Covid Risk Monitor IoT Device

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***Abstract*— This report provides an overview of our Covid Risk Monitor IoT Device. This IoT device collects data using three different sensors and stores its captured data on the cloud through the Raspberry Pi. This report includes the reasoning behind creating this device, detailed designs of all components of the system and an analysis of the system output.**

***Keywords*— Cloud, Data Acquisition, Sensors, IoT, Data storage**

I. Introduction

Although our community has taken great strides to combat Covid-19, (vaccine, social distancing, lockdowns etc.) we thought it would be appropriate to build a device that monitors Covid-19 exposure since we will always to prone to getting the virus moving forward. This way people can continue on with their daily activities stress free, knowing that as long as they wear this device they will be alerted when they come in contact with somebody else who has covid.

This report highlights key design parameters for both the hardware and software systems. To fully understand the systems in place, a high level approach will be taken first followed by a break down of the system into its lower level, more specific components.

The highlighted design factors that will be discussed in the following sections include the overall design of the system, the sensors, signal conditioning, multiplexer design, sample and hold circuit, analog to digital converter, theoretical simulation of the system, hardware and software components.

II. Design and Implementation

The design of the covid risk monitoring device includes three sensors, a Raspberry Pi and output signals for data acquisition. Below figure 1 illustrates a block digram of the IoT system.

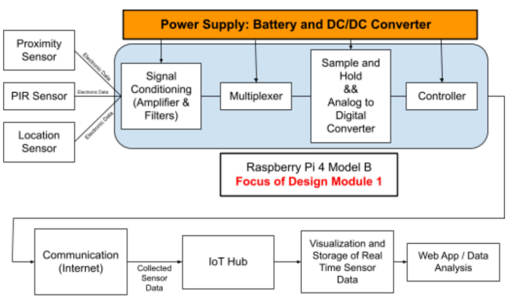

Fig. 1 System block diagram

A. Sensors

Sensors present in the system include a proximity sensor for determining the position of nearby people, a PIR sensor for detecting the presence of a live object (human), and a location sensor (gps) to determine the user's location.

TABLE I
SENSOR SPECIFICATIONS

Sensor	Electrical Parameters	Values
Proximity Sensor (LJC18A3-B-Z/BX)	Supply Voltage	10 V - 30 V DC
	Current Output	200 mA
	Response Frequency	100 Hz
	Detection range	1 mm to 10 mm
	Operating Tempeture	-25 to +65 °C
	Dimensions	6.81 x 5.08 x 2.21cm
	Net Weight	91 g
Passive Infrared Sensor (HC-SR501)	Supply Voltage	4.5 V - 20V
	Current Output	50 uA
	Operating Tempeture	-15 to +70 °C
	Detection range	0 m to 7 m
	Measuring Angle	< 100 degrees
	Net Weight	60 g
	Dimensions	12.2 x 8 x 3.4 cm
Location Sensor (BN-220)	Supply Voltage	3V - 5.5 V (typically 5V)
	Current Output	50 mA
	Operating Tempeture	-40 to +85 °C
	Max Altitude	50,000 m
	Max Velocity	515 m/s

B. Signal Conditioning Circuit

The following circuit illustrated in figure 2 was used to simulate the signal of our data acquisition system.

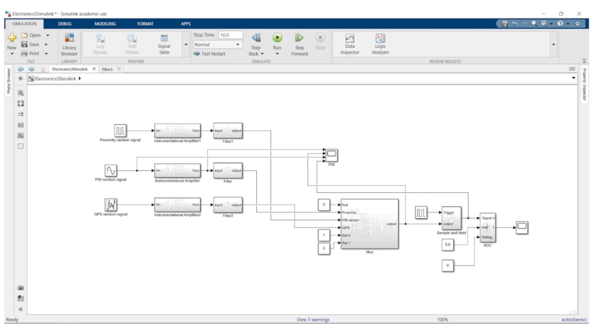

Fig. 2 Top Level Signal Conditioning Circuit

The circuit in figure 2 is comprised of individual blocks representing the signal conditioning steps. As shown below in the following figures, the individual blocks have been broken down into their lower level schematics.

