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IoT-based System for Covid-19 Indoor Safety Monitoring

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Abstract: The world is now facing a deadly pandemic named COVID-19. Although there are existing touchless thermometer and automatic sanitizer everywhere during this pandemic season that hit our country even the whole world.Therefore, this project aims to design an IoT based COVID-19 health monitoring system based on body temperature, sanitizing system, and air quality control.This Indoor Safety Monitoring system focusing on the entrance of the small room by displaying the reading of the body temperature and air quality at the moment.The overall system is working automatically by sensing the temperature, distance and existence of smoke. This signal will be processed by Arduino UNO as the microcontroller and send to the cloud. Users get the notification from BLYNK application that can be downloaded for Android and iOS user. The objectives of this project are achieved.

Keywords: Covid-19, Indoor Safety Monitoring, IoT

1. Introduction

Since November 2019, almost every aspect of people's lives globally has affected by the respiratory disease called COVID-19. The letters CO, VI, and D stand for corona, virus, and disease, respectively. This disease was previously known as the '2019 novel coronavirus'. First, it was discovered in China, but spread quickly to other continents in just few weeks [1]. According to [2], until 9th June 2021 the total number of identified cases was 174,744,066, while taking 3,762,784 lives worldwide.

COVID-19 virus particles travel more easily between persons indoors than outdoors. Indoors, viral particle concentrations are often higher than outdoors, where even a small breeze can quickly diminish concentrations. Ventilation mitigation solutions can help minimise virus particle concentrations when used inside. The lower the concentration, the less probable virus particles will be inhaled, contact the eyes, nose, and mouth, or fall out of the air to collect on surfaces. Airborne concentrations can be reduced, and the overall virus dose to occupants can be reduced, thanks to protective ventilation methods and measures.

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Fever, fatigue, sore throat, nasal congestion, loss of taste and smell are all symptoms of coronavirus sickness, however this virus is now unpredictable. In some circumstances, the infected person has no symptoms and simply has had close contact with someone who has been infected previously. As a result, the use of face masks and sanitizers has demonstrated to be effective in reducing illness spread [3]. With the discovery of the vaccine at the end of 2019, people all around the world will be relieved. On February 21, 2021, the first batch of Pfizer-BioNTech COVID-19 vaccines was expected to arrive in Malaysia sooner than expected. There were other four type of vaccine named Sputnik V, Sinovac, CanSino Biologics and AstraZeneca which give different per cent of efficacy rate.

When new varieties are discovered among the community, our relief fades quickly. Viruses are constantly evolving due to mutation. Several strains of the virus (SARS-CoV-2) that causes coronavirus sickness in 2019 are currently causing worry due to alterations in the virus's spike-like S protein, which it utilises to bind to and infect cells. One of these variations was discovered in the United Kingdom (B.1.1.7). This COVID-19 variety looks to be more easily transmitted and may require a higher risk of death. It includes a small impact on the effectiveness of some antibody treatments and reduces the effectiveness of antibodies generated by a previous COVID-19 infection or C-19 vaccine.

Due to these facts, governments have implemented a variety of protection and safety measures to reduce disease spread, including mandatory indoor mask wearing, social distancing, quarantine, self-isolation, and limiting citizens' movement within country borders and abroad, often in conjunction with the prohibition and cancellation of large public events and gatherings [4]. Not even the frontliners, all people in our country need to take the responsibility in following the regulation to stop this pandemic from spreading worsely.

In this project, IoT-based system for COVID-19 Indoor Safety Monitoring aiming to help people follow the COVID-19 safety rules in order to reduce the spread. This project also focuses on indoor measures such as meeting room. People should alert with their body temperature and make sure to sanitize regularly. Arduino Uno microcontroller board with contactless temperature sensor and air quality sensor is used in this project.

