IOT BASED TWO-WAY PERSON COUNTER WITH DATA VISUALIZATION

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TWO-WAY PERSON COUNTER IOT BASED WITH DATA VISUALIZATION

Brendan Q. Dela Cruz, Ria G, Fugaban, Lance P. Ubiña, Lyka P.Viloria

Abstract

As the corona virus (COVID-19) epidemic has expanded globally in recent years, it has sparked widespread concern, fear, and tension, all of which are reasonable and appropriate reactions to the ever-changing and uncertain position that everyone finds themselves in. WHO is concerned about the crisis's impact on people's mental health and closely monitored the situation alongside national authorities while also offered information and guidance to governments and the general public? Citizens throughout the world are firmly motivated to practice "social distance." According to health officials and experts, maintaining a physical distance from people and avoiding crowds was critical for slowing the spread of COVID-19. This research helps reduce the spread of the virus by increasing social distance and reducing overcrowding in buildings and rooms, as well as making it easier for people to follow government policy by placing the person counter in their vicinity. The system also collects and display foot traffic data to users. Users could use these data to analyze their establishments' foot traffic and customer behavior. According to the findings, the device was able to detect people entering and exiting the room, as well as notify people when the capacity of each alert level had been exceeded.

Keywords: Covid-19, Foot Traffic, Disease

INTRODUCTION

The COVID-19 pandemic as a significant health crisis has caught the attention of many researchers, which has led to the creation of a broad quantitative picture of human behavior during the coronavirus outbreak. COVID-19 is an infectious disease caused by a new coronavirus identified in December 2019 [1]. Corona viruses are a family of viruses known to cause respiratory infections [2].

As the coronavirus (COVID-19) pandemic sweeps worldwide, it is causing widespread concern, fear, and stress, all of which are natural and normal reactions to the changing and uncertain situation that everyone finds themselves in. WHO takes the impact of the crisis on people’s mental health very seriously and monitors the problem together with national authorities while providing information and guidance to governments and the public [3]. As of April 10, 2022, over 496 million confirmed had posted cases and over 6 million deaths globally [4].

The coronavirus (COVID-19) pandemic presents a significant challenge for all societies. To curb the spread of the virus, governments have enacted policies regulating peoples’ behavior and social habits. Citizens across the globe are intensely encouraged to engage in “social distancing” (also referred to as “physical distancing”) [5]. Health authorities and experts insist that maintaining a physical distance from others and avoiding crowds are crucial for mitigating the extent and the speed of COVID-19 spread [6]. And complementing other containment measures, such as hand hygiene and widespread testing, social distancing is key to reducing excessive demands on intensive health care services—and thus for ensuring the effective treatment of all who become

infected [7]. Social distancing is a recommended solution by the World Health Organization (WHO) to minimize the spread of COVID-19 in public places. Most governments and national health authorities have set the 2-m physical distancing as a mandatory safety measure in the shopping center, schools, and other covered areas [8].

The Alert Level System refers to the new Community Quarantine Classifications for dealing with COVID-19, covering entire cities, municipalities, and regions. Intended to manage and minimize the risk of the disease through System Indicators, Triggers, and Thresholds determined by the IATF to specify the public health and social measures to be taken concerning the COVID-19 response, as may be updated based on new scientific knowledge, information about the effectiveness of control measures in the country and overseas, and its application. The Alert Level 4 shall be allowed to operate at a maximum of 30% outdoor venue capacity provided that they have been a difficulty with a Safety Seal Certification. The Alert Level 3 shall be entitled to perform at 50% outdoor venue capacity. The Alert Level 2 shall be allowed to operate at a maximum of 70% outdoor venue capacity. And the Alert Level 1 may operate at a total 100% capacity [9].

A person counter IoT based device can inform if how many people are present in the installed area. The IoT person counter takes advantage of well-established technologies like ultrasonic. It performs the counting of individuals heading in a specific place [10]. Statewide social distancing measures were related to a statistically significant decrease in the COVID-19 case growth rate. And it is also associated with a reduction in the COVID-19-attributed mortality growth rate beginning seven days after implementation [11].

The idea came from the challenge that many businesses are currently facing of employing more supervisors to limit the number of people in shops to a reasonable maximum. Reduces the likelihood of the virus spreading further through human contact. Paying these extra staff increases the company's cost base. An alternative solution is to give out counting cards, which raises further questions about hygiene. Solving this problem requires a precise, contactless solution that does not require additional staff [12].

The study was created for a technology to help identify remedies for the Covid-19 epidemic, to help lessen interaction between people by viewing through this technology and to help maintain social distancing and statistical data that could greatly benefit the users. The device can inform how many people are inside the room. The information can be helpful in various scenarios; to alert if the number of persons has exceeded line with the government protocol; to give statistical data information about foot traffic in the area; and count how many persons are inside the facility.

Research Objectives

This study aimed to develop a person counter device with Data Visualization and Decision Support System. This study intends to:

1. To detect the distance of the sensor from the person entering and exiting the establishment.
2. To count the person entering and exiting the establishment.
3. To provide a data visualization to monitor foot traffic inside the establishment.
4. To notify when the room's capacity has been exceeded.

Significance of the Study

This study would greatly benefit the store owners, staffs, and customers visiting establishments to maintain and practice social distancing. Now that the Coronavirus pandemic is still a concern, it's essential to conduct social distancing, including staying away from the public. The test might be challenging to do in small and crowded locations due to large numbers of people entering the room, they must give safety protocols and proper instructions. Hence this study will keep track and limit how many people are in the room or building (which can be adjusted by the user). This study can help minimize the spread of the virus by making social distance easier to achieve and reducing overcrowding in buildings and rooms, and to make it easier for people to follow the government's policy by placing the person counter in their vicinity. The system will also gather and show users foot traffic data. Users could use these data to analyze foot traffic and to evaluate the customers behavior of their establishment.

Related Works

Preventing community transmission is the key to reducing the load on healthcare systems and keeping the economy rolling. Businesses are required to follow standard operating procedures (SOPs) provided by their governments to curb community transmission of the virus. However, small businesses have a financial impact on implementing specific SOPs and compliance rules. The SOP is aggravating when required to hire or re-appropriate staff members to enforce compliance, such as measuring the temperature of incoming customers and ensuring physical distance between them. According to a news article, one pharmacy business in New South Wales (NSW), Australia, had to spend AUD 1000–1500 per week on higher staff for monitoring temperature and ensuring distancing.

Internet of things (IoT), as an enabler of data sharing through connectivity, is beautiful in healthcare applications. An advantage of this technology is that it enables remote health monitoring. IoT also allows human-to-human, machine-to-human, and machine-to-machine communication without external intervention. Therefore, it can be a handy tool in implementing and monitoring human social interaction during COVID-19. Safe work Australia has prepared a checklist for small businesses in retail that outlines workplace safety procedures. Two key areas are physical distancing and monitoring COVID-19 symptoms (such as fever). We propose a low-cost option for small businesses to measure and report critical COVID-19 workplace safety parameters such as body

temperature (fever), The number of people per square meter, and the distance between individuals in the queue area. Furthermore, we present an active LED-based real-time solution to manage physical distancing for individuals standing in a queue dynamically. Current practices to ensure COVID-19 SOP compliance include hiring or appointing staff to monitor the body temperature of attendees and ensure physical distancing. While initial implementations consider symptom and distance monitoring elements, they do not provide a comprehensive real-time solution that can dynamically manage attendees to maintain COVID-SOP compliance [13].