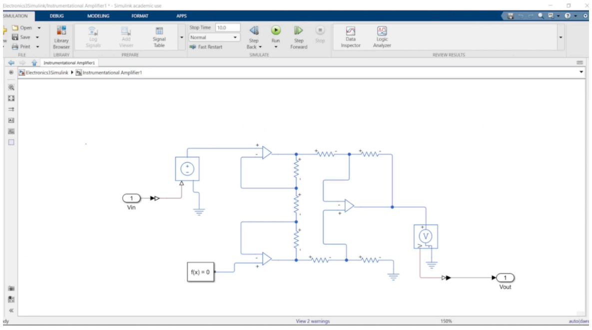

Fig 3. Instrumental Amplifier Schematic

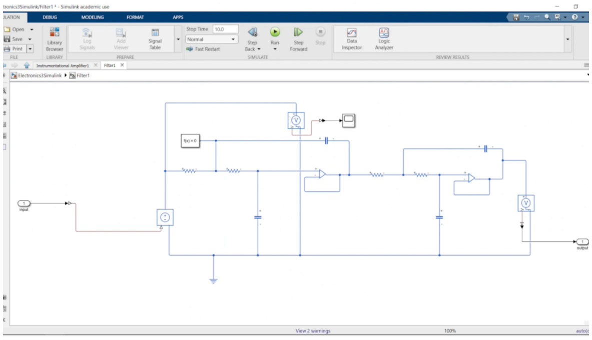

Fig 4. Filter Schematic

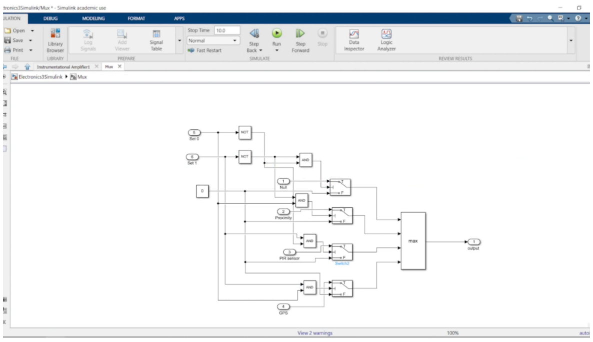

Fig 5. Multiplexer circuit schematic

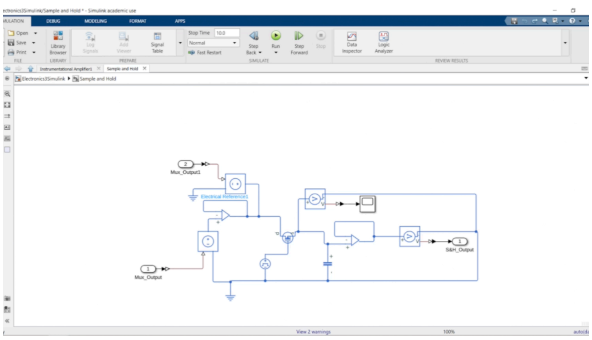

Fig 6. Sample and hold circuit schematic

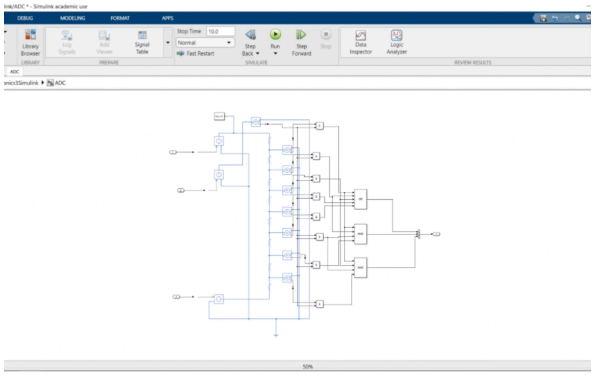

Fig 7. Analog to Digital Converter schematic

These lower level schematics were simulated using various forms of random signals. For demonstration purposes, we used a random sinusoidal signal to represent the behaviour of our PIR sensor. The output signal of our PIR sensor can be seen in the figure below.

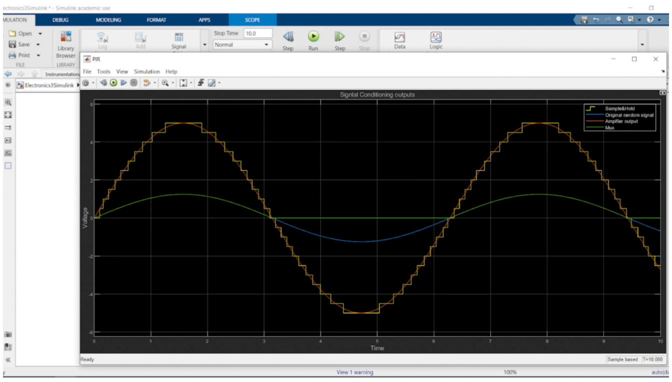

Fig 8. PIR sensor signal output

C. *Multiplexer Design*

A 4-1 multiplexer was designed using logic gates and boolean algebra. The multiplexer only receives input signals from the three sensors, thus one of the input signals is of type null.

TABLE II

MULTIPLEXER TRUTH TABLE

Sensor	Inputs		Outputs
	S0	S1	Y
	0	0	A0
Proximity	0	1	A1
PIR	1	0	A2
GPS	1	1	A3

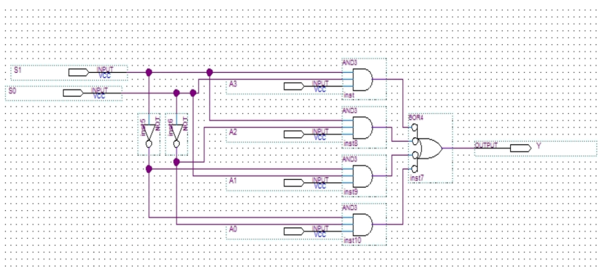

Fig 9. Multiplexer circuit in Quartus

D. Analog to Digital Converter

The analog to digital converter designed in figure 7 is a flash ADC. The input signals from the sensors are amplified, filtered, linearly connected to a voltage signal of 0V or 1V, and then digitized with a 12 bit DC. The resolution is calculated as seen below:

1/(2^12) = 0000244V or 0.244 mV per step

E. Sample and Hold Circuit

A sample and circuit is used to sample the voltage of a continuously changing signal and hold the voltage steady for a period of time. In our design, the sample and hold circuit samples the signal for a 10µS interval and holds the previous sampled value until the input signal is sampled again. Figure 6 illustrates the sample and hold circuit. In this way, the designed sample and hold circuit can be used to convert continuously changing signal into a series of discrete voltage samples, allowing the signal to processed and analyzed.

