Healthy-Gamer
In-Progress Review Follow-up Report

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Objective

The objective of this document is to provide an update to the second progress report presentation. In this document we will go over what changes we made in our healthy-gamer project in order to provide more accurate health readings. We will also go over what we plan on doing for our test case as well as what each member will do for the rest of the semester.

Fixes

One of the major issues that was raised during our presentation was that we were reading a user's surface temperature and not their internal body temperature. After doing some further research we found that the Thermal Resistor that we are using for our experiment can be used to read a user's internal temperature. In order to read the user's internal temperature we had to make some code changes in our project so that the sensor could read internal temperature. We also had to change the resistor value that was in series with the temperature sensor in order to change the amount of voltage that the sensor receives. A picture of our temperature reading when compared to a thermal gun can be found in the Validation of Sensors section.

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Another question that arose was why we were using 90 degrees instead of 360 degrees for the wrist angle. We are using the reference angle (90 degrees) because our testing device, as seen on page 4, uses the reference angle. So we just set up our environment to match our testing equipment for easy validation.

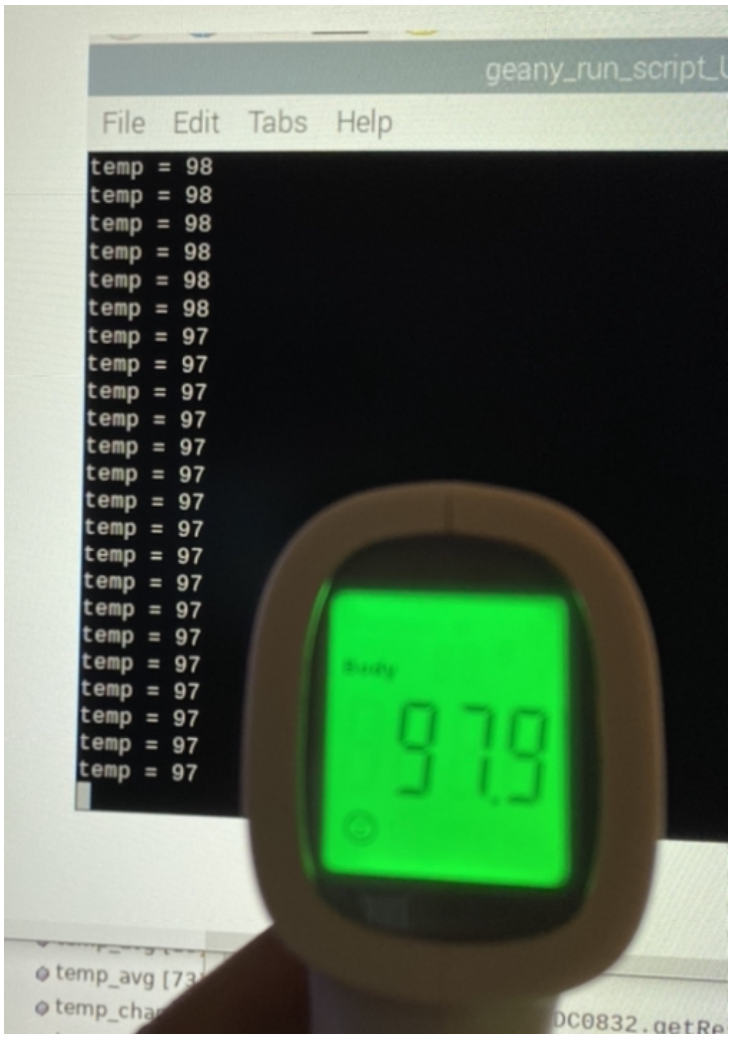
Another issue that came up in our presentation was the HRV value not being consistent. The HRV value is what we plan on using in order to determine if a person is experiencing some form of stress.When we were first presenting our data the HRV value would spike from 50 to 100 within a short amount of time even though the heart rate value was normal. This error was caused by a code error where we were inputting the wrong data into the HRV method. Another issue that caused the HRV value to be wrong was due to the heart rate sensor that we were originally using for our project. The heart rate sensor at times would read a value of zero even though we were touching it. After reading a value again the HRV would calculate the change of the heart rate from 0 to 80 thus spiking up the HRV value. When we were first trying to debug the issue of why the heart rate sensor wouldn't read our heart rate from time to time we couldn't find any issues with the PCB wiring or the code that we implemented. After some further research we found out the sensor we were using was a knock off and because of that we were receiving inaccurate values from time to time. After replacing the heart rate sensor with a new one we were able to fix this issue and are now able to read a user's bpm in a consistent manner. We have also implanted a design change where the heart rate sensor will be placed on the user's finger tip instead of their wrist. This is due to the fact that we are able to more accurately read a

user's heart rate if we are collecting the data from a fingerprint rather than their wrist. A picture of our BPM reading when compared to an apple watch can be found in the Validation of Sensors section.