1.1 Literature Review

In the field of coronavirus prevention, there a many action in order to apply the prevention measure such as getting vaccinated, staying at home, wearing a mask in public, avoiding crowded places, keeping a safe distance from others, ventilating indoor spaces, managing potential exposure durations, washing hands with soap and water frequently and for at least twenty seconds, using hand sanitizer on hand, and practising good respiratory hygiene. For instant, [5] are focus on most common indoor measures - individuals with high body temperature ought to remain at home, wearing mask is obligatory and distance between people ought to be at least 1.5-2 meters. [6] also developed a system which will automatically monitor and control the device. This project is beneficial for when temperature-controlled devices turn on or off, and the client receives a message on his phone via IoT. The researcher [7] introduced An IoT Guided Healthcare Monitoring System for Managing Real Time Notifications by Fog Computing Services. Author [8] said one of the the benefits of IoT are the high-speed processing and computation of big data, efficiently generated and controlled in the diverse applications. In this [9], their project actualized a smart hand sanitizer dispenser that employments ultrasonic sensor to identify the presence of a hand, actuates the primary servo motor to pour the liquid on the hand, de-energizes the electromagnetic lock and promptly sends a signal to the second servo motor to open the entrance door. In [10], the authors able to build a system that has a structure basically isolated into four parts consist of monitoring system, information storage, data analytics administrations, and information visualization system. [10] stated that There are two potential technologies that show a strong stage for the improvement of Indoor Air Quality monitoring systems which is wireless sensor innovations (WSN) and Internet of Things (IoT).

In this work, three sensors are use in order to monitor the health and prevention caution of a person by using infrared thermometer, ultrasonic and air quality sensor which is can be integrated into one system. Therefore, this paper is organized as follows. Section 2 discusses the methodology, Section 3 explains the results and followed by a conclusion and future works in the last section.

2. Materials and Methods

This section will present the methodology used to develop the proposed health monitoring system. The first subsection presents the overall block diagram of the system, followed by the hardware development and flow chart of process mechanism.

2.1 Block diagram

Figure 1 illustrates an overview of the system design for the proposed system. For the sensor part, this system using an infrared sensor to measure temperature, air quality sensor to monitor the presence of air pollution and ultrasonic sensor to measure the distance of the target object. For microcontroller, the Arduino UNO will be used. The output from these sensors are the opening and close of the door, pumping out the sanitizer and turning on the air purifier. Essentially, the smartphone device receives data via Blynk application.

