The Healthy-Gamer Device

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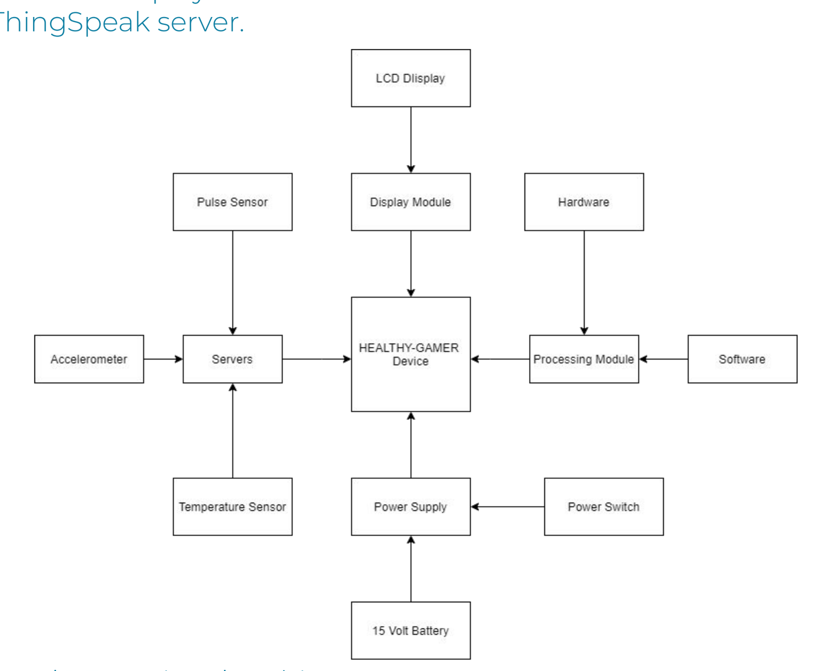
I. Abstract

With the advancement of technology, it has become easier to track an individual's physical and mental health. Although it is encouraged to live a healthy and active lifestyle the recent COVID-19 virus has made it harder for people to go outside and live an active lifestyle. As a result many people have been looking for other pastimes during this pandemic in order to entertain themselves. One of the most common hobbies that has been participated in during this pandemic is playing video games. Although indulging in video games is a great pastime, many of today's gamers are spending a huge chunk of their time gaming in order to entertain themselves. This increase of video game usage may be detrimental as spending a lot of time on gaming can cause potential health hazards. In order to mitigate the health issues that can arise from gaming we developed a portable health monitoring device called the "Healthy-Gamer" that will monitor a gamers psychologically and physically while they are gaming. The Healthy-Gamer device will track are a user's: stress level, heart rate, body temperature, and wrist movement. If the Healthy-Gamer detects that a user is experiencing a health hazard while they are playing the device will alert the user via email detailing them about the health hazard. The Healthy-Gamer also includes a feature where the user's health information will be stored on ThingSpeak which is a cloud based storage system.

II. System Architecture

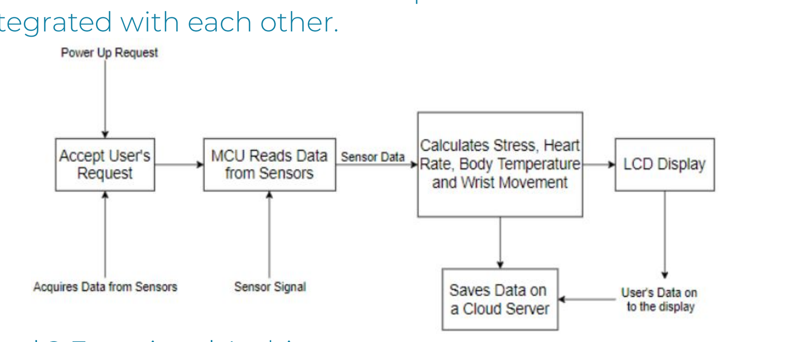
Design Architecture

The different sensors collect information from a user and sends it to a pi zero where it is interpreted. An LCD screen will then display the user's data and store the data in a ThingSpeak server.