F. Hardware

The hardware design of our Covid Risk monitor IoT device is shown below in figure 10. This IoT device consists of the three sensors, a bread board for connectivity, a raspberry Pi and other circuit elements such as a resistor.

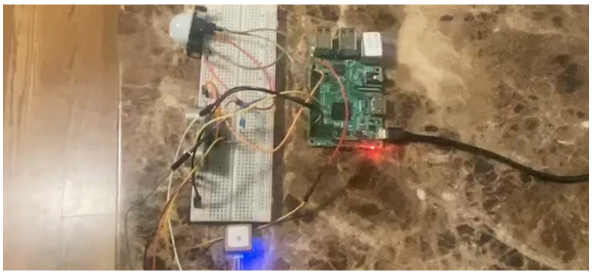

Fig 10. Covid Risk Monitor Device

G. Software

Using Visual studio code, we were able to write a program for our Raspberry Pi. This script can be seen in figure 11.

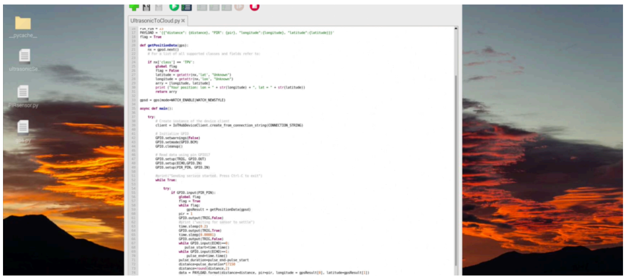

Fig 11. Python program for Raspberry Pi

The python program seen above works in the following manner. First we start at main(). In this main function many things occur. After the raspberry pi pins are initialized, the program then checks to see if the PIR detects any motion. If motion is detected, then the GPS sensor records the latitude and longitude before terminating. Lastly, the program returns to the main function where the proximity sensor now determines how far that person is.

While this program is being executed, the data collected by each sensor is sent to the Azure event hub. Here the data is read live and stored in a blog storage. Finally, power BI was used to display the data for the users.

G. Simulation

Simulating a hardware device is important because it allows designers to test and evaluate the performance of their device without having to physically build it. Not only can this save time and money, but it can also avoid potential problems that may arise if the device is found to be faulty or not perform as expected after being built.

To simulate our hardware device design, we used a web application called Circuit.Io. Figure 12 displays our wired connection simulation.

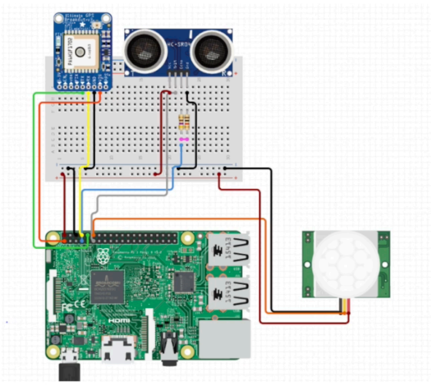

Fig 12. Sensor and GPIO wiring

Additionally, simulation can provide detailed information about the performance of a device, such as how it will behave under different operating conditions, how it will interact with different components in a system, and what its limitations and capabilities are.

Fig 13. Live simulation of our IoT Device

III. DISCUSSION

One of the main benefits of IoT devices is their ability to automate many tasks and processes. Instead of manually tracking when/where people are being exposed to covid, our device allows us to automate this process as long as the user is wearing the device. The valuable data and insights gained from our IoT device will not only allow user's to live stress free, it will also help public services track public user information. Down the road, this may help limit breakouts and help us understand how these breakouts occur. The goal of our design was to help everyone affected by covid and based on our final results, we were able to do so (even if it's on a small scale for the time being). Although this device is of practical use, it is always important to consult a healthcare professional before relying on any type of device for medical advice. Looking back on our project, the toughest challenge was creating a program that uploaded data to the cloud. Since we were relatively inexperienced in this field, it took a lot of work to understand how to implement it. Going forward, we hope to improve our device by building a proper case for its use. The design intent for the case is that it can be worn on a belt per clipped to one's pants.

IV. CONCLUSION

Based on our analysis of our IoT device, it appears that the device is effective in monitoring Covid risk and uploading data to the cloud. The device is easy to use, and the data it collects is accurate and reliable. It has the potential to be a valuable tool for individuals and organizations looking to monitor their Covid risk and take appropriate action. Overall, we believe that the device is a valuable addition to the growing field of IoT technology.

III. REFERENCES

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