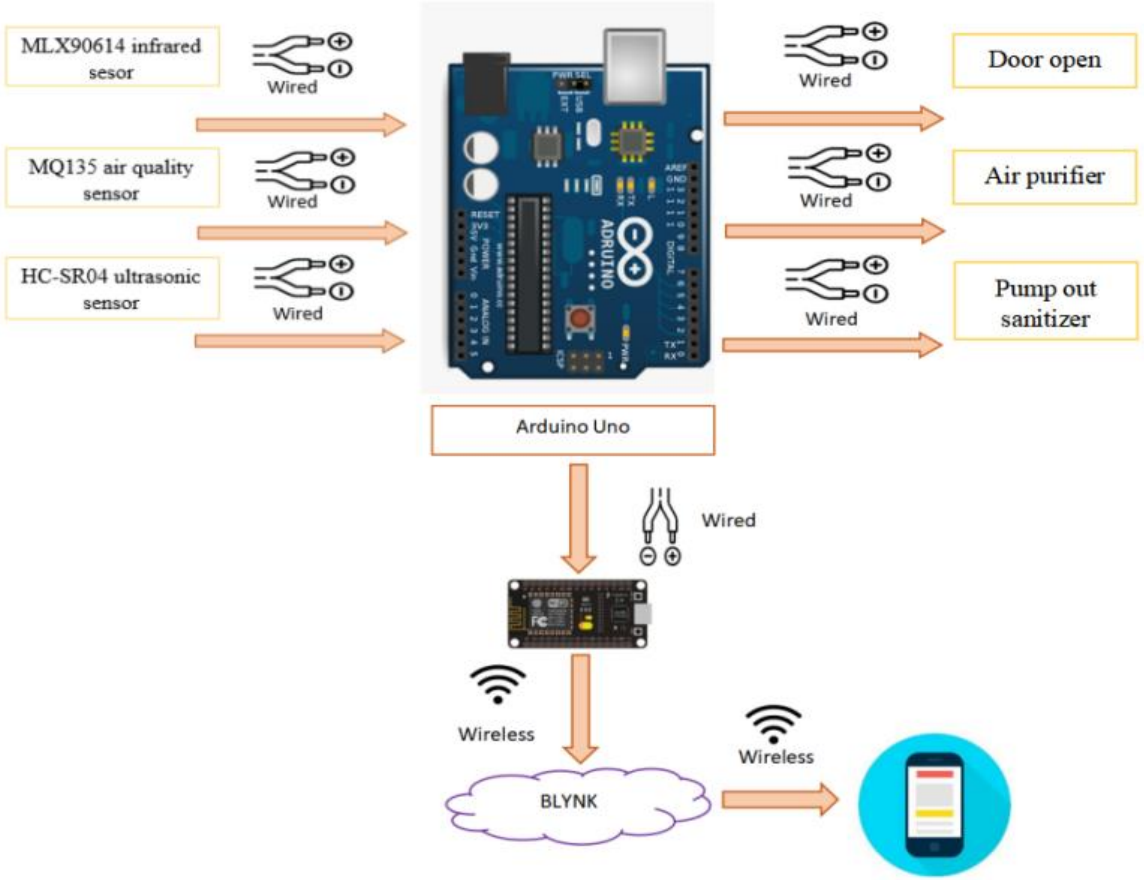


Figure 1: Block diagram of the system

2.2 Hardware Development

For this system to operate, tools and components being used is Arduino Uno board, MLX90614 sensor, HC-SR04 sensor, MQ135 sensor, ESP8266 Wi-Fi module, servo, LED bread board, battery and smartphone. Arduino Uno board is used as a microcontroller to connect between the sensors and Wi-Fi module. It enables to collect the analog output from the sensors and display the value through

smartphone, which helps in data collection for the devices. Using programming C++, the microcontroller was programmed to interface with the sensor and display the output of the sensor on the output terminal of Arduino IDE. Figure 2 shows the connection of components for hardware development.

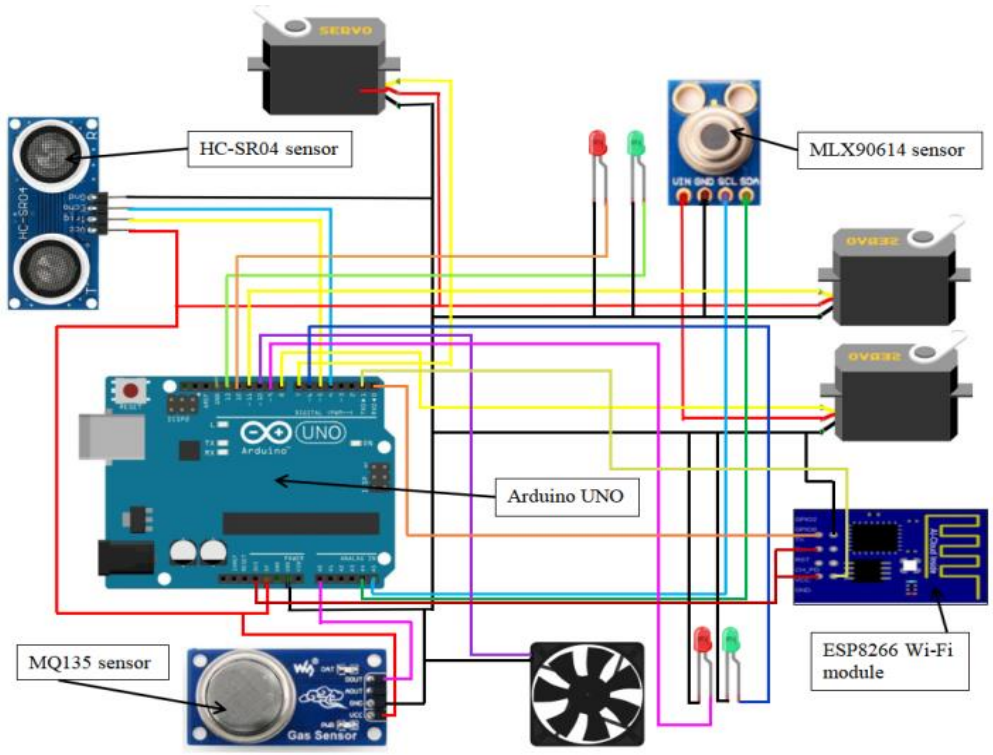


Figure 2: Connection of components for hardware development

2.3 Flowchart

The system starts when a person intends to enter a room. A person need to pass through an infrared sensor and at the same time the air quality sensor will detect the surrounding atmosphere. Ultrasonic sensor also working when a person places the hand near and the sanitizer will pump out. Arduino as the microcontroller will execute the code and fetch data from the infrared sensor and air quality sensor. The value of the body temperature and air quality from Arduino will display through handphone. To get notification from the cloud, Blynk application is used as the platform for the proposed system. Figure 3 illustrates the overall flowchart of the system.