Ultrasonic distance [14] sensors are used to detect distances without using contact, and they come in a variety of different varieties. A transmitter and receiver (or transceiver) that can send and receive data ultrasonic sound may be transmitted and received. The main concept is to calculate the time it takes for an ultrasonic sound wave to travel from a sensor to a recognized item. The receiver collects the reflected sound from the item after an ultrasonic transmitter emits a sound frequency of over 18 kHz through the air at a speed of 344 meters per second (at 20°C). The distance between the transmitter and the item may be estimated using a simple computation that considers the time it takes for the ultrasonic wave to travel from the transmitter to the receiver and be reflected. The measurement range is many meters long. Since most materials reflect sound waves, ultrasonic sensors are a good fit for a variety of applications. These sensors are distinguished from their photoelectric counterparts by their superior ability to detect and measure films, transparent objects, and liquids. Ultrasonic sensors are unaffected by the target color or rapid color changes. Ultrasonic sensors work effectively in dusty, unclean situations because they employ sound waves. They do not, however, work well with small targets against big backdrops or objects that absorb sound waves efficiently, such as foam batting.

Automatic counting systems for tracking shoppers are being used by stores and shopping malls to maintain track of customer numbers. Existing systems use infrared beams and count beam disruptions to instrument doors; however, this method is ineffective for resolving large groups of individuals. We're using a vision-based solution that uses a stereo camera set above a door and pointed down to detect and track individuals. The system divides the scene by picking stereo pixels falling inside a 3D region of interest, which is placed to capture the heads and torsos of adult shoppers, after applying real-time stereo vision and 3D picture reconstruction. Our technique is unique in that it (1) remaps stereo disparities to an orthographic "occupancy map," which simplifies human modeling, and (2) uses a Gaussian mixture model to monitor individuals. Our approach obtained a net counting error rate of just 1.4 percent on a test set of 900 enter/exit events in four hours of video [15].

The researchers looked at how state and local laws, such as stay-at-home orders, public school closures, and limits on restaurants, entertainment, and big social gatherings, might induce social isolation. Foot traffic in six industries (essential and non-essential retail, entertainment, hotel, restaurant, and business services) as well as the proportion of mobile phones that are at home all day are all derived from cell phone statistics. Models of structural breakage demonstrate that mobility series at the national and state levels begin to alter drastically in a brief timeframe from March 8-14, well before any significant state or local restrictions are imposed. Declaratory pronouncements of state of emergency diminish foot traffic and increase social distance in difference-in-

difference models. Staying at home constraints account for just a small portion of the variation in behavior across outcomes. Restrictions imposed on certain industries have a significant influence. Restricted dining in restaurants, for example, reduces traffic in restaurants, hotels, and non-essential shops. In most sectors, private, self-regulatory conduct accounts for more than three-quarters of the reduction in foot traffic. Restrictive legislation is responsible for half of the drop in vital retail foot traffic and 75% of the increase in the percentage of people who stay at home all day. Public school closings have a significant impact on this latter conclusion [16].

METHODOLOGY

Block Diagram

Statewide social distancing measures were related to a statistically significant decrease in the COVID-19 case growth rate. Diverse components of the Two-Way Person Counter IoT Based with Data Visualization and Decision Support System incorporate the Microcontroller, Ultrasonic Distance Sensor, ESP8266 ESP-01 Module Bluetooth Module HC-06, Bluetooth Module HC-05, and Led Matrix Display.

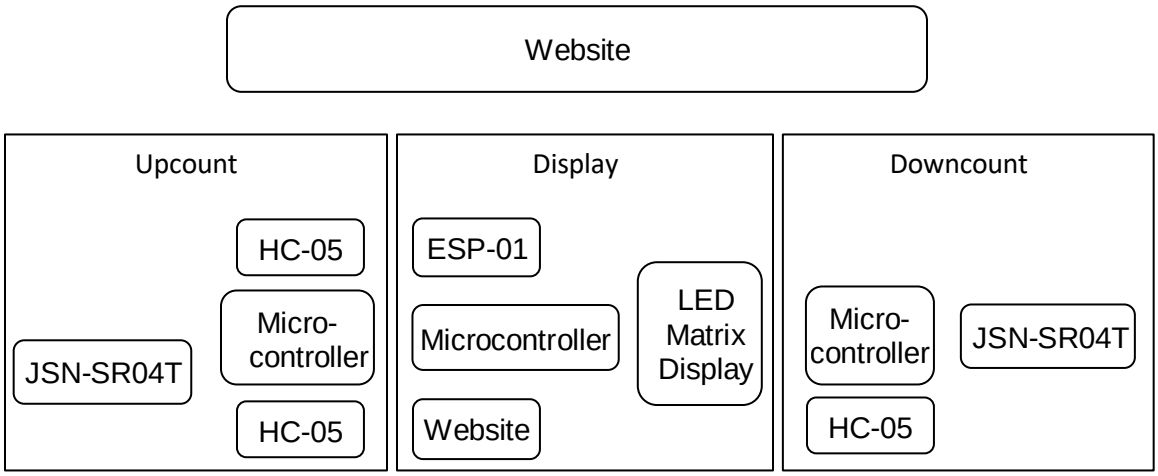

Figure 1. *Block schematic of a Two ways Person Counter with Data Visualization.*

Based on the figure above, the Microcontroller will be the center of the device, which will serve as the processor. Both upcount and downcount have a distance sensor that detects motion and passes it to the Microcontroller.

When a person enters the establishment, the Bluetooth module of device 1 transmits the distance sensor output and the data gathered from device 3 to the Bluetooth module receiver of device 2 to display information in the Led Matrix processing by the Microcontroller, and the Wi-Fi module of device 2 sends data gathered to the website.

When a person exits from the room, the Bluetooth module of device 3 transmits the distance sensor output process by the Microcontroller to the Bluetooth module receiver of device 1.

