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Development of Crowd Control and Tracing for Indoor Facility

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Abstract: The recent spread of a communicable virus-like Covid-19 has already disrupted people's daily life and even threatened our lives. The challenging problems are maintaining social distance and tracing the patients or people who may contact the patient. This study aims to provide solutions to prevent and detect individuals who may have been exposed to patients. The solutions are divided into three parts: crowd control system, RFID attendance system and trace positioning system. The module prototype with these systems are assembled with an Arduino board, ESP board and some sensors. The purpose of the methods is to limit the number of people, record time with names and maintain social distance. As a result, these systems function and work as expected and the percentage of detection of the system reached 100%. The project proved its uses and benefits, but there needed improvement to apply in society. As a recommendation, upgrading the parts and covering the exterior is an important step.

Keywords: Covid-19, Crowd Control, RFID Attendance, Tracing, Social Distance

1. Introduction

Many technologies are being researched and developed to prevent the spread of the disease in this era of the Covid 19 pandemic. COVID-19 is believed to spread mainly through droplet transmission, infecting everyone within a 1-metre distance [1]. Therefore, social and technical measures have been developed worldwide to slow down the spread of the virus and prevent its reappearance.

As each country draws closer to containing the epidemic, the Ministry of Health has reduced containment restrictions in various ways. Even though limitations on access to past sectors have loosened, some people may still avoid visiting these organisations [2]. However, these precautions do not eliminate the risk of being in a crowd. The difficulty of regulating emerging infectious illnesses spread due to human interaction and presence is exacerbated by changes like economic activities. Furthermore, pandemics can potentially break or disrupt supply networks and harm aggregate demand

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for commodities [3]. The COVID-19 pandemic, which has caused a massive global economic downturn, exemplifies this.

1.1 Evaluation of technology

Much different technology has been applied in the medical, industrial, transportation, and environmental fields. Digital health technology can facilitate pandemic strategy and response in ways that are difficult to achieve manually [4]. Some countries have integrated digital technology into government-coordinated containment and mitigation measures like monitoring, testing, contact tracing, and rigorous quarantine, which might be linked to their incidence curves flattening early [5]. Among various technologies, contact tracing is a crucial control measure for breaking COVID-19 person-to-person transmission chains [6]. Since COVID-19 symptoms are generic, asymptomatic, and often undetectable in many people, testing alone will not stop the virus from spreading. Instead, contact tracing will quickly identify an afflicted person's contacts and prevent future transmission.

To save money and time, Malaysia launched a " Mysejahtera " application to track infected or suspected cases [7]. The application is used to track the people in the whole of Malaysia. So, this method may not be too accurate. In contrast, this project is limited to use in an indoor facility for precise tracking and more efficient control of people's social distance.

1.2 Idea of Plan

This project will help limit the maximum number of people and maintain social distance. Therefore, this project aims to control the flow of the crowd in any indoor facility, record their entry-exit time, and track their position to avoid and investigate who has close contact with the Covid-19 positive people.

2. Materials and Methods

This section discusses the basic processes of project work, including the chosen materials, software and methods used.

2.1 Materials

Table 1 shows the materials and software used in this project.

Table 1: List of material and software

No.	Material	Software
i.	Arduino UNO board	Tinkercad
ii.	ESP8266	Arduino IDE
iii.	ESP32-UWB	Visual Studio Code
iv.	I2C-LCD screen	-
v.	RC522 RFID Reader	-
vi.	RFID card	-
vii.	Servo Motor	-
viii.	Ultrasonic sensor	-

2.2 Methods

The implementation of the workflow of systems on this project is shown in Figures 1, 2 and 3. Figure 1 shows the whole workflow of the crowd control system. Depending on the situation, the system will provide the needed action. Figure 2 there is the process of the RFID attendance system. When the RFID reader detects the card, it will transfer and store the data in the sheet by ESP8266. Figure 3 illustrates the workflow of the trace positioning system. It uses ESP32 with an ultra-wideband to receive the signal from another device and send it to the PC.