2.4 Experimental Set-up

Five participants of both genders (four females and one male) and different ages (14 to 60 years old) are being selected as the test participants for this project. All data were recorded on a computer. One participant is having fever, one participant is not detected and the remaining participants are having normal temperature reading. During the experiment participants were placing their forehead at the infrared thermometer around 3 centimeters from the sensor. After the temperature is taken make sure the reading is normal temperature otherwise the door will not open. The participant placed their hand approximately less than 5 centimeters from the ultrasonic sensor. The servo at the sanitizer will trigger to rotate in order to pump out the sanitizer liquid. While these two sensor work, the air quality sensor is doing its own task which is measure the air quality continuously. If there is contaminants detected, the air purifier turned on automatically to filter the air at the moment. The air purifier will turn off by itself when the reading is below the risk level. There was a condition where the participant need to retake the temperature, for example if the participant scan for temperature the Blynk appear ‘Not

Detected'. The participant need to placed their forehead closer to infrared thermometer. This is because the participant too far from the thermometer to get the logic reading for a human body. The reason there are difference condition was to compare the result of effectiveness of this system.

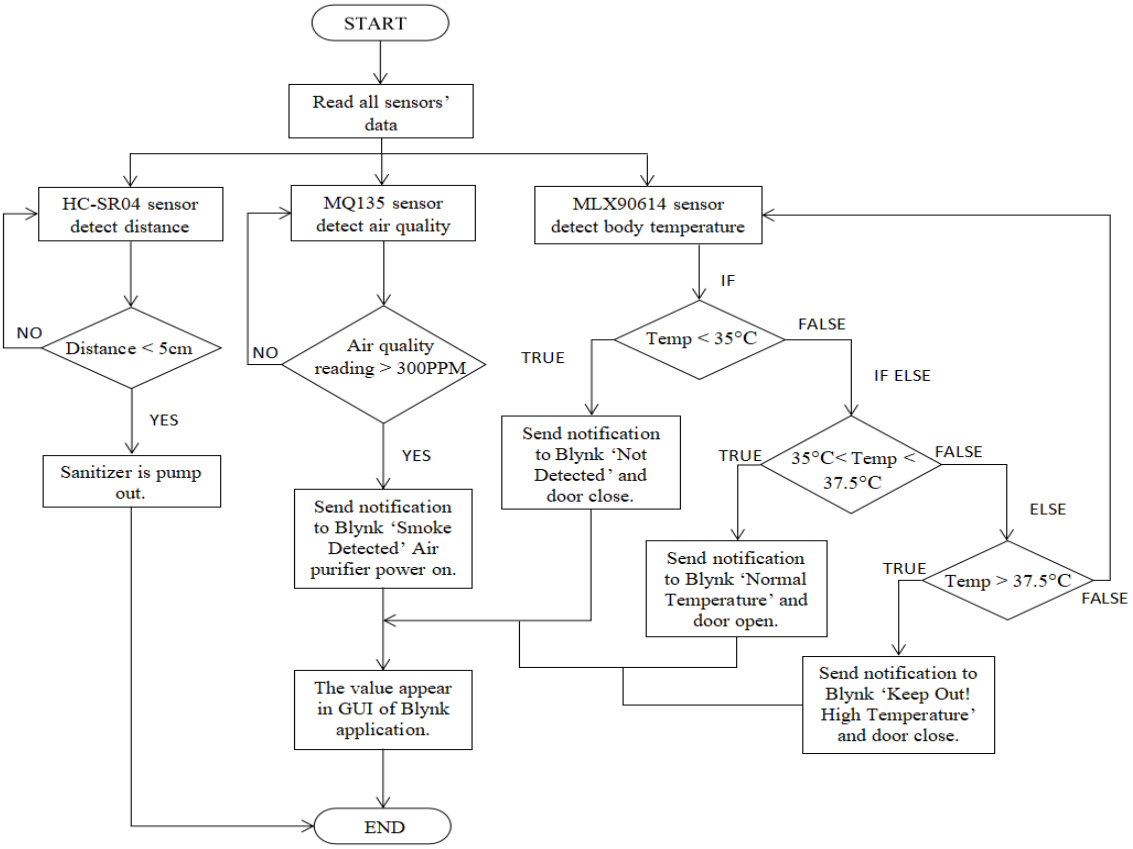


Figure 3: The operational flowchart of the system

3. Results and Discussion

The results of the data collected by record the output value of infrared thermometer sensor, air quality sensor and ultrasonic sensor using computer. For infrared thermometer sensor, the result will show the condition of the participants whether in healthy or unhealthy condition. The normal temperature range is between 35.0 - 37.5°C and the feedback from this temperature is the door is open for the person to pass through. The temperature above 37.5°C is considered as unhealthy and the door will not open for that person. For air quality sensor, the air purifier will turn on when the reading of the air quality is above 300PPM. The ultrasonic detect the distance between the hand and sensor. The sanitizer will pump out when the reading of the distance is below 5cm. The output display of the device was shown at BLYNK application. Figure 4 shows the prototype of the monitoring and notification device.