Flowchart

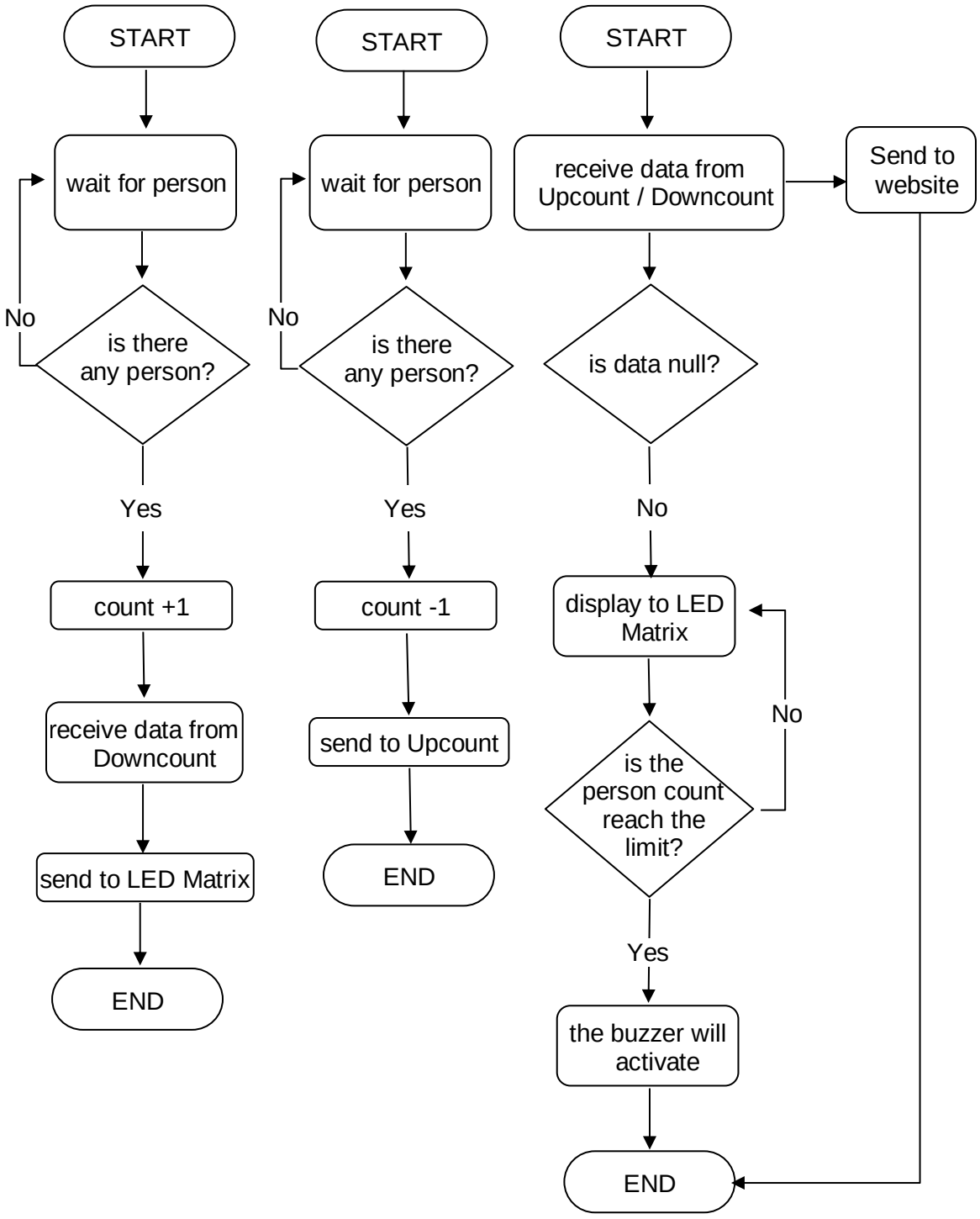

Figure 2. Flowchart of a Two ways Person Counter with Data Visualization.

The system composed of three devices namely upcount, downcount and matrix. The Upcount device will start waiting for the person and will commence asking if there is already a person; if there is not, it will simply return to the first process of waiting for the person; if there is, it will add a count and send the data to the led matrix device.

Similarly, at the Downcount device, subtract the count instead of adding and sending the data to the Upcount device.

The led matrix device will start receiving data from the upcount device and send the data to the website. It will then start asking if the data is null? if the data is null, it will simply return to the first process that will receive data at the upcount device; if the data is not null, it will be present in the led matrix. It will ask again if the number has reached the capacity limit, and the buzzer will activate when the person count reaches capacity, and it will deactivate when the downcount device has reduced the count.

Schematic Design

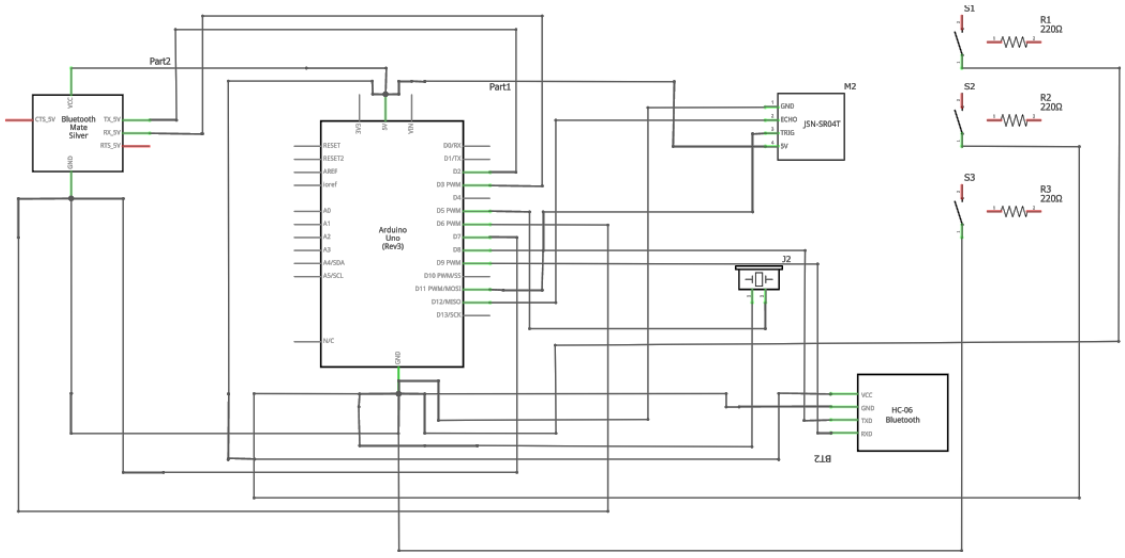

Figure 3. Schematic of Upcount

In Figure 3, the ground pin and VCC pin of the HC-05 and distance sensor are connected to the 5v and GND pin of the Arduino. The Trig pin of the distance sensor is connected to D11, and the echo pin is connected to D12. The HC-05 sender TX is connected to D2 and RX to D3, while the HC-05 receiver TX is connected to D8 and RX to D9. The buzzer pin is connected to D7.

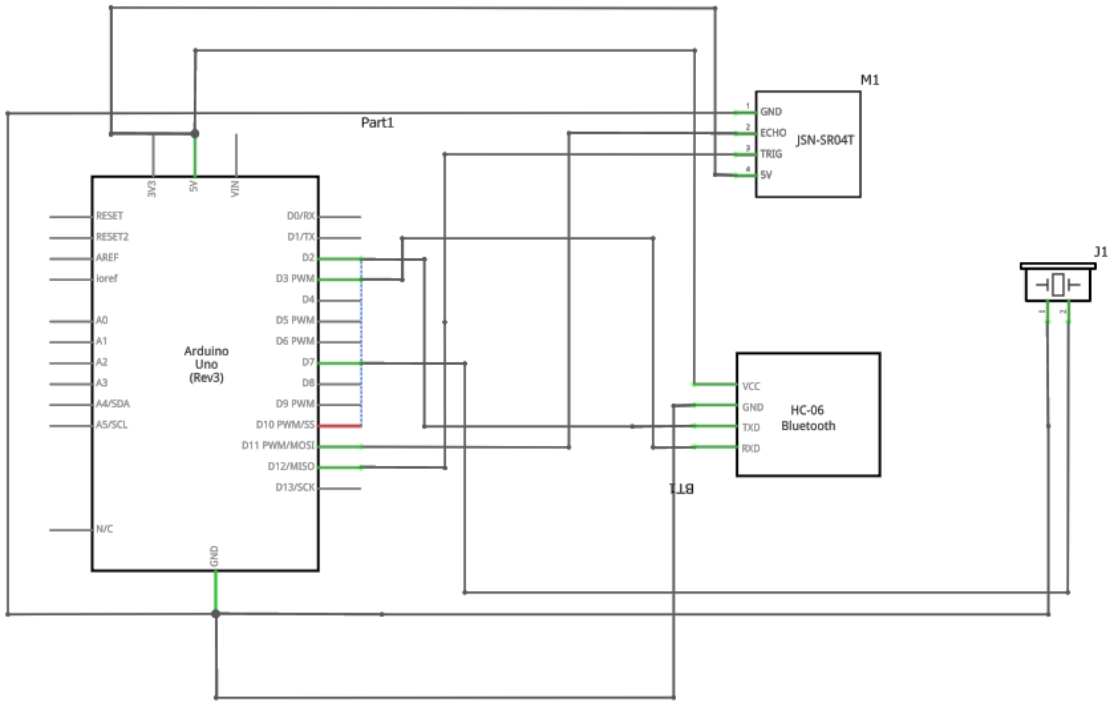

Figure 3.1 Schematic of Downcount

In Figure 3.1, the GND pin and VCC pin of the distance sensor and HC-05 are connected to the 5v and GND pin of the Arduino. The TX pin of the HC-05 is connected to D2, and RX is connected to D3. The trig pin of the distance sensor is connected to D11 and the echo pin to D12. At the same time, the buzzer is connected to D7.

