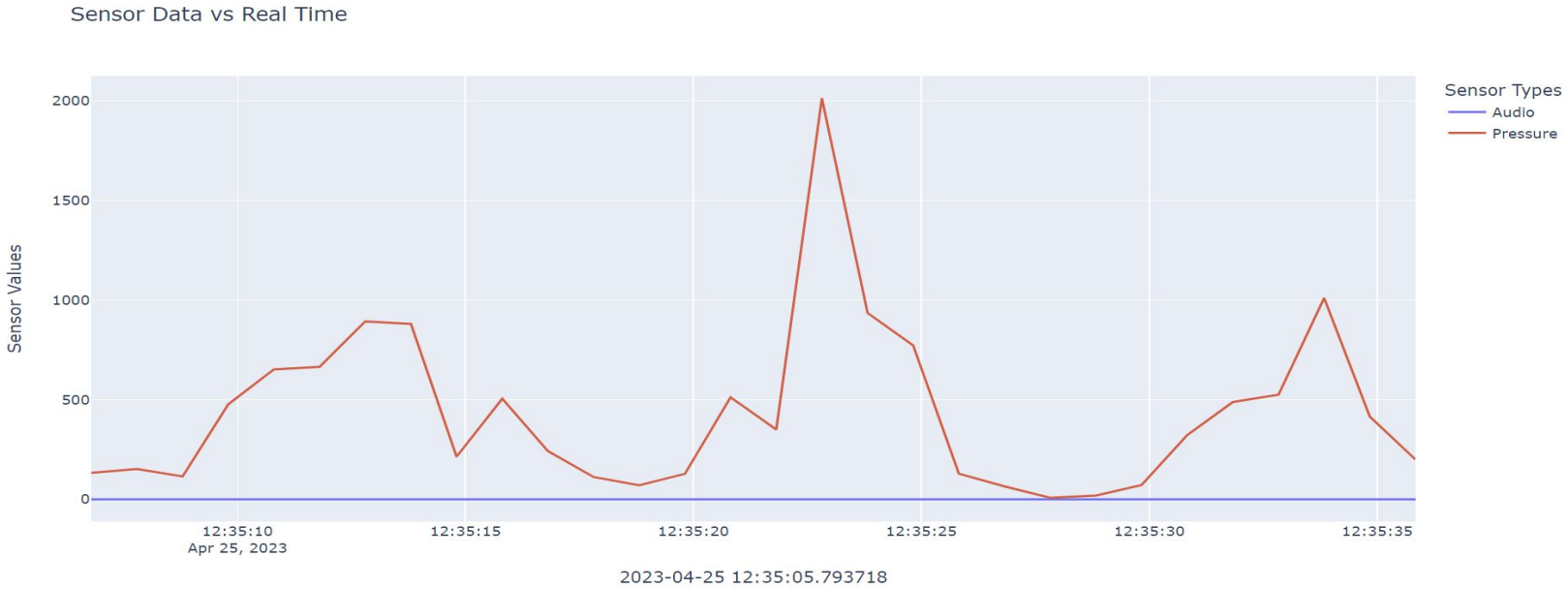
```
27    long currentTime = millis(); // Get current time
```