3.1 Experimental results

Five people with different condition of temperature, distance and air quality reading participated in this project. This is to prove that the IoT-based system for COVID-19 Indoor Safety Monitoring is tested and had been tabulate in Table 1.

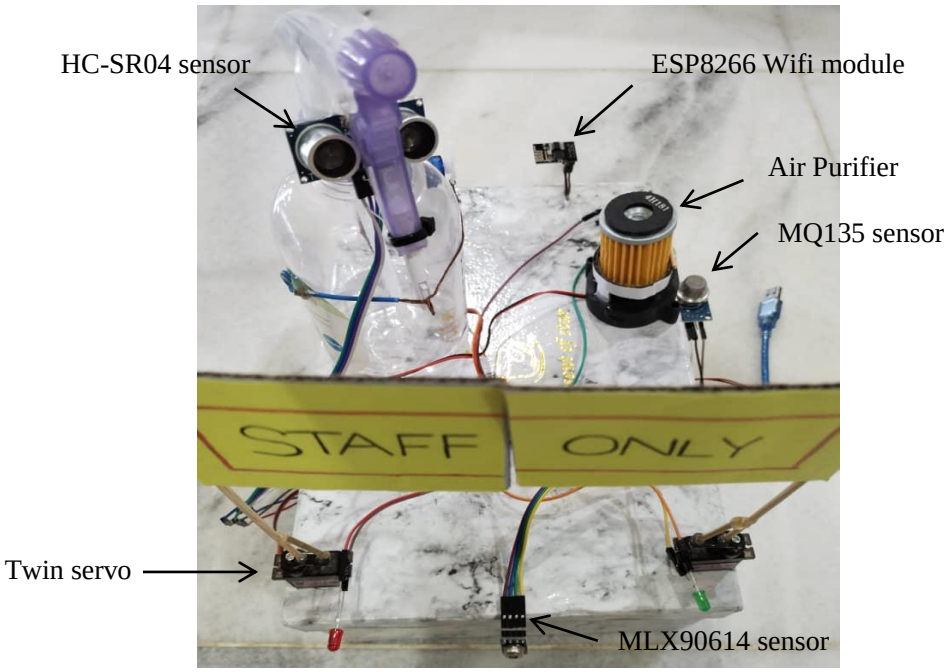


Figure 4: Prototype of the monitoring and notification device

Table 1: Result for five participants

	Temperature (°C)	Distance (cm)	Air Quality (PPM)
Person 1	36.2	3	246
Person 2	33.0	2	366
Person 3	36.7	10	242
Person 4	38.1	4	235
Person 5	37.0	1	240

3.2 Output Display of the Device

Output display for BLYNK application is shown in Figure 5 with the body temperature reading, and air quality reading. The recipient and user can monitor their body condition with help of BLYNK application. A push notification will be sent to the recipient.

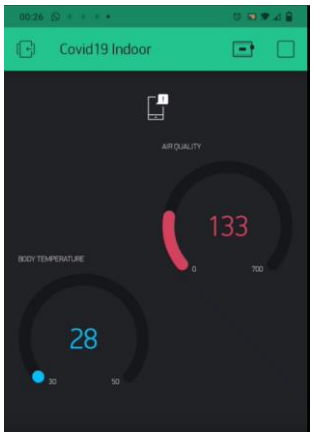
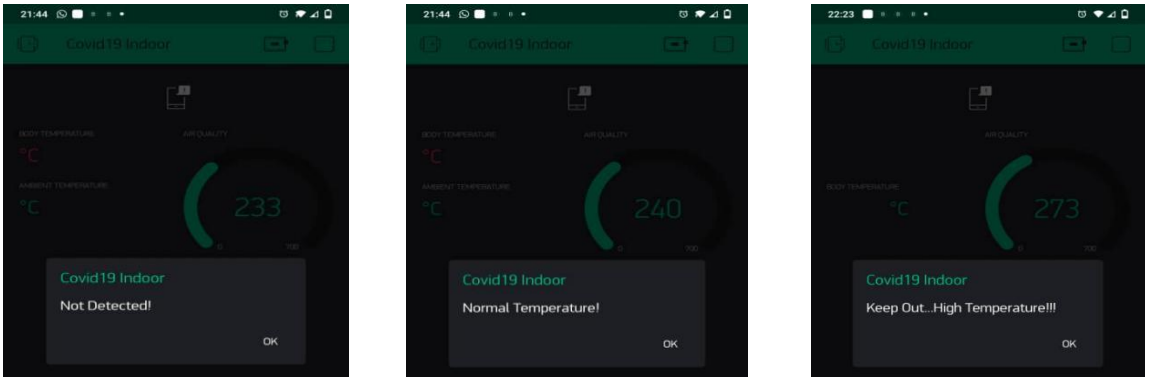