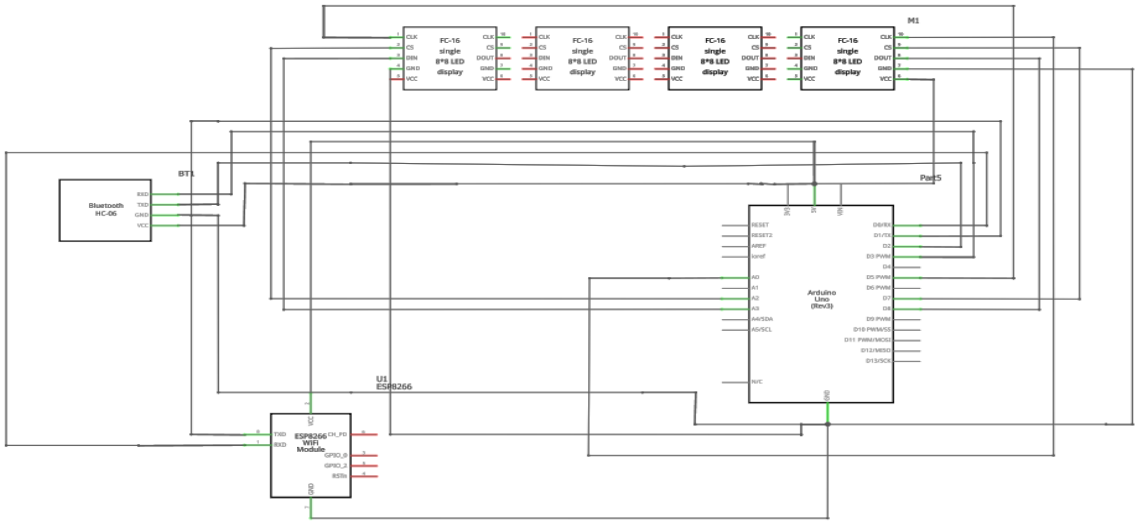

Figure 3.2 Schematic of Led Matrix

In Figure 3.2, the ground pin and VCC of the esp, HC-05, and led matrix are connected to the GND pin and 5v of the Arduino. The TX pin of the HC-06 is connected to D0 while the RX is connected to D1. The TX of the esp is connected to D2 while RX is connected to D3. The led matrix connection is CLK to D5, DAT to D12, STR to D13, K0 to A0, K1 to A1, K2 to A2, K3 to A3, K4 to D8, K5 to D9, K6 to D10, K7 to D11.

Materials/Components

Hardware

In Figure 4, an Arduino uno microcontroller is an open-source electronics platform based on easy-to-use hardware or circuit board and software [17]. Arduino was use as a main Microcontroller for the project. It serves as programmable component to control the sensors connected to it.

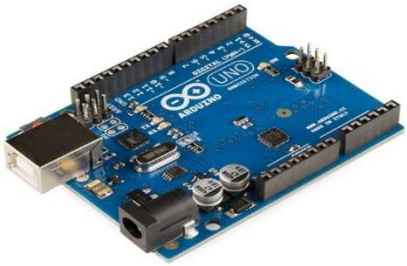

Figure 4. Arduino Uno Microcontroller

Figure 4.1 shows a waterproof ultrasonic sensor that uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity [18]. The ultrasonic sensor uses these pulses as a person's in / out counts inside the establishment in the project.

Figure 4.1. Waterproof Ultrasonic Sensor

Figure 4.2 shows a red led matrix display, it is a grid of lights arranged into rows and columns [19]. It displays the information recorded from the upcount and downcount devices.

Figure 4.2. 8x32 5mm dia Red Led Matrix Display

Figure 4.3 shows the ESP8266 ESP-01 adapter, this is specially designed for ESP8266 ESP-01 Wi-Fi Module [20]. An ESP-01 adapter can use for easier interfacing with the ESP8266 ESP-01 Wi-Fi modules for wireless communications in the project.

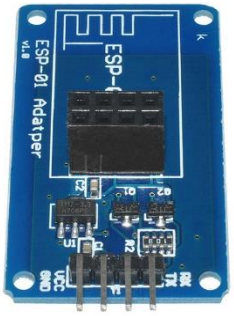

Figure 4.3. ESP8266 ESP-01 Adapter

Figure 4.4 shows the ESP8266 ESP-01 module that can use as a serial Wi-Fi Bridge to add Wi-Fi capability to a project, or it can even be programmed directly and used as a little stand-alone processor. It has full TCP/IP capability built in [21]. ESP-01 module was used as a Wi-Fi bridge to connect the led matrix device to the website in the project.

Figure 4.4. ESP8266 ESP-01 Module

Figure 4.5 shows the HC-05 Bluetooth module and HC-06 Bluetooth module, first the HC-06 Bluetooth module has two operational modes: the Data mode, which can

transmit and receive data from other Bluetooth devices, and the AT Command mode, which can send and receive commands from other Bluetooth devices [22]. HC-05 used to be the sender and receiver to connect the three devices in the project.

Second, the HC-06 Bluetooth module, which is also known as a secondary module, can receive serial data when sent out from a master Bluetooth device (device able to send serial data through the air: smartphones, PC) [23]. HC-06 is used to be the receiver to convey data gathered from the other device in the project.

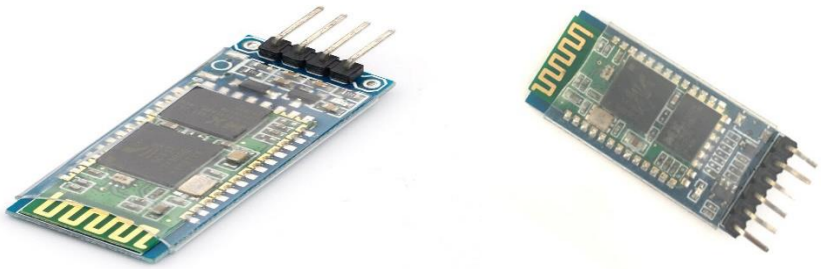

Figure 4.5. HC-05 Bluetooth module and HC-06 Bluetooth module

Figure 4.6 shows the piezoelectric buzzer, it is a sound producing piezoelectric speakers in digital quartz timepieces and other electronic gadgets [24]. Buzzer was used for notification when the room hits its maximum capacity.

Figure 4.6. Piezoelectric Buzzer

Software

Figure 5 shows the Arduino Uno IDE that makes it easy to write code and upload it to the board [25]. Arduino IDE works to write all the codes for the three devices in the project.

Figure 5. *Arduino Uno IDE*

Figure 5.1 shows the JavaScript, it is a scripting language that enables you to create dynamically updating content, control multimedia, animate images, and pretty much everything else [26]. JavaScript used to create both front end and back end of the website.

Figure 5.1. JavaScript

Figure 5.2 shows the HTML, it is the markup language that we use to structure and give meaning to our web content, for example defining paragraphs, headings, and data tables, or embedding images and videos in the page [26]. HTML works to organize text and images on the website. HTML provides structure for all parts on the page including the header, footer element, main content, and any inline elements.

Figure 5.2. HTML

Figure 5.3 shows CCS, it is a language of style rules that we use to apply styling to our HTML content, for example setting background colors and fonts, and laying out our content in multiple columns [26]. CSS works to style the website in the project to look presentable.

Figure 5.3. CSS

Figure 5.4 shows PHP, it is a server-side scripting language that is embedded in HTML [27]. PHP works to fetch the data gathered from thing speak in the project.

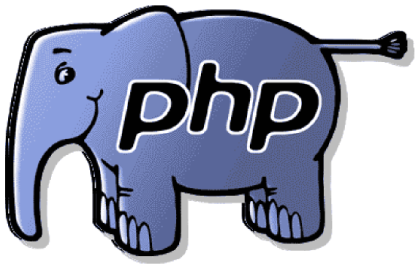

Figure 5.4. *PHP*

Figure 5.6 shows ThingSpeak, it is an IoT analytic platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud [28]. Thingspeak is used to send data from a device project to the website.