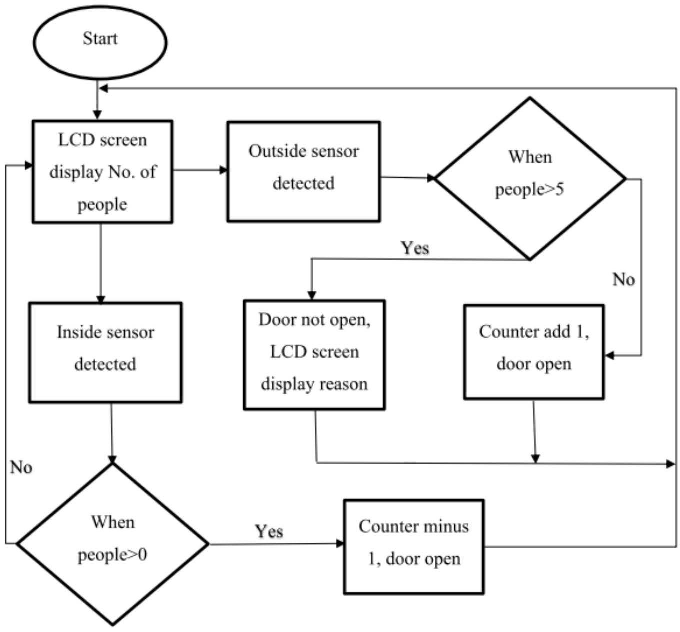


Figure 1: Workflow of crowd control system

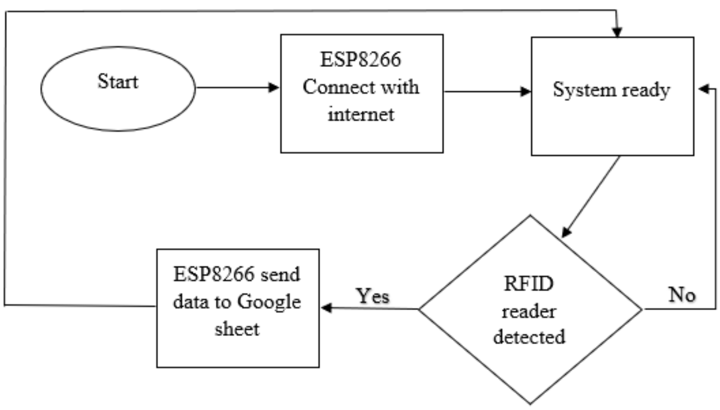


Figure 2: Workflow of RFID attendance system

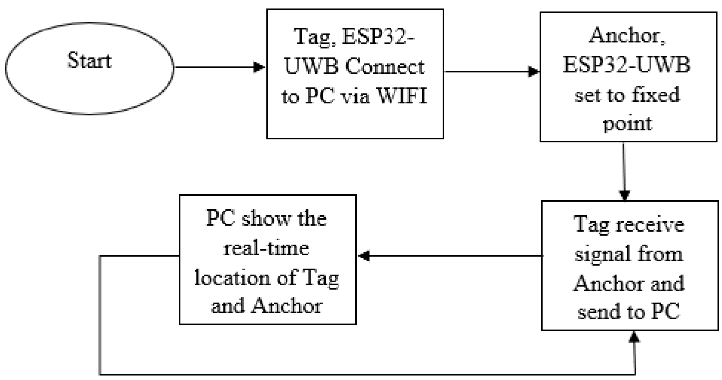


Figure 3: Workflow of trace positioning system

3. Results and Discussion

The results and discussion section presents the demonstration results of the crowd control system, RFID attendance system and trace position system. There are using a table with a cover to simulate the room situation.

3.1 Crowd Control System

The system aims to limit the number of people in a room simultaneously. Figure 4 shows the front door of the room. The door will be opened when people scan the sensor, and the system will count the number of people. The system can modify the maximum quantity of people depending on room size.

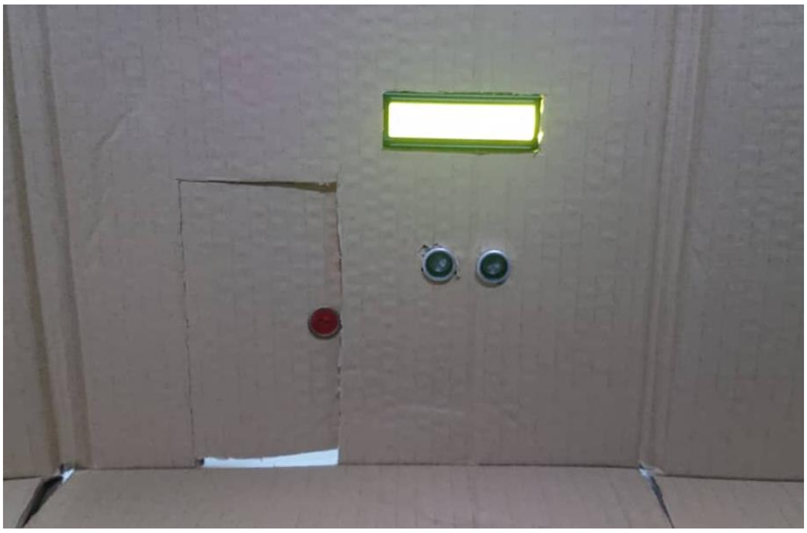


Figure 4: Front of door

Figure 5 shows the door open automatic with a servo motor. After one person has been entered, the screen shows that the number of people is 1, from Figure 6. This situation means the number of inside people is one person.