Validation of Sensors:

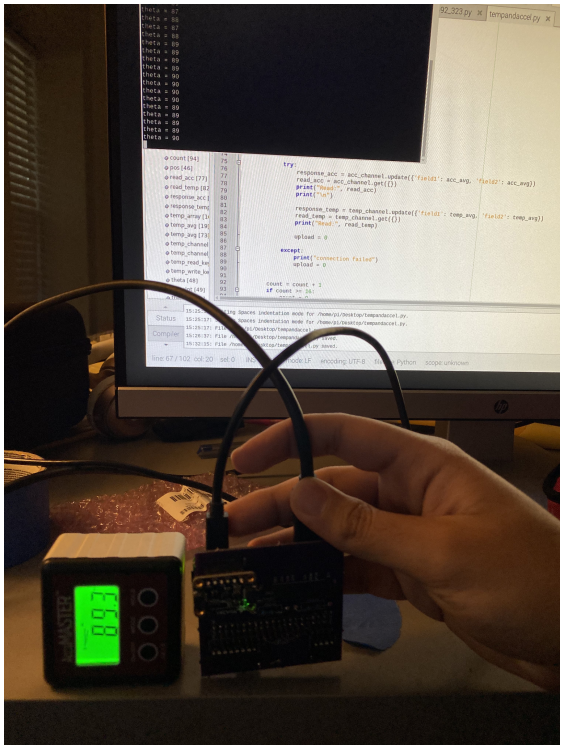
Here we are testing out our sensors implemented in our project with other instruments in order to show our sensors validity.

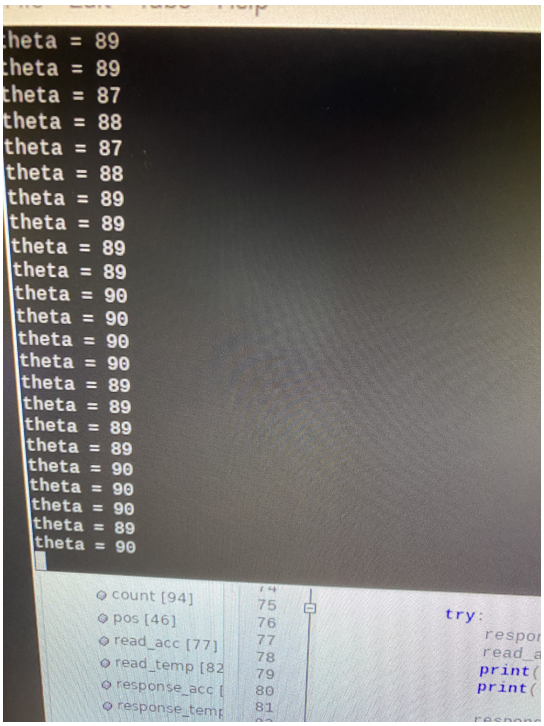
Temperature Sensor



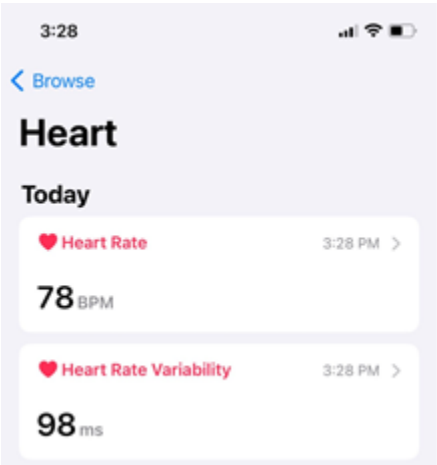
Heart Rate Sensor

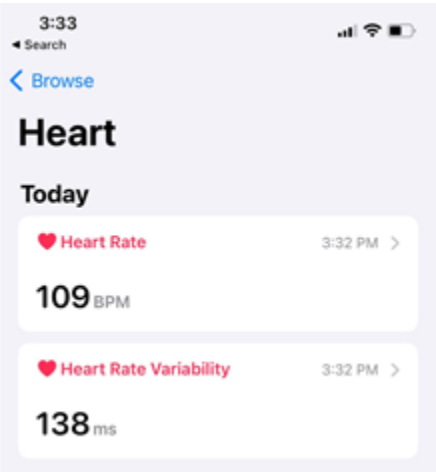
Angle Sensor





HRV: Resting and Active Data from Apple Watch Health App for iPhone





Extended BPM-HRV values from the App from different points and people

bpm	hrv	
84	93	
75	116	
82	98	
82	100	
87	129	
80	111	
86	123	
82	50	Dad
76	80	Mom