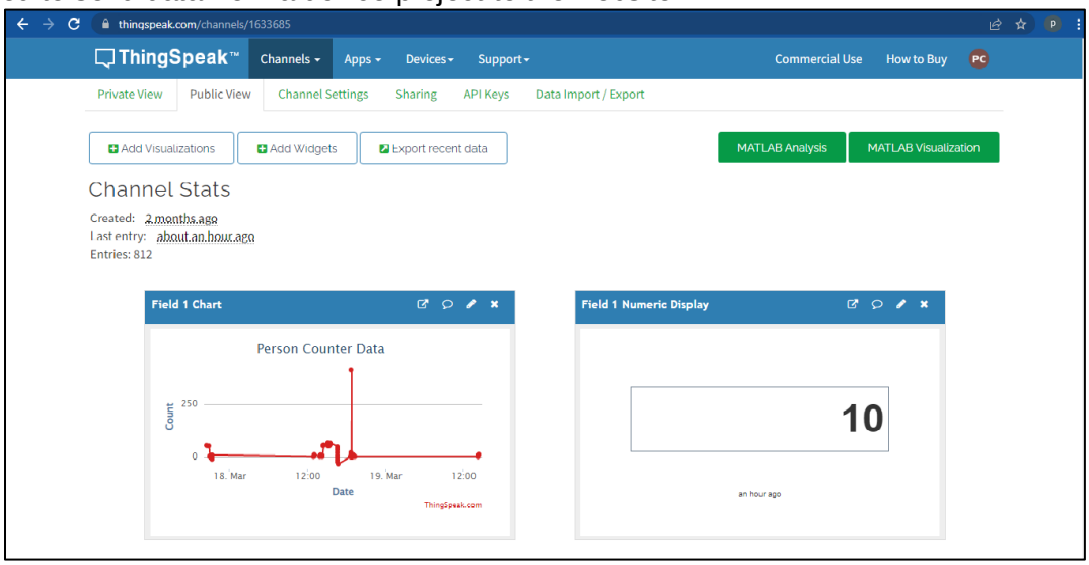

Figure 5.6. ThingSpeak

Figure 5.7 shows 000webhost, it is a free website hosting solution that provides an array of valuable features, including a website builder, WordPress support, and no ads [29]. 000webhost works as a domain in the project.

Figure 5.7. 000webhost

Prototype Sketch Design

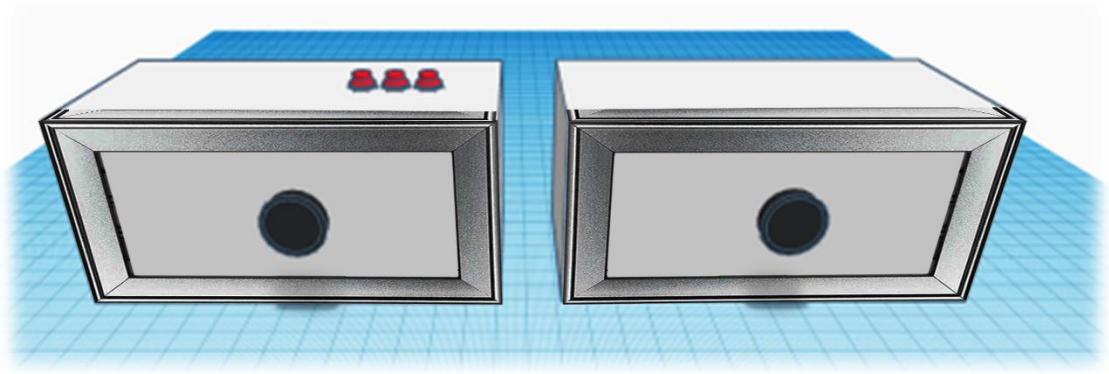

Figure 6. Full view of an Upcount (left) and Downcount (right) Device.

Shown in Figure 6, the buttons (1,2,3) are located at the top right corner of the upcount device. The button (1) is used to add, button (2) is used to subtract and button (3) is used to change the alert level of the device. While the ultrasonic sensor (4) is located at the center front part of the upcount device.

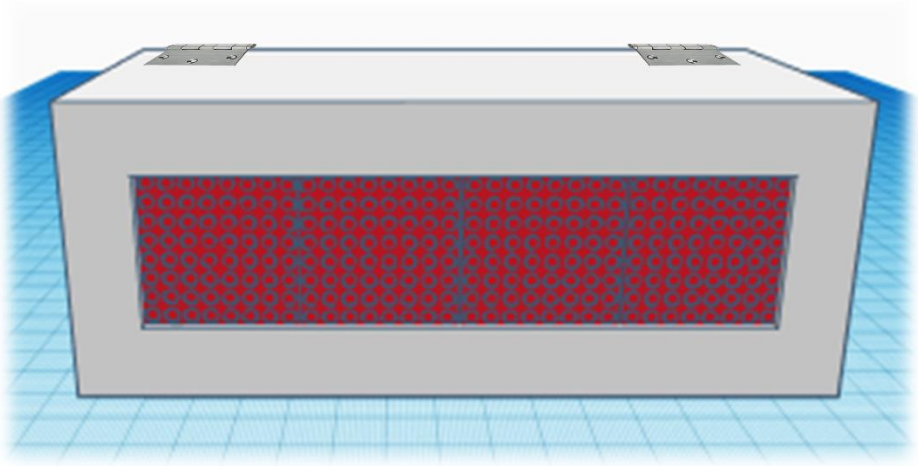

Figure 6.1 Full view of a Led Matrix Display Device.

Shown in Figure 6.1, the led matrix (1) is located in the center front of the device.

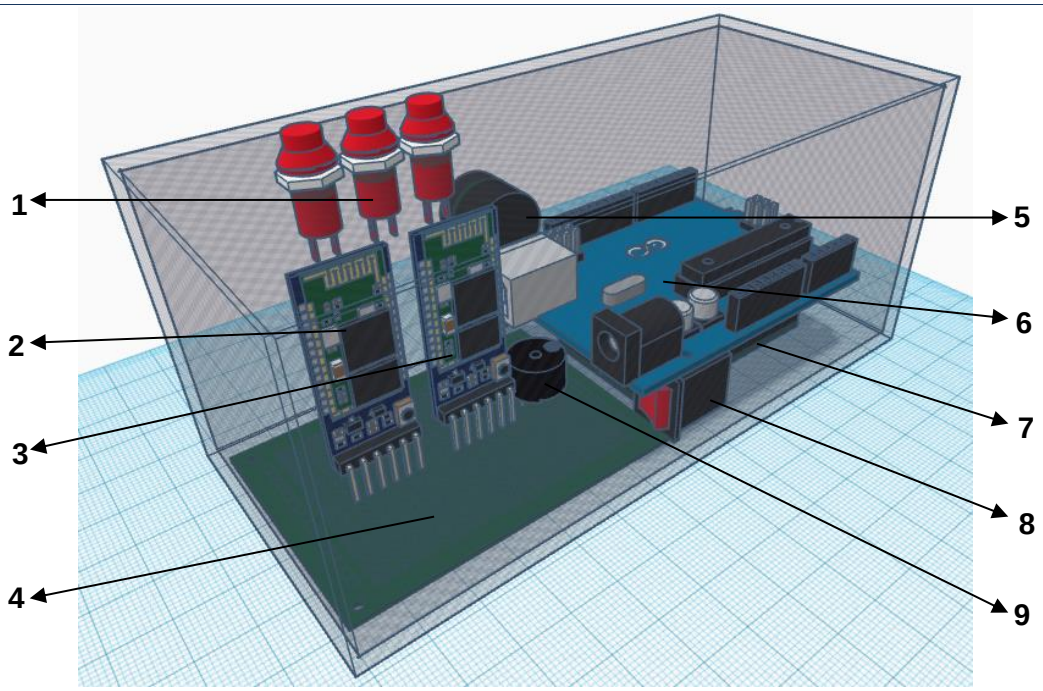

Figure 6.2 Parts and Inner View of an Upcount Device.

Shown in Figure 6.2, the buttons (1) were located at the top right of the upcount device. Both HC-06 sender (2) and HC-06 receiver (3) were located below the buttons. The PCB (4) is located in the right base part of the device and the buzzer (9) is located on top of it. The ultrasonic sensor (5) is located in the center part of the device. The Arduino microcontroller (6) is located above the battery holder (7). The switch (8) is located behind the PCB.