Figure 5: Door Open

Figure 6: Screen display No. of people:1

In this demonstration, the system has set the maximum number of people at 5. Figure 7 shows the screen display, Max. Occupancy reached. Figure 8 shows the people trying to scan the sensor to open the door, and the screen would be delivered 'You can't enter now' due to the room already having five people. Therefore, the system would not allow people to enter the room after the fifth person enters. There must be waiting for people to scan the inside sensor to come out. The counter of the system would be minus one. Then, the outside people can enter.

Figure 7: Reason displayed by the screen

Figure 8: Trying open the door after max. occupancy

Table 2 shows the performance of the crowd control system. The system fully succeeds in function with every detection. The crowd control system aims to simultaneously limit the number of people in a room. Therefore, every detection is very important in controlling the crowd. As a result, this system can avoid the risk of clustering and causing the spread of an epidemic.

Table 2: Performance of crowd control system

No.	Open the door by the outside sensor (Entry)	Open the door by the inside sensor (Exit)	Detection of system
1.	1	1	
2.	1	1	
3.	1	1	100%
4.	1	1	
5.	1	1	

3.2 RFID Attendance System

When people enter the room, they must register their name with an RFID card and use that card to scan the RFID reader. The ESP8266 NodeMCU would be received these data and send them to the sheet. Figure 9 shows the RFID card scan of the RFID reader. The system recorded the accurate date and time with the name on the sheet. Due to the sheet being connected to the Google account, these data were stored in Google Drive as shown in Figure 10. The user can clear these data by every 20 days. The virus outbreak would be taken 7 to 14 days, so it was estimated that the data would be cleaned every 20 days. This method would not affect the investigation and also would not lead to the issue of data leakage.

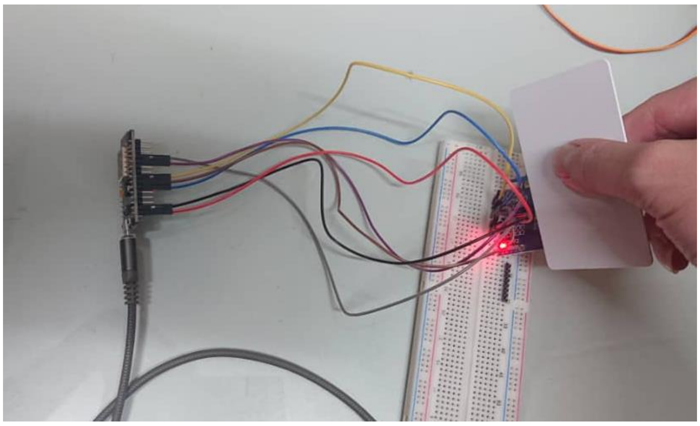
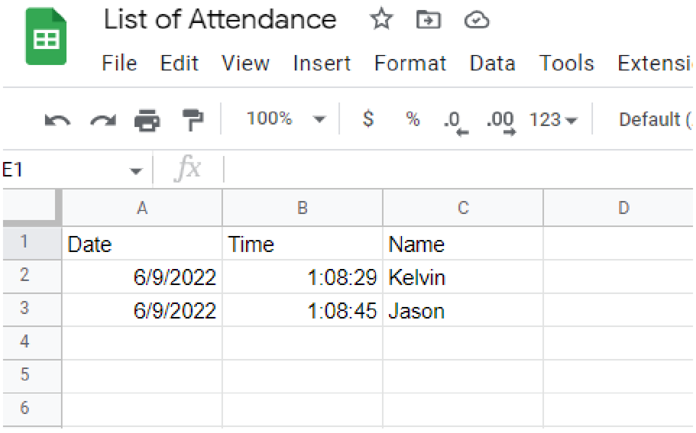


Figure 9: Scan the RFID card with the system



	A	B	C	D
1	Date	Time	Name	
2	6/9/2022	1:08:29	Kelvin	
3	6/9/2022	1:08:45	Jason	
4				
5				
6				

Figure 10: Updated information on Google Sheet

Table 3 lists the time taken for ESP8266 to send to Google Sheet. It can be analysed that the average time of sending data is 3.56s. If the internet connection is unstable or there is less signal, the time taken for ESP8266 to send the data to Google Sheet will become longer. The time taken for data transfer of fewer than 4 seconds means excellent system performance. The final goal of this system was to confront the epidemic and prevent it from spreading. When people get positive for Covid-19, the government can use the list to trace people at risk of patient contact.