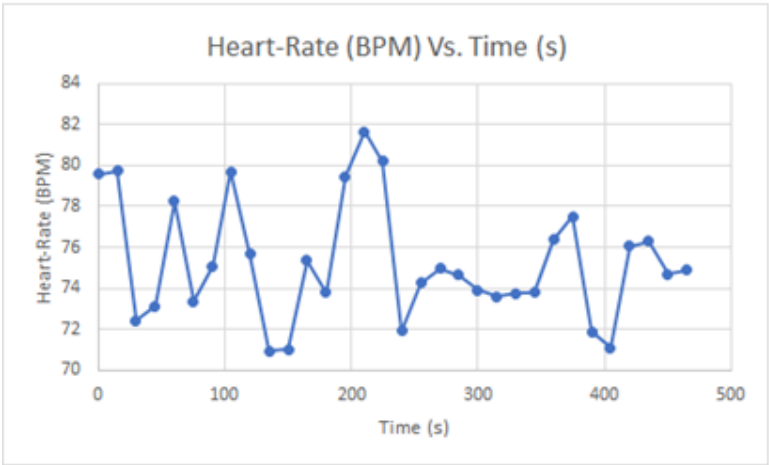
Data

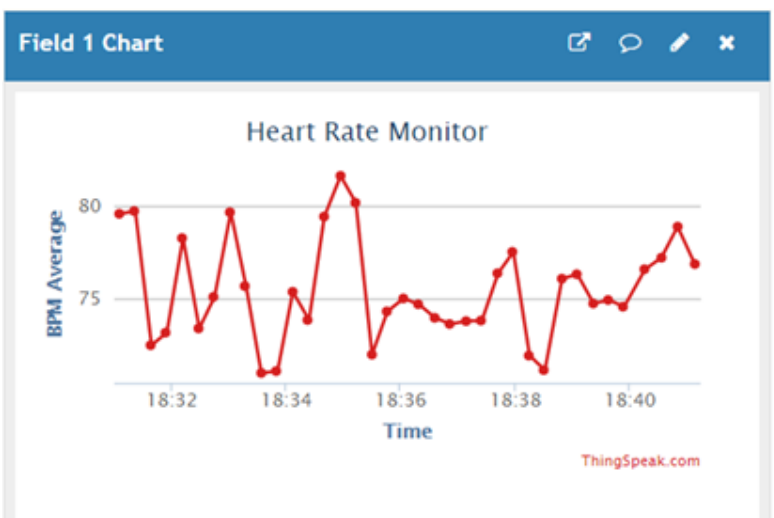
Another critique that we were given in our presentation was that we didn't have enough data points in order to show that our device was reading reliable data. Taking this critique and the changes we made on our device we decided to test our device over two different time periods that lasted from 7-8 minutes. In the first test that we conducted we took a user's health reading while they were sitting down and the other health reading while they were performing squats. The health data that was recorded over both of these sessions can be found in the below pictures. The data on the graph show the average health reading of a user every 15 seconds. The reason it is showing the average is because ThinkSpeak can only update every 15 seconds. So rather than having 1 data point be sent every 15 seconds we decided that it would be better to have a collected average of data being uploaded insead.

Sensor data over 8 minutes while sitting:

We have both the thingspeak graphs and excel graphs as excel graphs are easier to read, but they are the same exact sets of data

Heart-Rate while sitting:

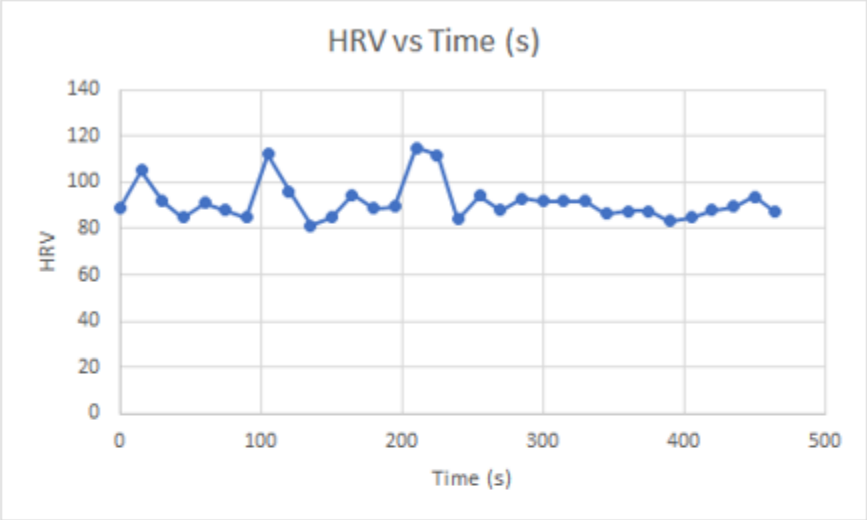




Heart-Rate Data Points

Time (s)	Heart-Rate (BPM)
0	79.58862422
15	79.7397517
30	72.44191913
45	73.12710946
60	78.26615027
75	73.35511311
90	75.07023297
105	79.67205186
120	75.65696528
135	70.9333985
150	71.03661065
165	75.34548773
180	73.81394063
195	79.4377324
210	81.65254143
225	80.19155642
240	71.93292296
255	74.27896645
270	74.98497965
285	74.67022893
300	73.93054186
315	73.59651174
330	73.75233956
345	73.78435302
360	76.35580281
375	77.51898488
390	71.87749611
405	71.09118808
420	76.06004412
435	76.30107182
450	74.71129491
465	74.90234644