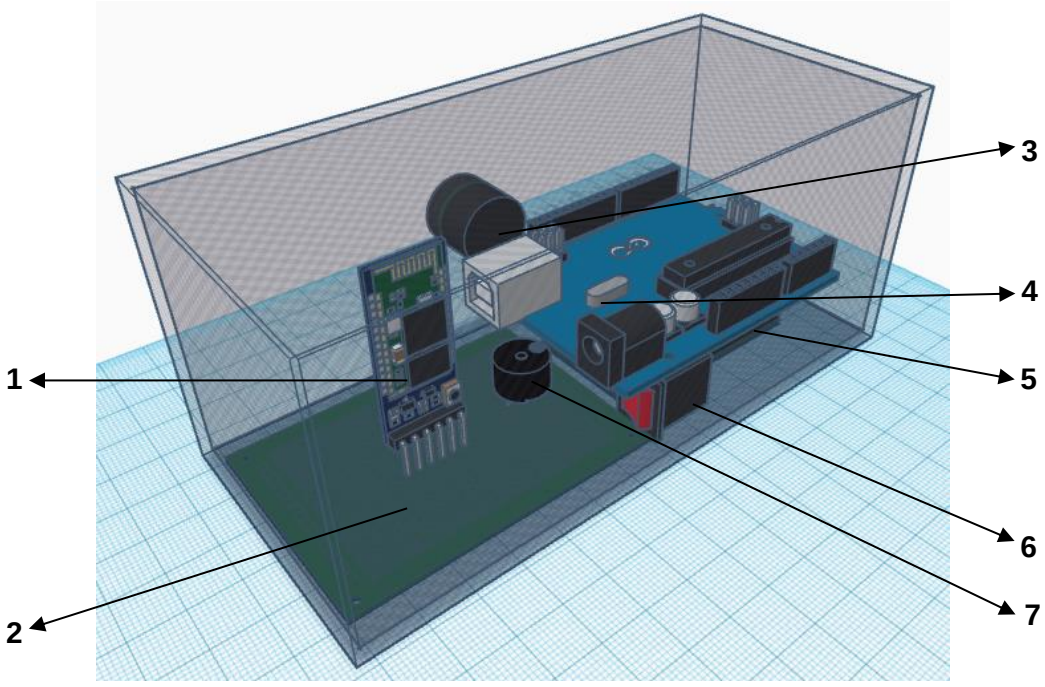

Figure 6.3 Parts and Inner View of an Downcount Device.

Shown in Figure 6.3, HC-06 (1) is located on top of the PCB (2), and the buzzer (7) is located on top of it. The ultrasonic sensor (3) is located in the center part of the device. The Arduino microcontroller (4) is located above the battery holder (5). The switch (6) is located behind the PCB.

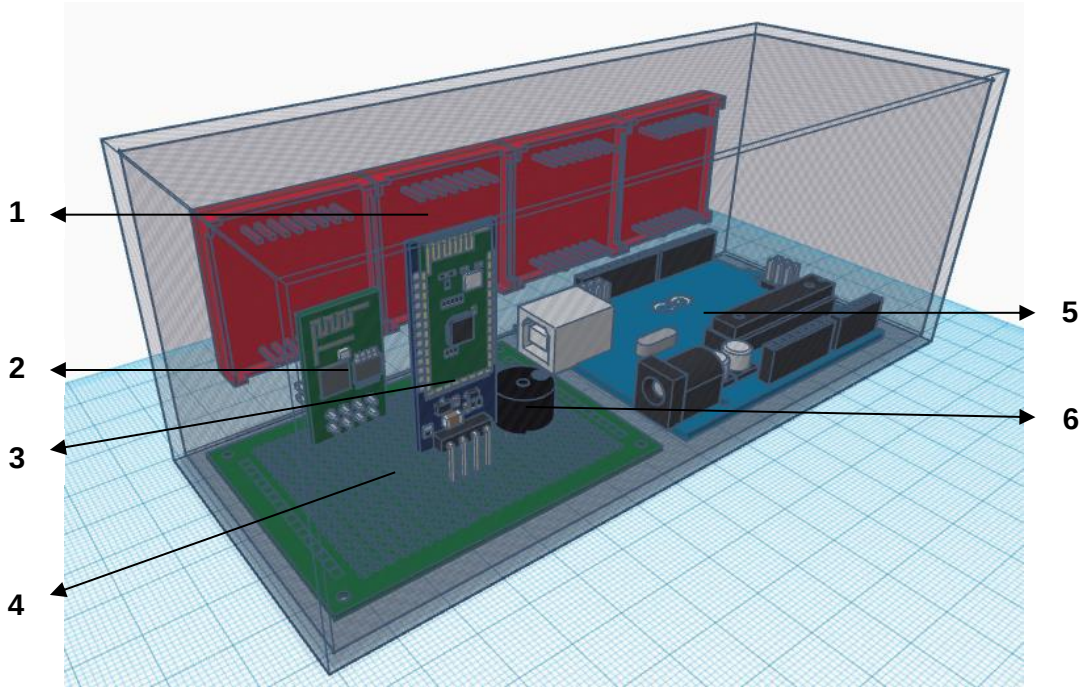

Figure 6.4 Parts and **I**nner View of the Led Matrix Display Device.

Shown in Figure 6.4, the led matrix is located in the center part of the device. ESP-01 (2) and HC-06 (3) and the buzzer (6) is located on top of the PCB (4). The Arduino Microcontroller is placed next to the PCB.

Testing and Evaluation

The distance accuracy test will be using the percent error formula 1:

$$\text{Percent error} = \frac{|Measured\ distance\ -\ Actual\ distance|}{Actual\ distance} \times 100 \qquad (1)$$

$$\text{Accuracy Percentage} = 100\% - \text{Percent error}$$

RESULT AND DISCUSSION

Person Counter IoT Based Devices

Figure 7. The Person Counter IoT Based Devices

Figure 7 shows the three small devices constructed to reduce the spread of the virus by expanding social distance and reducing building overcrowding. The main electronic components of the devices are the Microcontroller, Distance Sensors, a Led Matrix, Bluetooth Module, and ESP-01 8266. These devices are for small businesses. The upcount and downcount device's distance sensor facing forward can detect people up to 50 centimeters away. The upcount has buttons in the upper left corner for adjusting the capacity level and the number of people limits. The Led Matrix Display is placed in front of the Led Matrix Device to view the data. The design of the machine was constructed with three small devices with a casing made from wood for it to be strong and will be repaired fast in the future. It contains various hardware components assembled inside the case of the three devices.

Table 1. The foot counter of person entering the room and the data sent to the website.

Trial	Entry Count in Module Detection	Led Matrix	Website
1	Counted	1	Yes
	Counted	2	Yes
	Counted	3	Yes
	Counted	4	Yes
	Counted	5	Yes

2	Counted	6	Yes
	Counted	7	Yes
	Counted	8	Yes
	Counted	9	Yes
	Counted	10	Yes
3	Counted	11	Yes
	Counted	12	Yes
	Counted	13	Yes
	Counted	14	Yes
	Counted	15	Yes
4	Counted	16	Yes
	Counted	17	Yes
	Counted	18	Yes
	Counted	19	Yes
	Counted	20	Yes
5	Counted	21	Yes
	Counted	22	Yes
	Counted	23	Yes
	Counted	24	Yes
	Counted	25	Yes

Shown in Table 1, all the peron who entered the room, where recorded and counted in the detector, to the led matrix, and to the website. The 5 trials from monday to friday where done smoothly, and the researchers did not encounter any problem.

Table 1.1 The foot counter of person exiting the room.

Trial	Exit Count in Module Detection	Led Matrix
1	Counted	25
	Counted	24
	Counted	23
	Counted	22
	Counted	21
2	Counted	20
	Counted	19
	Counted	18
	Counted	17
	Counted	16
3	Counted	15
	Counted	14
	Counted	13
	Counted	12
	Counted	11

4	Counted Counted Counted Counted Counted	10 9 8 7 6
5	Counted Counted Counted Counted Counted	5 4 3 2 1

Shown in Table 1.1, all the peron who exited the room, where recorded and counted in the detector, to the led matrix, and to the website. The 5 trials from monday to friday where done smoothly, and the researchers did not encounter any problem.