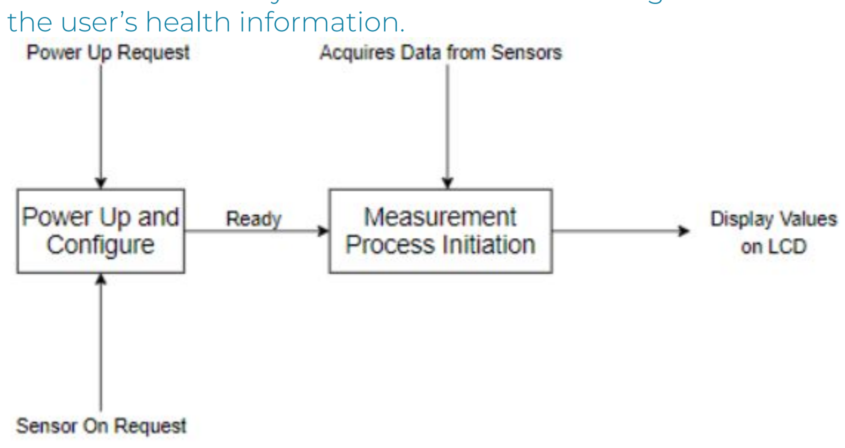
Level 1 Functional Architecture

The picture below goes into more detail regarding the top level functions and how the components of the device are integrated with each other.

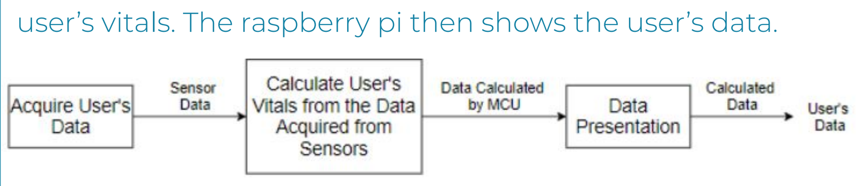


Level 2 Functional Architecture

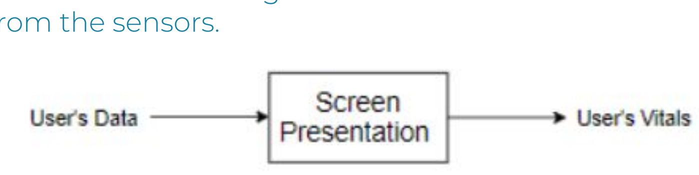
The user will need to power on the Healthy-Gamer in order for the device to start reading their vitals. Once the user turns on the Healthy-Gamer the sensors will begin to read the user's health information.



The data collected from the user is sent to the raspberry pi zero where data from different sensors such as the pulse rate sensor and the accelerometer are used to calculate the user's vitals. The raspberry pi then shows the user's data.



The user's Data is then sent to the LCD Display's screen presentation allowing the user to see the data collected from the sensors.



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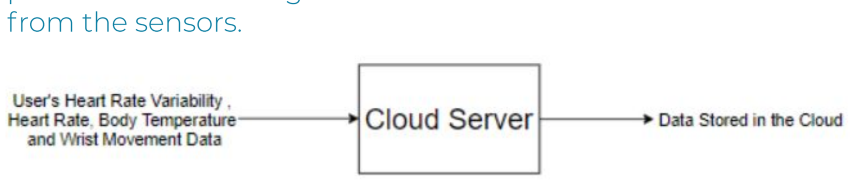
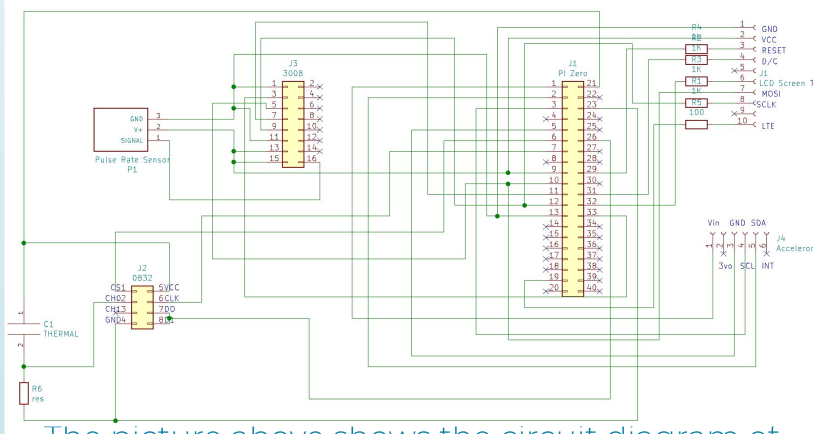