Table 3: Time taken for ESP8266 to send the data to Google Sheet

No.	Time taken for ESP8266 to send the data to Google Sheet (s)	Average (s)
1.	4.00	
2.	3.20	
3.	3.60	3.56
4.	3.50	
5.	3.80	
6.	3.30	

3.3 Trace Position System

In this system, there are using 3 ESP32-UWB. Two devices become Anchor, and another one becomes a Tag. Figure 11 shows the declaration of address to Anchor with the main coding. These Anchors set the address to 1782 and 1783. Each Anchor or Tag must specify the address to justify their position. The Anchors must be calibrated to obtain the accurate distance to the Tag.

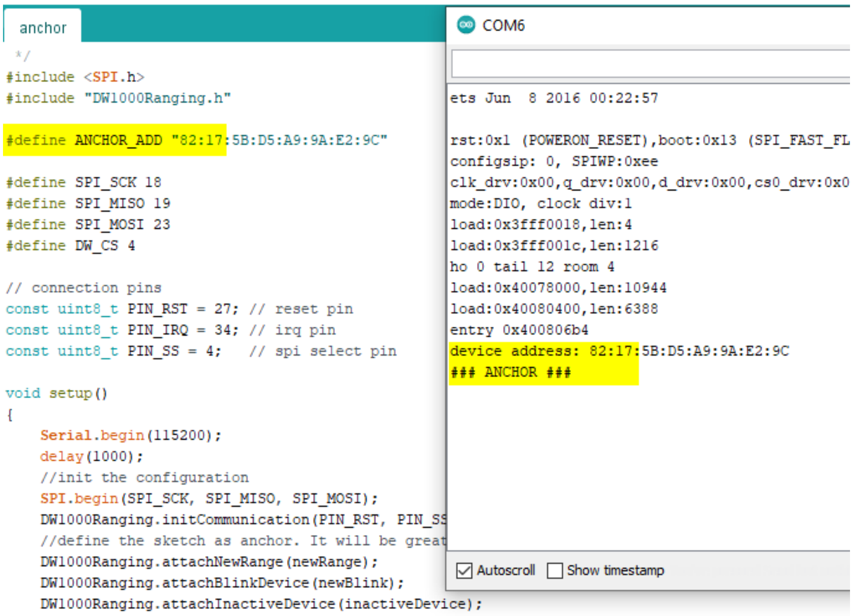


Figure 11: Declare address to Anchor

Table 4 lists the performance of Anchors and Tag before and after calibration. Anchor distance between Tag within 20cm compared to the actual distance after calibration. This result has illustrated the performance of the system is accurate in determining the indoor location.

Table 4: Testing the accuracy between Anchors and Tag before and after calibration

No.	Actual distance (m)	Distance between Anchor 1 and Tag (m)		Distance between Anchor 2 and Tag (m)	
		Before calibrate	After calibrate	Before calibrate	After calibrate
1.	8	8.83	8.12	7.14	7.98
2.	7	6.21	7.05	7.87	7.09
3.	6	5.14	5.98	6.79	6.16
4.	5	5.86	5.14	4.26	4.97
5.	4	3.43	4.05	4.60	4.07
6.	3	2.45	2.95	3.65	3.10

After setting up the Tag, the function of the Tag and Anchor can be tested. Figure 12 shows that the Tag was successfully connected to the internet and found the appeal of Anchor 1782. Then, the Tag received data from Anchor 1782 and was established in the serial monitor. It shows the range between the Tag and Anchor.

Figure 13 shows the power provided to TAG and Anchors, then run the python program on the PC side. After the Tag is connected to the PC, the graphical interface pops up like in Figure 14, to show the real-time position. The graphic display for the position in the 2D format used a plane orientation algorithm to calculate the location from 3 points. There could be added more TAG based on the requirement of the user. This system's purpose was to remind people to maintain social distance from others. Because the spreading of Covid-19 was significantly more straightforward, it could contact our eyes, nose or mouth through the air. Therefore, keeping social distance from others was the best way to prevent infection.