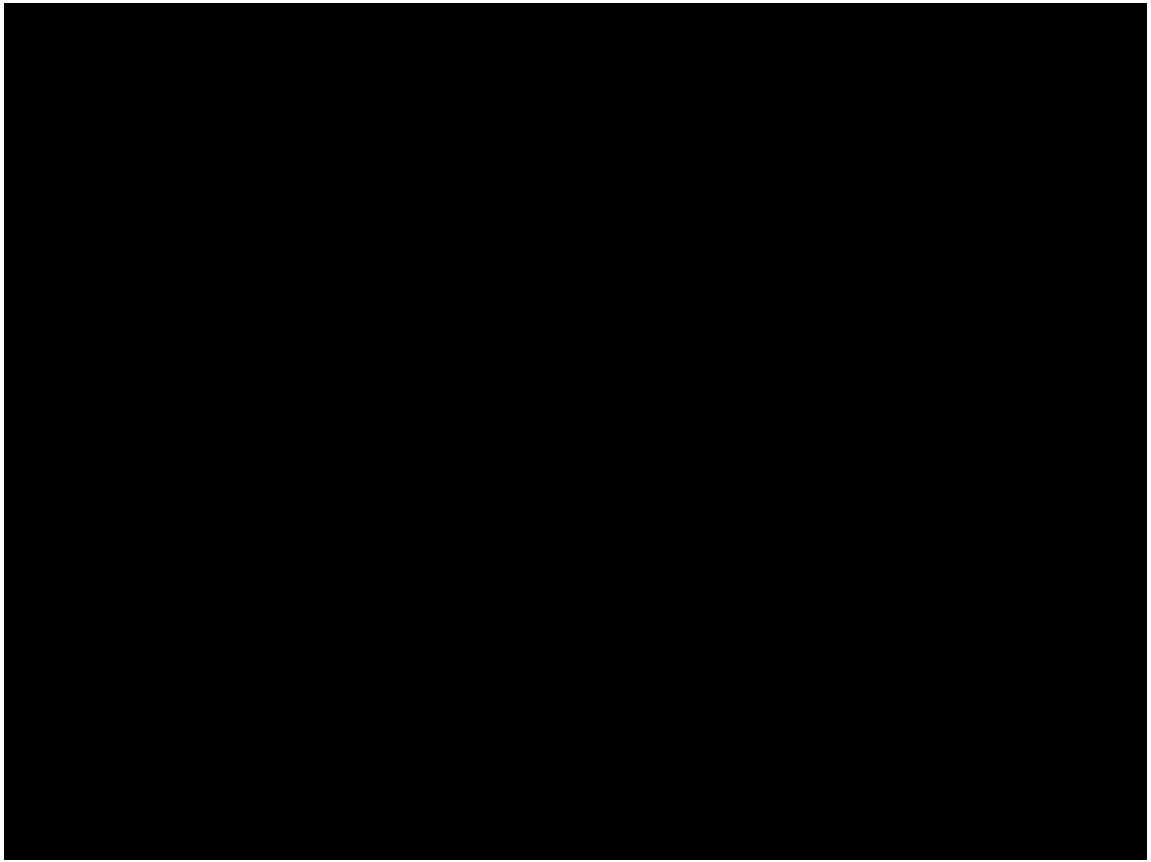
```
38  while line <= samples:
39      getData=ser.readline()
40      dataString = getData.decode('utf-8')
41      data=dataString[0:][:-2]
42      print(data)
43
44      readings = data.split(",")
45      print(readings)
46
47      readings[0] = current_time + timedelta(milliseconds=int(readings[0]))
```

Pressure Data Collection Process

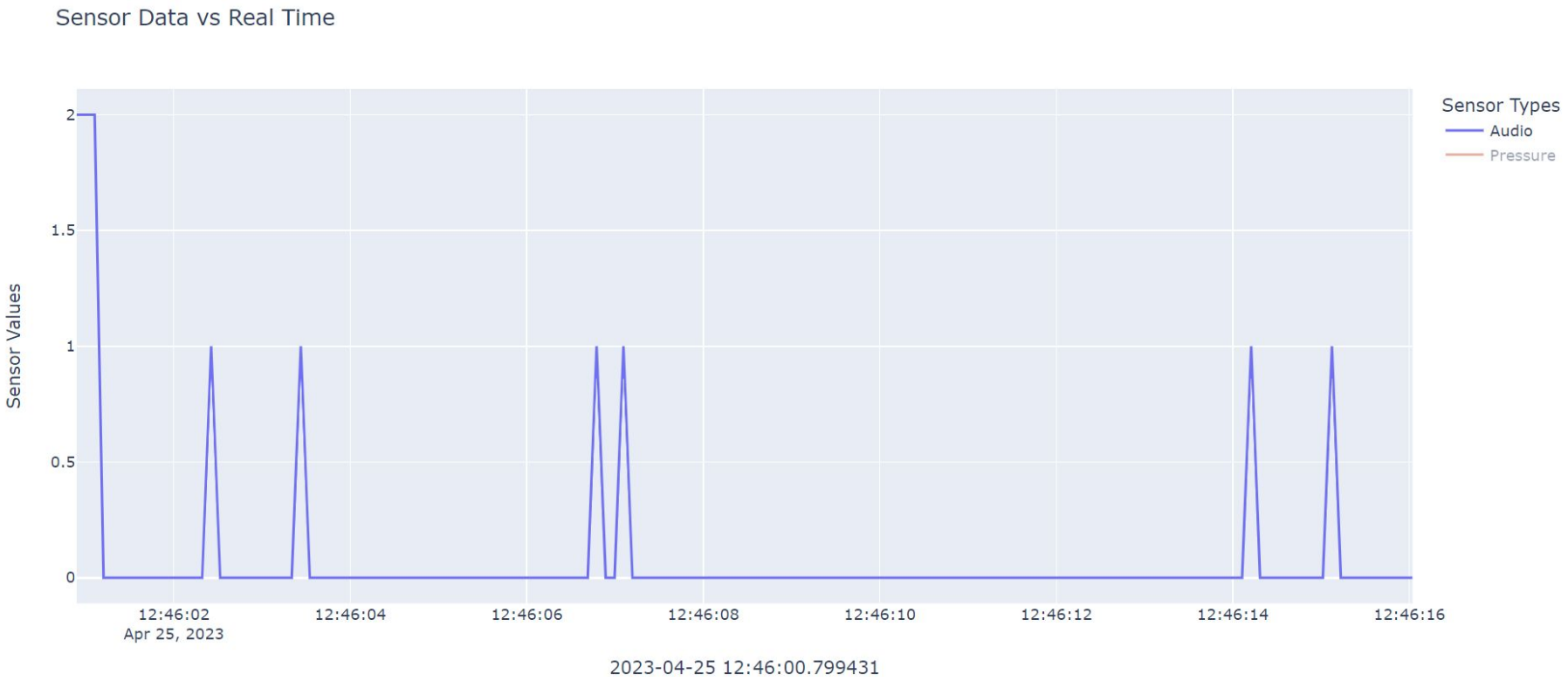
- Pressure data is used to determine when to play white noise

```
49      if ((int(readings[9])+int(readings[10]))>1300):
50          winsound.PlaySound('white_noise.wav', winsound.SND_FILENAME)
```