Data collected from the sensor is uploaded into the ThingSpeak Cloud Server to be stored.

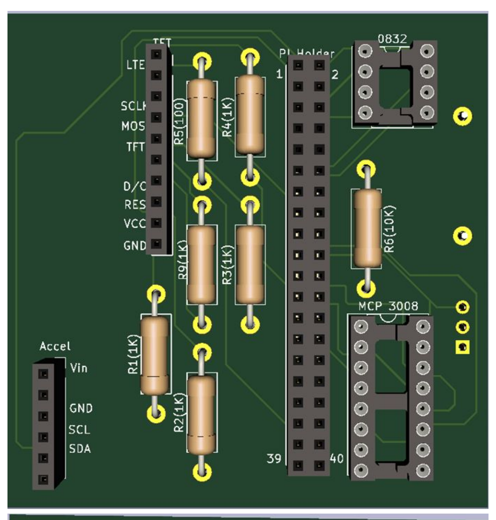
III. Circuit Diagram/PCB Design

Circuit Schematic Level

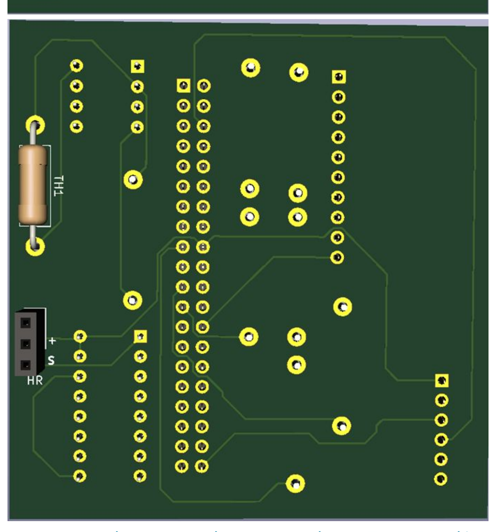


The picture above shows the circuit diagram of the Healthy-Gamer device. The schematic includes a: raspberry pi zero, thermal resistor, LCD screen, pulse rate sensor, accelerometer, and 2 ADC chips.