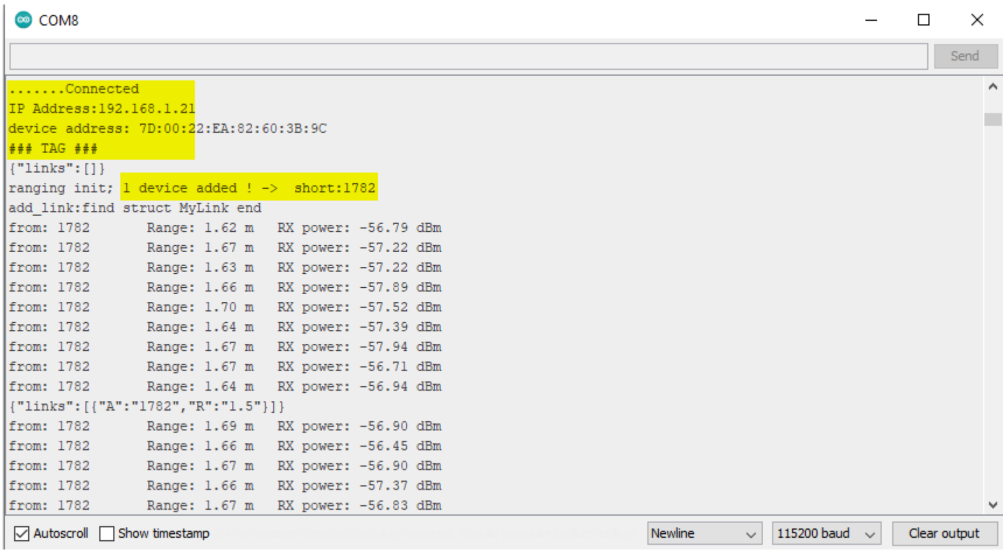


Figure 12: Testing of Tag in Arduino IDE

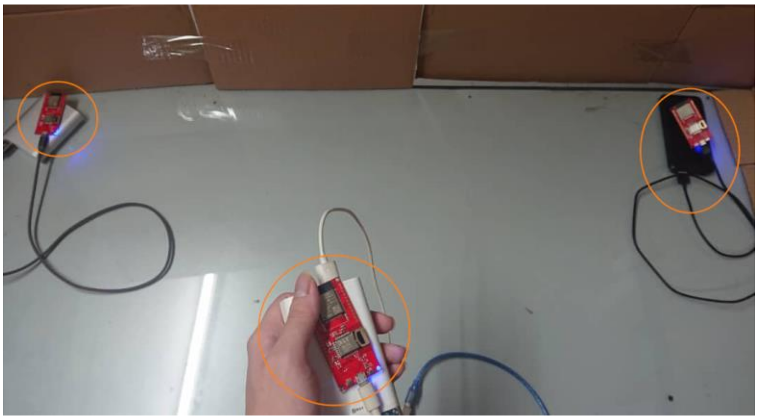


Figure 13: Working of Anchors and Tag

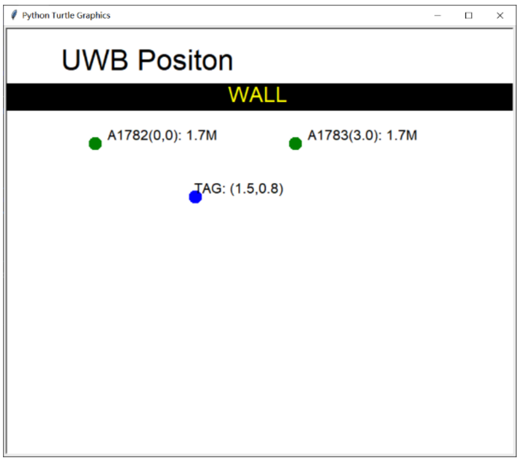


Figure 14: Graphics display of Anchors and Tag

4. Conclusion

This project has developed a prototype of a crowd control system, RFID attendance system, and trace positioning system. After the research and discovery, the crowd control system circuit was simulated by Tinkercad and assembled with hardware parts. For the RFID attendance system, the circuit connection directly uses the hardware to complete. The system is based on ESP8266 NodeMCU. It enabled the link to the internet and made the received data sent to a sheet and saved in Google Drive. Besides that, the trace positioning system was realised by ESP32 UWB. As Anchor and Tag, the Tag can collect the signal from the Anchor and send it to the PC for graphical display. These functions of systems also had been demonstrated. There are a few suggestions: upgrade the parts and cover the exterior before applying. The crowd control system could be added more sensors beside the door to detect the people who have entered or come out. Furthermore, the RFID attendance system was recommended to prepare two devices, one for writing the name to a new RFID card and one for sending data to a Google sheet. Lastly, the trace positioning system could be upgraded to a 3D graphic collection for the user used for building with different floors.

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