Table 2. The estimated distance covered by the sensor between the person entering.

Trial	Entry Counting Module	Person Distance to the Module
1	Detected	46 cm
2	Detected	47 cm
3	Detected	48 cm
4	Detected	49 cm
5	Detected	50 cm
6	Not Detected	51 cm
7	Not Detected	55 cm
8	Not Detected	65 cm
9	Not Detected	75 cm
10	Not Detected	100 cm

Table 2.1 The estimated distance covered by the sensor between the person exiting.

Trial	Entry Counting Module	Person Distance to the Module
1	Detected	46 cm
2	Detected	47 cm
3	Detected	48 cm
4	Detected	49 cm
5	Detected	50 cm
6	Not Detected	51 cm
7	Not Detected	55 cm
8	Not Detected	65 cm
9	Not Detected	75 cm
10	Not Detected	100 cm

Shown in Table 2 and Table 2.1, the sensor can only detect the person from 20cm up to 50cm only. While 51cm and up, the sensor cannot detect the person anymore. All the trials were done completely and there were no problems encountered.

Table 3. The number of people counted by entering and exiting the establishment.

Person	Way In/Out	Entry Count	Exit Count	People Count
1	In	Yes	No	1
2	In	Yes	No	2
1	Out	No	Yes	1
3	In	Yes	No	2
2	Out	No	Yes	1
4	In	Yes	No	2
5	In	Yes	No	3
6	In	Yes	No	4
3	Out	No	Yes	3
4	Out	No	Yes	2
5	Out	No	Yes	1
6	Out	No	Yes	0

Based on the results given in Table 3, we conducted a week of testing to fill in the data needed on the website and determine the accuracy of the devices. Furthermore, some individuals entered the establishment, but none had left yet. If we compare the results, the upcount and downcount are not the same, and if none of the customers leaves yet the number of individuals inside the establishment will remain the same, and if some of them go, the number inside will decrease vice-versa. The data below shows the successful test for the accuracy of devices one and three by almost meeting the exact value detected, thus making the distance sensor accuracy high.

Table 4 The status when the maximum capacity of each alert level has been reached and exceeded.

Alert Level	Capacity	Count	Exceeded Capacity	Alarm Notification
1	30	29/30	No	No
		30/30	No	No
		31/30	Yes	Yes
2	25	24/25	No	No
		25/25	No	No
		26/25	Yes	Yes
3	15	14/15	No	No
		15/15	No	No
		16/15	Yes	Yes
4	10	9/10	No	No
		10/10	No	No
		11/10	Yes	Yes

Shown in Table 4, there are 4 alert levels, and each level has their own capacity. When the capacity of the alert level has exceeded its capacity, the led matrix will automatically alarm and produce sound from its buzzer.

Data Visualization Website

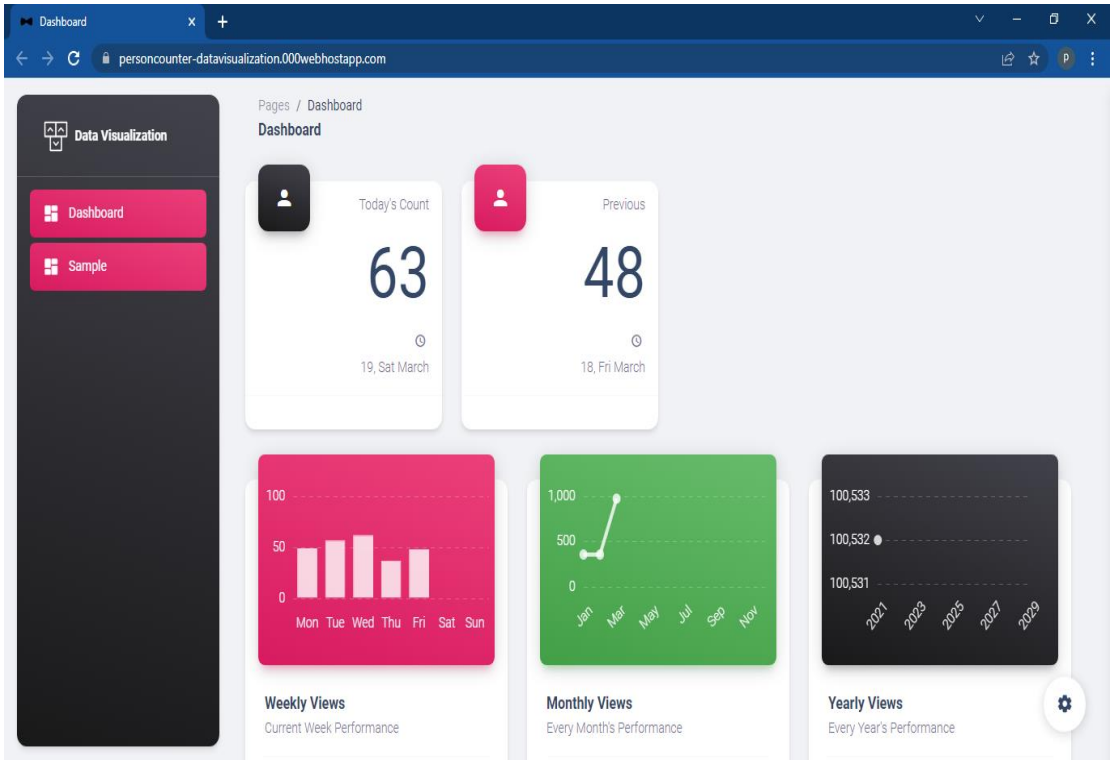

Figure 8. Dashboard

Data visualization can empower users to operate a business and enhance efficiency. Maintain track of every duration a person enters and exits the user's area in real-time. To provide real-time performance information by integrating data into Thing speak, passing it to a dashboard, and storing the data in Local Storage. The Person Counter-Data Visualization will show graphs of the current and previous also the total count for the week, months, and years.

By integrating two distance sensors and one led matrix, device one and device three will count people entering and leaving the establishment and display the count to LED Matrix. After connecting to the Wi-Fi server and sending the data to the ThingSpeak.com website to analyze and fetch to Dashboard. We obtain the data visualization of the people entering and exiting the establishment, wherein we can monitor the foot traffic inside the store.

CONCLUSION

This research project proposes a Two-way Person counter IOT based with Data Visualization and Decision Support System the results of this paper benefits in terms of strictly following the occupancy limit given by the government, enables people inside a establishment secure social distancing, alert if the occupancy limit has been surpassed, and show a real-time data visualization of visitor count via thingspeak to website a data which could be a great help for the users. Based on the first test our device achieved to detect persons going in and out of the establishment, at the same time with a little delay it also successfully sent the person in data to thingspeak and to our website to show a data visualization of the visitor flow, in the last testing it can display how many person is currently in the vicinity and our device also achieved to activate a sound notification whenever the person limit has exceeded. Based on the results we managed to execute our research objectives which is significant to help during crisis like this by limiting interaction and to practice social distancing a lot better.