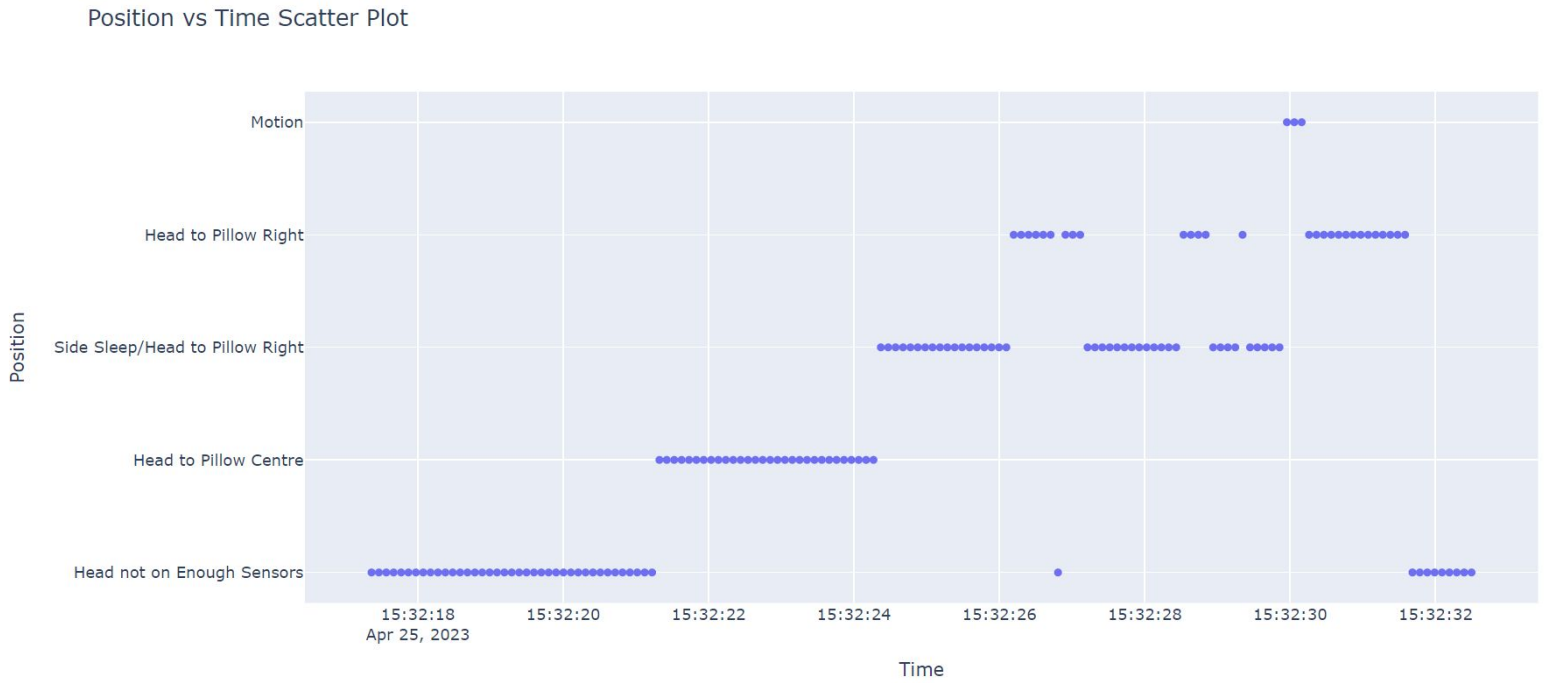


Audio Data Analysis



Positioning Readings

- Utilizes data from the touch sensor to determine the head position



Conclusion

Ethics and Safety

- Used LiPo battery
  - Biologically better
- Low voltage system
  - Less hazardous
- Open wiring
  - Solution: Foam Casing

Problems faced

- PCB soldering and parts delay
- Budget issues - lesser and cheaper sensors
- No wifi access for real time

Summary

- We were able to get real time data from all the sensors which allowed the microcontroller to trigger the bluetooth subsystem when required

- All the sensors gave us reliable and accurate data

- The project met all the high level requirements

Future Plans

- Add a thick foam layer on top of the wires on the breadboard
- Cover the pillow with a thick pillow case with a foam lining
- Move the breadboard to the PCB to avoid large chunks of wires

THANK YOU