PCB Design



Front Side

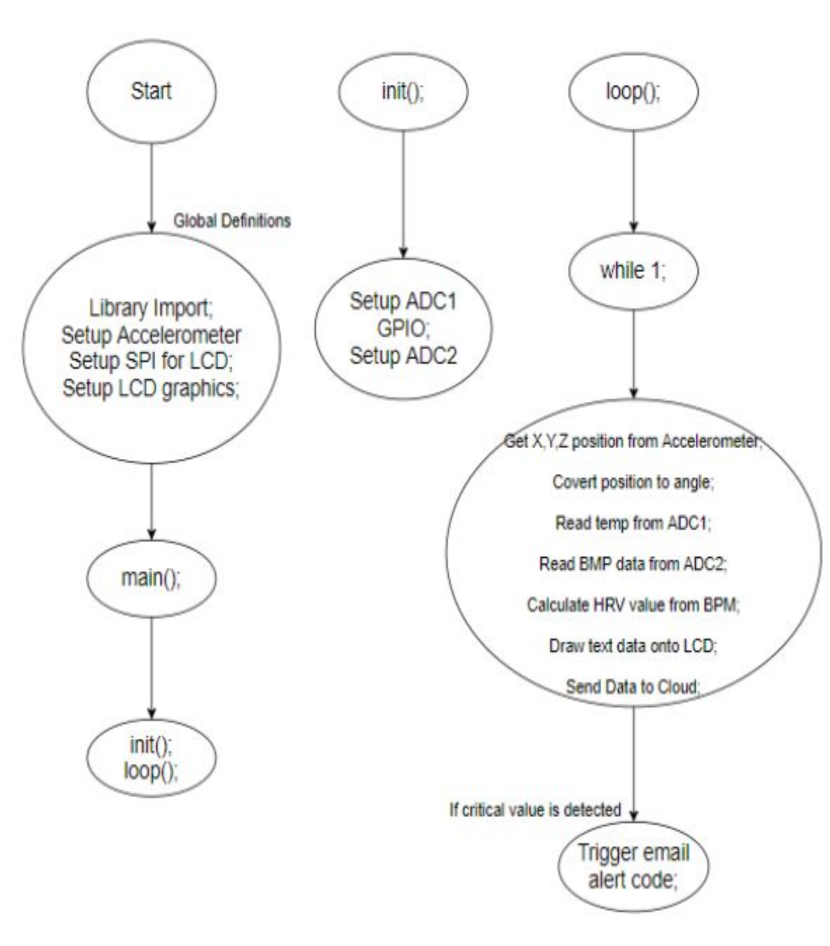


Back Side

The picture above shows the PCB diagram of the Healthy-Gamer device. The LCD and accelerometer are located on the front left side of the PCB while the pulse rate sensor and thermal resistor are located on the back right side of the PCB.

IV. Software Flow Chart

The algorithm begins by setting up I2C for the accelerometer and SPI for the LCD. The LCD also needs some graphical data to set up ahead time so everything can be properly drawn on the display. Then the algorithm setups both ADCs to properly convert the thermistor data into a temperature value and to convert the pulse rate sensor into BPM. After that it enters the main loop where everything is done. First it obtains the x, y and z positions from the accelerometer and then converts it into a wrist angle. Then it reads the temp from one of the ADCs, and gets the BPM from the other ADC. Then this data is sent to the LCD and the Cloud. If any critical values are detected then this will trigger the email warning feature.



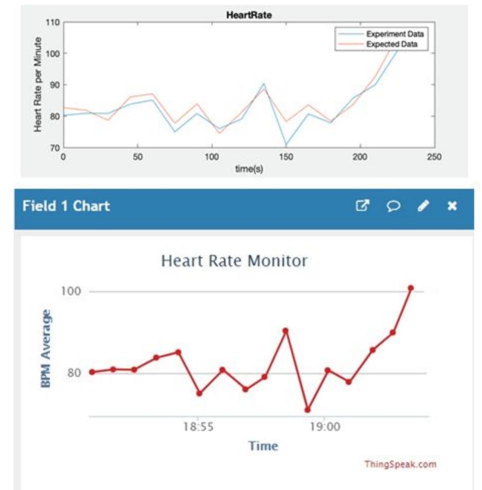
V. Results

In this section we will be discussing the different experiments that we conducted in order to test the validation and accuracy of the Healthy-Gamer device. The experiment section will show that each sensor works as well showcasing that the cloud feature and notification feature both working as intended.