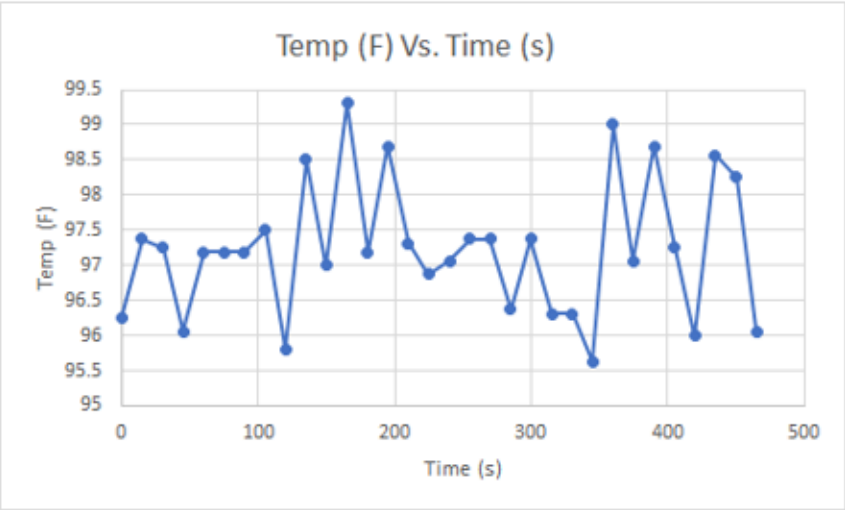
HRV data while sitting:

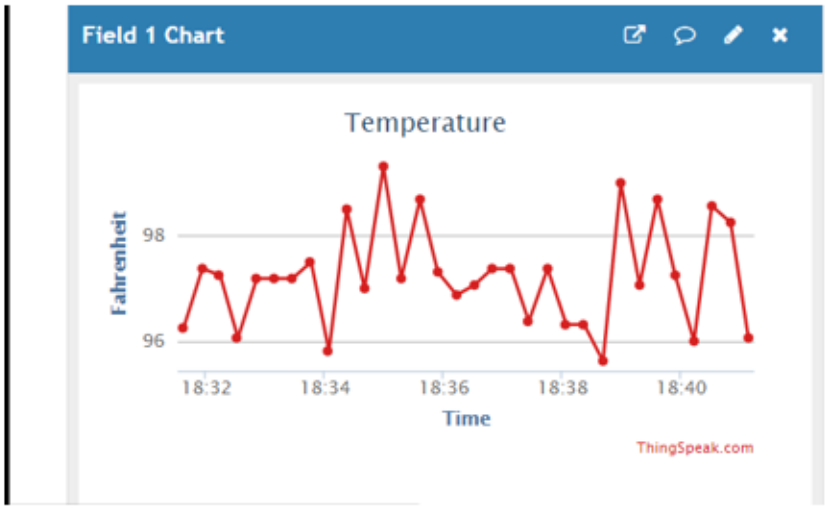


HRV data points

Time (s)	HRV
0	88.787
15	104.9306
30	91.76079
45	84.88482
60	90.91426
75	87.93025
90	84.85838
105	112.2499
120	96.04476
135	81.31924
150	84.69643
165	94.42436
180	88.7514
195	89.58774
210	114.7773
225	111.9291
240	83.98534
255	94.16948
270	87.79375
285	92.8586
300	91.87665
315	91.64409
330	91.84467
345	86.49378
360	87.69873
375	87.42036
390	83.13074
405	84.68253
420	88.10121
435	89.36811
450	93.66251
465	87.00172

Internal Body Temperature while sitting:

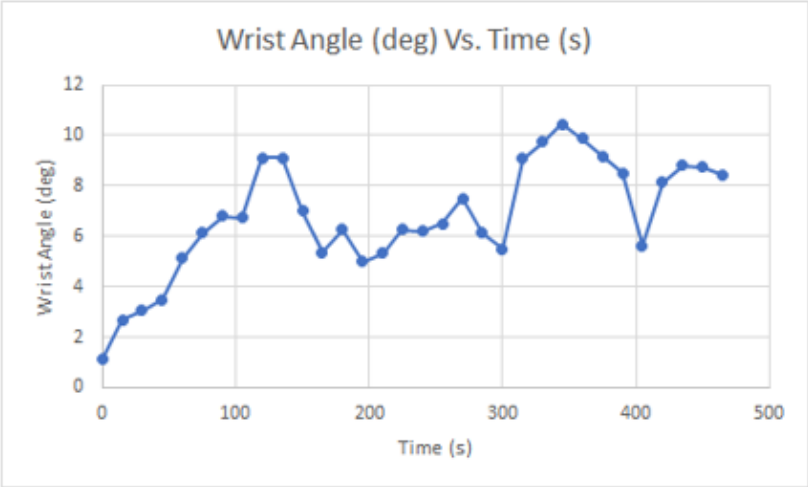


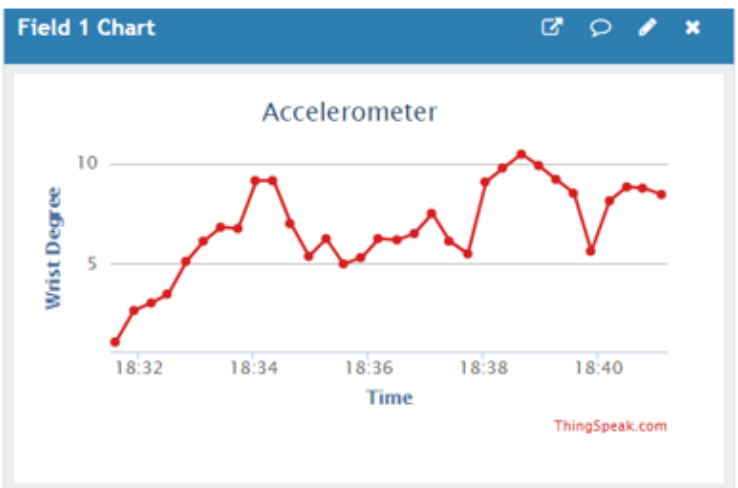


Temp data points

Time (s)	Temp (F)
0	96.25
15	97.375
30	97.25
45	96.0625
60	97.1875
75	97.1875
90	97.1875
105	97.5
120	95.8125
135	98.5
150	97
165	99.3125
180	97.1875
195	98.6875
210	97.3125
225	96.875
240	97.0625
255	97.375
270	97.375
285	96.375
300	97.375
315	96.3125
330	96.3125
345	95.625
360	99
375	97.0625
390	98.6875
405	97.25
420	96
435	98.5625
450	98.25
465	96.0625

Wrist Angle while sitting:





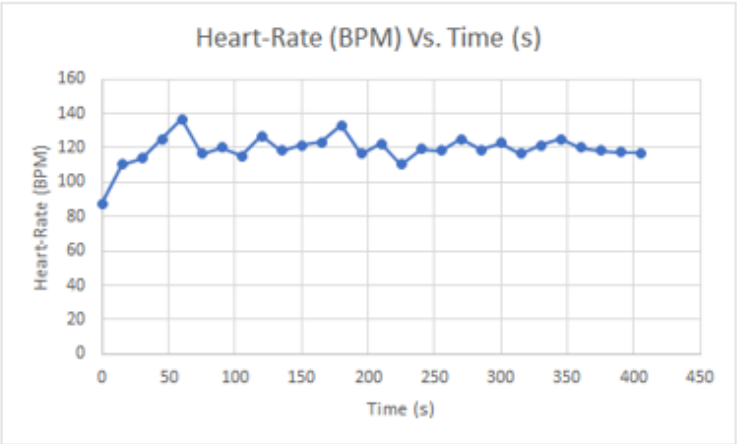
Wrist Angle Data points

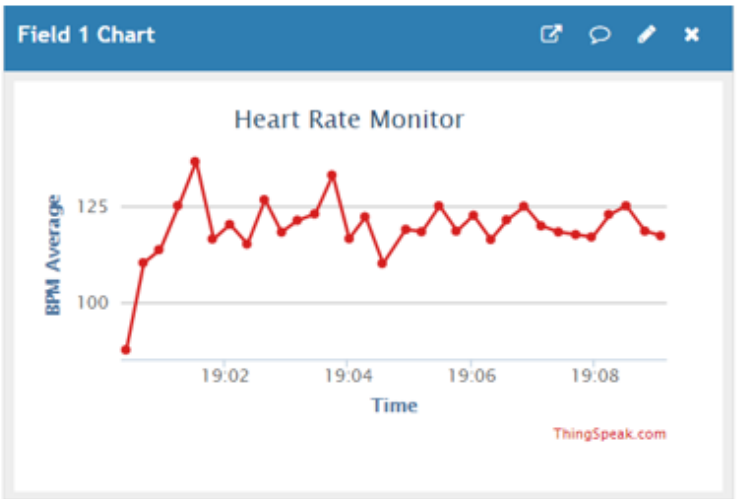
Time (s)	Wrist Angle (deg)
0	1.125
15	2.6875
30	3.0625
45	3.5
60	5.125
75	6.125
90	6.8125
105	6.75
120	9.125
135	9.125
150	7
165	5.375
180	6.25
195	5
210	5.3125
225	6.25
240	6.1875
255	6.5
270	7.5
285	6.125
300	5.5
315	9.0625
330	9.75
345	10.4375
360	9.875
375	9.1875
390	8.5
405	5.625
420	8.125
435	8.8125
450	8.75
465	8.4375

Sensor Data over 7 Minutes while Exercising:

We have both the thingspeak graphs and excel graphs as excel graphs are easier to read, but they are the same exact sets of data

Heart-Rate while exercising:

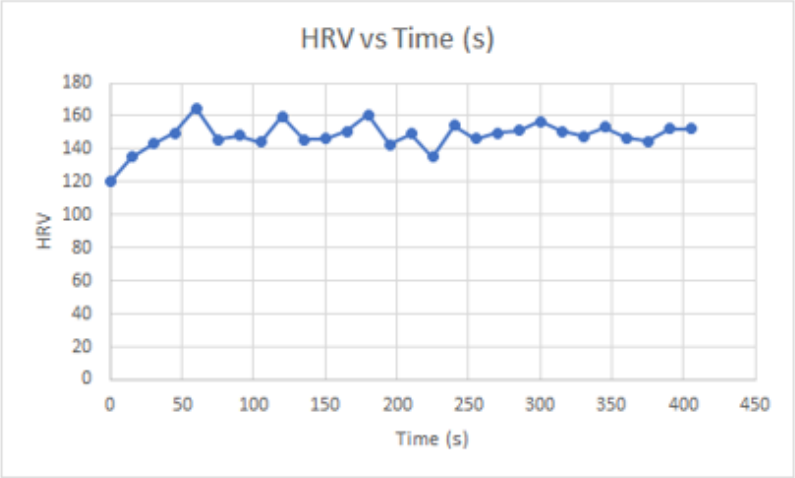


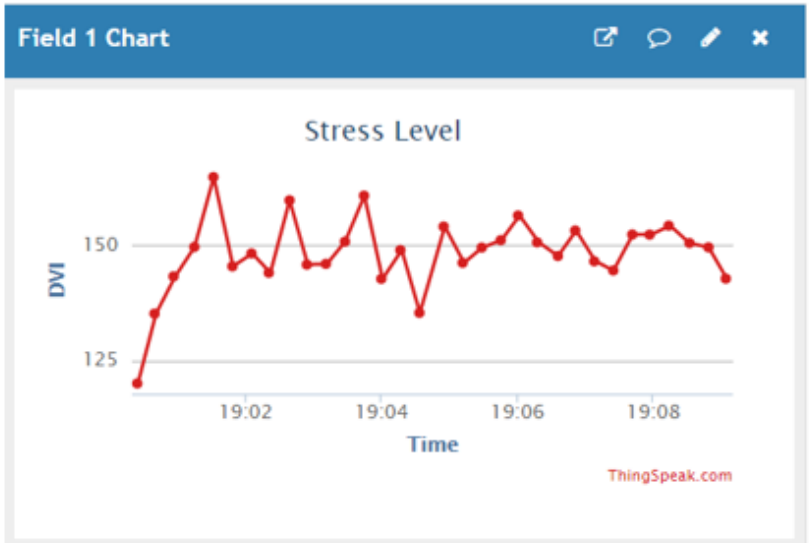


Heart-Rate Data Points

Time (s)	Heart-Rate (BPM)
0	87.69438341
15	110.3440864
30	113.7330289
45	125.2146852
60	136.65017
75	116.5201504
90	120.3019978
105	115.2048596
120	126.7246237
135	118.297251
150	121.3762697
165	123.0593512
180	133.1325288
195	116.6073794
210	122.2956831
225	110.1556703
240	119.012651
255	118.4153429
270	125.1255461
285	118.5896785
300	122.6676403
315	116.3978323
330	121.4986425
345	125.0276916
360	119.9487717
375	118.3562682
390	117.6637504
405	117.0409568

HRV while exercising:

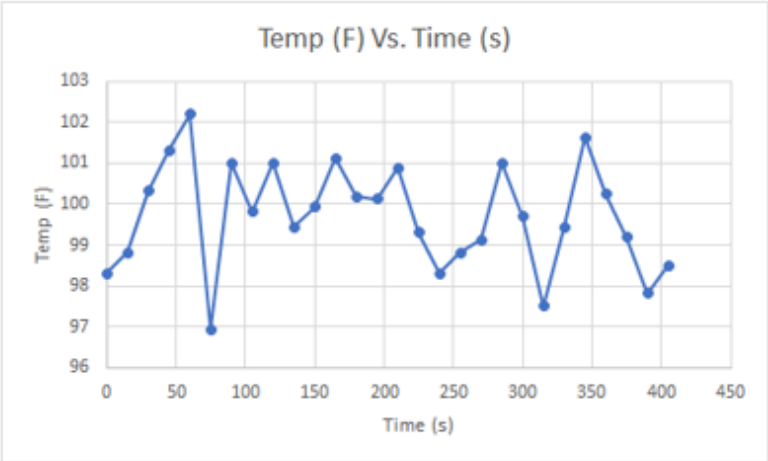


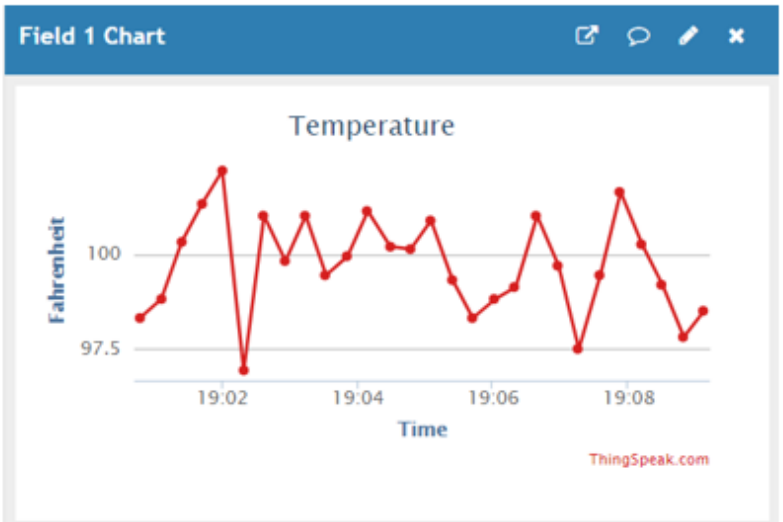


HRV Data Points:

Time (s)	HRV
0	119.9562
15	135.1468
30	143.257
45	149.6528
60	164.8644
75	145.4391
90	148.2462
105	144.0403
120	159.8102
135	145.8176
150	145.9836
165	150.8256
180	160.8184
195	142.7209
210	148.9718
225	135.3241
240	154.094
255	146.2091
270	149.522
285	151.1376
300	156.5051
315	150.6695
330	147.6852
345	153.2361
360	146.536
375	144.5522
390	152.3674
405	152.3317

Temp while exercising:

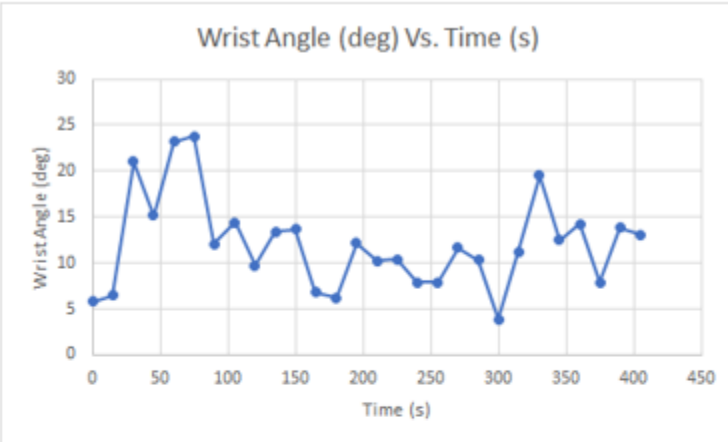


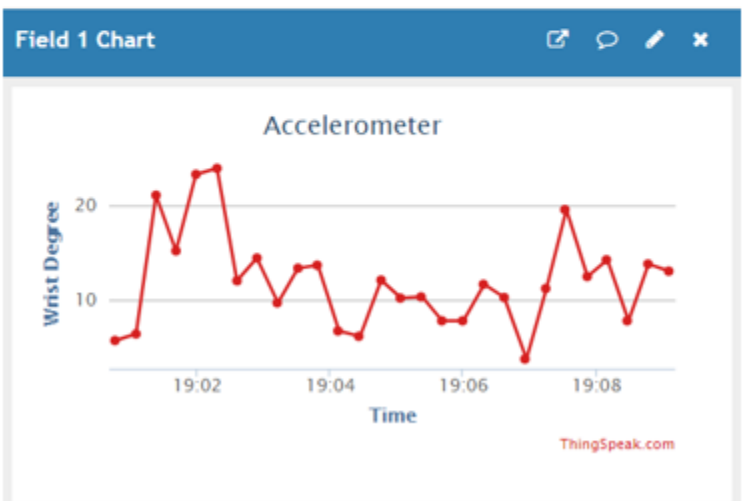


Temp Data Points:

Time (s)	Temp (F)
0	98.3125
15	98.8125
30	100.3125
45	101.3125
60	102.1875
75	96.9375
90	101
105	99.8125
120	101
135	99.4375
150	99.9375
165	101.125
180	100.1875
195	100.125
210	100.875
225	99.3125
240	98.3125
255	98.8125
270	99.125
285	101
300	99.6875
315	97.5
330	99.4375
345	101.625
360	100.25
375	99.1875
390	97.8125
405	98.5

Wrist Angle while exercising:





Wrist Angle Data Points

Time (s)	Wrist Angle (deg)
0	5.8125
15	6.5
30	21
45	15.1875
60	23.1875
75	23.8125
90	12.0625
105	14.4375
120	9.75
135	13.375
150	13.6875
165	6.8125
180	6.25
195	12.125
210	10.25
225	10.375
240	7.875
255	7.875
270	11.6875
285	10.3125
300	3.875
315	11.25
330	19.5
345	12.5
360	14.25
375	7.875
390	13.8125
405	13.0625

Data Analysis

Aftering looking at both the data points from when we were sitting to when we were squatting we have come to the conclusion that our sensors are fairly accurate when it comes to reading our health measurements. We also tested our data points with other instruments such as an apple watch and temperature gun (pictures from pg 3) in order to make sure that they are accurate. Aftering confirming that our data is accurate the last part that we need to work on is our test case which will be defined below.