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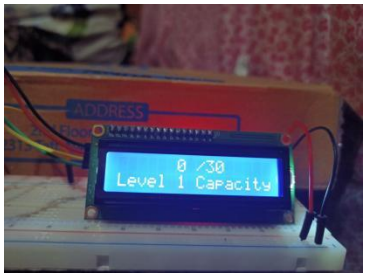
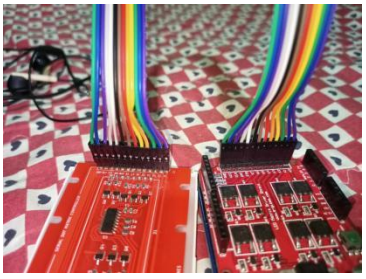
Appendix A. Documentations











Appendix B. Curriculum Vitae

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2018-2022

Appendix C. Literature Matrix

AUTHOR	OBJECTIVE/S	VARIABLES	METHOD/S	FINDINGS
Bashir, A., Izhar, U., & Jones, C. (2020, November 14). IoT-Based COVID-19 SOP Compliance and Monitoring System for Businesses and Public Offices. MDPI; www.mdpi.com. https://www.mdpi.com/2673-4591/2/1/14	To implement and monitor human social interaction during COVID-19.	IoT compliance monitoring coronavirus pandemic COVID-19 Internet of things IoT applications smart sensor crowd counting COVID compliance social distancing	The setup assumes the floor space of small retail businesses and checks for the number of people entering or leaving the space, any COVID-19 symptoms before entering, their body temperature, the distance between the queued customers, and distance between the customer and the office counter, Figure 1. Infrared obstacle detectors keep a count of incoming and exiting individuals at the entrance and exit points, providing a required measure of the number of people per	An effective solution to ensure COVID-19 safety compliance is presented in this work. The system relies on open-source software and widely available sensors to make a low cost and easy to configure and customize set up. It relays useful real-time information wirelessly to a dashboard which can be used to monitor and assist in COVID-19 SOP. The system is currently limited to check distance violation only in the specified area (i.e., queue). Future efforts will

			square meter. Upon entering the premises, the individual is required to answer the COVID-19 symptom-related questionnaire which is linked to the dashboard. They then move on for the body temperature measurement using a non-contact IR temperature sensor MLX90614.	be focused to expand the detection for the complete floor area, contact tracing, and support for additional queues. The system can be extended easily with minimal time and is quickly adaptable to different situations.
AUTHOR	OBJECTIVE/S	VARIABLES	METHOD/S	FINDINGS
Kelemen, M., Virgala, I., Kelemenová, T., Miková, Ľ., Frankovský, P., Lipták, T., & Lörinc, M. (2015). Distance measurement via using of ultrasonic sensor. Journal of Automation and Control, 3(3), 71-74.	To measure time to fly of ultrasonic sound wave from sensor to detected object.	Ultrasonic distance measurement sensor uncertainty	Ultrasonic distance sensor with analogue output 0 – 10V has been selected for testing. The sensor uses 300 kHz sound frequency. Measurement range is from 120 mm up to 1000 mm and it has linear characteristic Repeat accuracy is ±0.15% and	Ultrasonic sensors have variety application as distance measurement, obstacle avoiding and anti-collision detection, robot navigation, measurement in automotive parking assistance systems, measurement of air flow velocity - anemometer, medical ultrasonogra

			resolution is 0.037 mm.	phy, nondestructive testing, piezoelectric transducers, level measurement, pallet detection on forklifts, vehicle detection in barrier systems etc. Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target, and can detect certain clear or shiny targets otherwise obscured to some vision-based sensors.
AUTHOR	OBJECTIVE/S	VARIABLES	METHOD/S	FINDINGS
Beymer, D. (2000, December). Person counting using stereo. In Proceedings Workshop on Human Motion (pp. 127-133). IEEE.	Our approach to person counting is to track stereo blobs within a 3D volume of interest. A stereo camera is mounted in the ceiling near the door, pointing straight down. An operator first	Stereo camera Occupancy maps Gaussian mixture models Person detector	We describe the hardware setup for our person counter, including the camera setup, calibration, and specifying the volume of interest	The main contributions of this paper are the introduction of the occupancy map and the use of Gaussian mixture models for tracking multiple

	specifies a 3D volume of interest in a normally empty region by the door, but outside the door swing region. The person counter then detects and tracks the heads and upper torsos of people as they pass through the volume of interest.			people. The occupancy map remaps stereo disparities in a way that simplifies camera viewpoint and subsequent modeling. In our person counting problem, it turned the problem of tracking irregularly shaped blobs with varying depth into one of tracking Gaussian shaped blobs.
AUTHOR	OBJECTIVE/S	VARIABLES	METHOD/S	FINDINGS
Cronin, C. J., & Evans, W. N. (2020). Private precaution and public restrictions: what drives social distancing and industry foot traffic in the COVID-19 era? (No. w27531). National Bureau of	First, SOE declarations reduce foot traffic and increase social distancing by statistically significant amounts in all models. Between seven and 28 percent of the total decline in mobility is due to SOE declarations. Second, SAH restrictions explain between	Foot traffic Social distancing	We use foot traffic data from cell phone records provided by SafeGraph to estimate the impact of state and county SAH restrictions on foot traffic in six key industries (nonessential and essential retail, entertainment , hotel,	We find that restaurant dine-in bans have large effects on restaurant foot traffic. In fact, two weeks post-policy, the dine-in ban had a larger effect on restaurants than any other policy – the ban yielded a

Economic Research.	three and 26 percent of the decline, depending on the mobility measure. Third, restrictions on particular industries have predictable and measurable impacts, similar in magnitude to the SAH restrictions. For example, restrictions on dining in restaurants reduce traffic in restaurants, hotels, and nonessential retail. Entertainment bans reduce traffic in that sector, as well as in restaurants. Fourth, bans on gatherings of 50 or more people have little impact on most sectors. Finally, private, self-regulating behavior explains over three quarters of the decline in foot 3 traffic in discretionary industries.		restaurant, and business services), plus an aggregate measure of social distancing (the fraction of cell phones home all day)	roughly 15 percent reduction in traffic. Results are similar for entertainment bans on the entertainment industry. The dine-in and entertainment bans lead to large reductions in foot traffic in complementary industries as well.

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Research Adviser's Acceptance Form URDC-F02

August 25, 2021

✓ I hereby accept the proponents:

1. Brendan Keith Q. De la Cruz
2. Ria Angelica G. Fugaban
3. Lance Romnil P. Ubiña
4. Lyka Angela P. Viloria

as research advisees for the study,

Two-way Person Counter IoT Based with Data Visualization

for the School Year 2021-2022

I promise to abide by my duties and responsibilities and ascertain that my advisees finish their research output on schedule and according to the rules set by the University Research and Development Center.

Conforme:

_____

Printed Name and Signature of Adviser

☐ I cannot accept the above thesis/research advisership due to the following reasons:

_____

_____

_____

_____

Printed Name and Signature of Adviser

UNIVERSITY of SAINT LOUIS
TUGUEGARAO CITY, PHILIPPINES

Progress Report Form

Name of the Proponent/s	1.	4.
	2.	5.
	3.	
Working Title		
Research Instructor		

DATE	ACTIVITIES
Aug. 20-24, 2021	Activity: Searched …. Result: You were able to finalize the list of items that we will purchase for the project.

_____

Adviser's Signature over Printed Name/ Date

UNIVERSITY of SAINT LOUIS
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Certification for Initial Plagiarism Check URDC-F06

This is to certify that the research paper entitled:

TWO-WAY PERSON COUNTER IOT BASED WITH DATA VISUALIZATION
(Title of Research)

by
DE LA CRUZ, BRENDAN KEITH Q.
FUGABAN, RIA ANGELICA G.
UBINA, LANCE ROMNIL P.
VILORIA, LYKA ANGELA P.
(Name of Proponents)

Has undergone the initial plagiarism check with an originality score/grade of _____.

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EROVITA TERESITA B. AGUSTIN, DME
Name of the Evaluator

April 29, 2022
Date

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Editing Certification URDC-F08

Research Proponents: **DE LA CRUZ, BRENDAN KEITH Q.**
FUGABAN, RIA ANGELICA G.
UBINA, LANCE ROMNIL P.
VILORIA, LYKA ANGELA P.

Program: **BACHELOR OF SCIENCE IN COMPUTER ENGINEERING**

Research Title: **TWO-WAY PERSON COUNTER IOT BASED WITH DATA VISUALIZATION**

This is to certify that I have thoroughly edited the final draft of the Research of the students listed above in terms of grammar and organization.

_____ **April 29, 2022**
Editor Date

This is to certify that I have thoroughly edited the final draft of the Research of the students listed above for compliance with the APA format and style.

_____ **April 29, 2022**
Editor Date