Experiment 1 [Test Case 1]

Sensor data while gaming

Heart-Rate

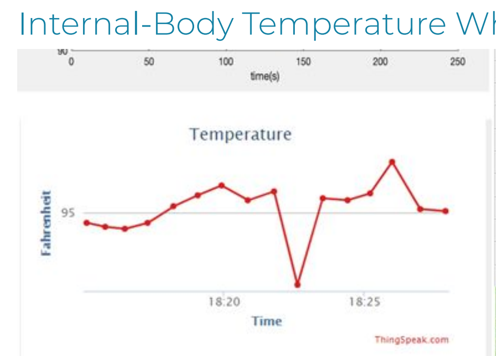


Time (s)	Measured BPM	Expected BPM	% Error
0	80	83	2.9
15	81	82	1.2
30	81	79	2.8
45	84	86	2.6
60	85	87	2.3
75	75	78	3.5
90	81	84	3.7
105	76	74	2.1
120	79	81	2.6
135	90	89	2.0
150	71	78	9.3
165	81	84	3.4
180	78	78	0.7
195	86	84	2.4
210	90	93	2.8
225	101	105	4.4
	Measured BPM	Expected BPM	% Error
Min	71	74	4.7
Max	101	105	4.4
Avg	82	84	1.9
STD	6.86	7.10	

HRV While Gaming

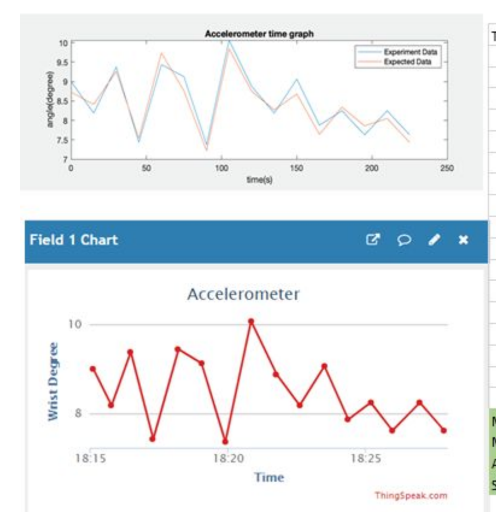
Time (s)	Measured HRV	Expected HRV	% Error
0	94.4	80	18.0
15	124.0	110	12.8
30	107.4	103	4.2
45	88.4	95	7.0
60	87.5	98	10.7
75	107.8	120	10.1
90	107.5	115	6.5
105	115.8	122	5.1
120	87.0	103	15.5
135	114.2	95	20.2
150	107.5	103	4.3
165	92.8	87	6.7
180	122.2	110	11.1
195	87.7	99	11.4
210	107.3	105	2.2
225	94.8	88	7.7
	Measured HRV	Expected HRV	% Error
Min	87.0	80.0	8.8
Max	124.0	122.0	1.7
Avg	102.9	102.1	0.8
STD	12.2	11.3	

Internal-Body Temperature While Gaming



90	96.8	97.1	0.4
105	95.8	97.1	1.3
120	96.4	96.9	0.5
135	90.4	97.1	6.9
150	95.9	97.2	1.3
165	95.8	97.1	1.3
180	96.3	97.1	0.9
195	98.3	96.9	1.4
210	95.3	97.1	1.9
225	95.1	97.2	2.1
	Measured Temp	Expected Temp	% Error
Min	90.4	96.9	6.7
Max	98.3	97.2	1.1
Avg	95.3	97.1	1.8
STD	1.64	0.10	

Wrist Angle while Gaming:



Time(s)	Measured Angle	Expected Angle	% Error
0	9.0	8.7	3.1
15	8.2	8.4	2.6
30	9.4	9.3	1.2
45	7.4	7.5	1.4
60	9.4	9.7	3.1
75	9.1	8.8	4.2
90	7.4	7.2	2.1
105	10.1	9.8	2.3
120	8.9	8.8	1.4
135	8.2	8.3	1.0
150	9.1	8.7	4.4
165	7.9	7.6	3.1
180	8.3	8.3	1.1
195	7.6	7.9	3.0
210	8.3	8.1	2.5
225	7.6	7.4	2.6
	Measured Angle	Expected Angle	% Error
Min	7.4	7.2	2.1
Max	10.1	9.8	2.3
Avg	8.5	8.4	0.9
STD	0.78	0.76	

Experiment 5 [Test Case 2] Warning sent to email

The picture below displays when the Healthy-Gamer device detects hazardous behavior and sends an email notification to a user detailing them about their hazardous behavior.