Test Case

<u>Test 1:</u>

1. **What do you test**

   Requirements:

   - The Healthy-Gamer will use data-gathering sensors in order to collect a user's health symptoms every second as well as upload the average health reading every 15 seconds. This test will be done by Saad, Aayush, and Priyam.

2. **How Do you test it**

   - The user will equip a professional-grade heart-rate sensor like a “Fitbit” to measure their heartbeat and compare that data to ours.
   - Test the body temperature using a professional infrared thermometer and compare results.
   - Wrist angle will be measured using a digital incline tool, and be compared to our device.
   - HRV will be derived from the Apple Watch Health App for iPhone
   - The sensors will measure a user’s health information for 10 minutes.
   - We will repeat the experiment 3 times.

3. **Which data is collected, from which locations and how will it be collected?**

   The main data that is being collected by the Healthy-Gamer is a user’s health vitals, more specifically their: heart rate, stress level, body temperature, and wrist movement. The data of the user’s health will be collected using the multiple sensors that are on the device. Once the data is collected it will be sent over to a Raspberry Pi Zero where the health information will be processed. Once the user’s health information is processed the data will be sent over to a ThinkSpeak cloud dashboard where a user can look at the data over time.

4. **How will raw data be processed?**

   The user’s health data will be displayed on an LCD screen that way a user can look at their health information in real-time. The raw data from the pi will collect 15 data points every 15 seconds for each sensor and send that average data value to the cloud. Same will be done for the tools that are used to assess the accuracy of the data, but this will be done manually by us. We will run best fit lines for the 6 data plots (2 sets of 3 data plots) and assess the best fit line of the Pi and the Tools.

5. **Determine Characteristics to be used to present results -- graphs (what is represented by x-axis, y-axis?)**

The user's health data will also be graphed onto a line chart using ThinkSpeaks cloud-based system. By displaying a user's health information using a line chart, a user can easily analyze their health records over time. The x-axis will represent time and the y-axis will represent the user's health information such as their heart rate or stress level. There will be multiple charts on ThinkSpeak that will display a graph of every health measurement that is being measured.

6. **Evaluate project success -- a set of quests to be answered on the above mentioned graphs**
    a. Is raw data reliable, any outliers?
    b. Is data being gathered every second?
    c. How much does heartbeat data deviate from the tool?
    d. How much does body temperature data deviate from the tool?
    e. How much does wrist angle data deviate from the tool?
    f. How much does stress data deviate from the tool?
    g. Was data collected in a consistent amount?

Test 2:

1. **What do you test**

    Requirements:

    - The Healthy-Gamer will alert the user if their stress level, heart rate, body temperature, or wrist movement is at a high rate for an extended period of time. The alert will be sent as an email telling the user which health reading is high and advising them to take a break from their gaming session. This test will be done by Jamil, Ryan, and Moneeb.

2. **How do you test it?**

    - Force high body measurements such as excessive wrist movement while typing in order to confirm that a health alert is being deployed to the user.
    - Validate that the message is received within an acceptable time frame in order to alert the user.
    - Validate that the message is sent when the Healthy-Gamer device is actually really a high health variable.
    - Ensure that the correct health vital is being alerted.
    - The experiment will be repeated 5 times.

3. **Which data is collected, from which locations and how will it be collected?**

The data being collected here is the accuracy and reliability of the notification system. We will keep a tally to indicate how many incorrect alerts we have and how many correct alerts have been sent. We will also measure how many alerts are not being sent or if they are being sent at an unreasonable time delay such as 20 seconds.

4. **How is raw data processed?**

We will keep a tally track of how many correct, incorrect and unreasonable alerts we have. We will then look at the average number for each column after the 5 experiments. Will then look at our correct percent value and assess if it is reasonable, such as over 90 percent correct alerts.

5. **Determine Characteristics to be used to present results -- graphs (what is represented by x-axis, y-axis?)**

_____We will keep a tally of the alerts that are being sent to a user. The tallies will consist of how many alerts were sent at a reasonable time vs an unreasonable time frame. The tallies will also consist of how many correct alerts have been sent vs in correct alerts. The data will be tracked using a table.

6. **Evaluate project success -- a set of quests to be answered on the above-mentioned graphs**
    1) Is the alert that is being sent reliable, any outliers?
    2) Is the alert being sent within a reasonable time frame?
    3) How many incorrect alerts have been sent?
    4) If an alert has not been sent what is causing the issue?
    5) What is the percent value of correct alerts?