Figure 5: Display on BLYNK application for body temperature reading, and air quality reading

3.3 Results of notification via Blynk application

For result of the infrared thermometer, there is three state which is not detected, normal and keep out. All three state are shown through Blynk notification to tell the user about their current state when they scan at the thermometer. Other than that, the Blynk also will send the notification to the user when the reading at the meter gauge which is indicate the air quality turn greater than 300PPM. The Blynk notification is shown in Figure 6 and 7.



(a) (b) (c)

Figure 6: The notification appears when the temperature (a) below 35°C, (b) between 35-37.5°C, and (c) above 37.5°C

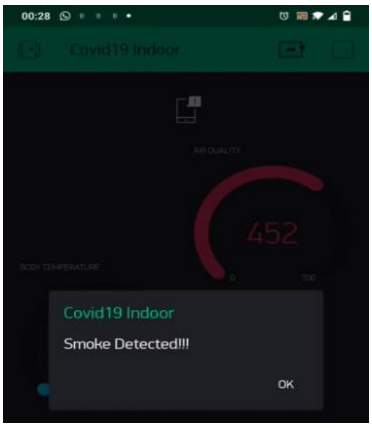


Figure 7: The notification appears when there is smoke exist

3.4 Discussion

There are three sensors that were analyzed. The result for these sensors is due to their manufacturing characteristic and coding that was set through Arduino Uno.

3.4.1 Infrared Temperature Sensor

MLX90614 sensor which is refer to infrared thermometer sensor is used as the indicator to open or close a door. A typical adult body temperature ranges from 36.4 - 37.6°C, though different sources may provide slightly different figures such as sex, age, time of day, ethnicity, body mass index (BMI), or menstrual phase [11]. In this project, the normal body temperature in range between 35.0 - 37.5°C. When a person is scanned and the body temperature between this range, the green LED will light up and the door will open to allow them to pass through. The temperature below 35.0°C is refer as 'Not Detected' because it is below the normal body temperature. While the temperature above 37.5°C is indicate as fever and will remains the door close. At the same time the red LED will light up.

3.4.2 Ultrasonic Sensor

HC-SR04 sensor is used as the hand detector. The servo is activated when distance between the hand and the sensor is below 5cm. This is because the servo will rotate 180° to pump out the sanitizer. The sensor is set not to function when the distance is greater than 5cm, this is because when the sanitizer pump out it might miss the target which is the hand.

3.4.3 Air Quality Sensor

MQ135 to detect air quality of the indoor area. The sensor work as a switch to the air purifier. The air purifier is turn on when the reading of the air quality is above 200 PPM. The initial reading of the sensor is range 100 - 200 PPM. The reading will change according to the presence of smell and smoke.

4. Conclusion

Overall, infrared thermometer, ultrasonic and air quality sensor are used to monitor and notify the health condition. MLX90614 sensor is a type of sensor used (Serial Peripheral Interface) SPI bus to measure the temperature rate value, HC-SR04 sensor is type of sensor that used ultrasonic sound waves to measure distance of a target object and MQ135 is type of sensor that used to detect excess of gases. Arduino UNO is used as a microcontroller to collect the analog output from the sensors and display in the laptop which helps in data collection for the system. The output of the body temperature and air quality can be observed at smart phone screen to monitor body condition and air quality at the moment. However, there is an obvious limitation of this system, which is the system is only suitable for small area as the device used is not accommodate in large area. Technically, the IoT part can be upgraded so that it can reduce the problem of lost signal between the hardware and software part.

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