The pictures below shows the expected results from the user vs the measured results of the user is experiment 1. All of the measured variables are considered consistent since the average error is about 2%.

	Measured BPM	Expected BPM	% Error
Min	71	74	4.7
Max	101	105	4.4
Avg	82	84	1.9
STD	6.86	7.10	

	Measured HRV	Expected HRV	% Error
Min	83.2	85.0	2.2
Max	134.7	144.0	6.4
Avg	107.2	110.1	2.6
STD	14	18	

	Measured Temp	Expected Temp	% Error
Min	93.4	96.9	3.6
Max	96.3	97.2	1.0
Avg	94.6	97.1	2.5
STD	0.66	0.09	

	Measure Angle	Expected Angle	% Error
Min	7.3	7.0	4.3
Max	10.4	10.3	0.6
Avg	8.8	8.8	0.6
STD	0.82	0.90	

The picture below shows the expected notification vs the actual notification from experiment 5. All of the message alerts were sent within 10 seconds after they were recorded in ThingSpeak. The Healthy-Gamer device had a 100% success rate when it came to alerting a user of their hazardous health behavior.

Time (s)	BPM	Actual Notification	Expected Notification	Mismatch
0	105	1	1	0
15	105	1	1	0
30	108	1	1	0
45	102	1	1	0
60	100	1	1	0
75	104	1	1	0
AVG	104			
STD	2.47			

Time (s)	Temp (F)	Actual Notification	Expected Notificaiton	Mismatch
0	98.4	0	0	0
15	98.2	0	0	0
30	98.3	0	0	0
45	98.3	0	0	0
60	98.5	0	0	0
75	98.2	0	0	0
AVG	98.3			
STD	0.11			

Time (s)	HRV	Actual Notification	Expected Notificaiton	Mismatch
0	135.5	1	1	0
15	130.4	1	1	0
30	134.4	1	1	0
45	135.0	1	1	0
60	132.4	1	1	0
75	131.3	1	1	0
AVG	133.2			
STD	1.91			

Time (s)	Wrist Angle (deg)	Measured Notificaiton	Expected Notification	Mismatch
0	18.0	0	0	0
15	17.2	0	0	0
30	17.7	0	0	0
45	17.6	0	0	0
60	17.4	0	0	0
75	17.7	0	0	0
AVG	17.6			
STD	0.26			

VI. Picture of Healthy-Gamer Device

The picture below shows the Health-Gamer device fully integrated with its cover on. The cover has a cutout in order to show the LCD screen. As seen in the picture the user's: BPM, wristangle, stress level, and body temperature are displayed on the LCD screen. The pulse sensor is also attached to the user's finger tip and is attached with a velcro piece.

The picture below shows the Health-Gamer device's without its cover. In the picture, the front side of the PCB is shown as well as the components that are integrated within it. The LCD screen and the accelerometer are on the left side while the thermal resistor and the pulse sensor are on the right side.

The picture below shows the thermal resistor and pulse rate sensor sticking out of the Healthy-Gamer box. These sensors need to stick out in order to come in contact with a user's skin and analyze their health readings.

VII. Conclusion

The Healthy-Gamer device is a health monitoring that tracks a users: heart rate, stress level, wrist movement, and body temperature while they are gaming. The device is intended to store a user's health data on a ThingSpeak cloud based system and is intended to alert a user if it detects any hazardous health behaviours. When implementing the code for the Healthy-Gamer device we had to find creative ways to structure our code in order to make sure that our code compiled as efficiently as possible in order to avoid any runtime errors. We also had to find creative ways to wire and implement the different components onto the PCB in order to make sure that the Healthy-Gamer device was as compact and as portable as possible. This senior design project took almost a year to complete, as a result many of us have learned valuable lessons from this project that we plan on using in our professional careers.