Automated Social Distancing Gate with Non-Contact Body Temperature Monitoring using Arduino Uno

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Abstract – *With a total of 74, 390 COVID-19 confirmed cases in the Philippines[1], the country continues to implement tighter precautionary measures especially with the re-opening of business and government establishments in areas under General Community Quarantine. This paper proposes an automatic social distancing gate and body temperature detection sensor that uses infrared, ultrasonic, and infrared thermometer sensors to maximize efficiency and minimize cost. The ultrasonic and infrared sensors are coupled with a speaker to monitor and maintain the social distancing of people entering the gate. An automatic non-contact, body temperature is installed at the end of the entrance to check the temperature of individuals before finally entering the vicinity. A buzzer alarms when the detected body temperature is above normal to signal the gate personnel for immediate action. Arduino Uno runs the sensors, speaker and buzzer.*

***Key Words*: COVID-19, social distancing gate, Arduino Uno, ultrasonic sensor, infrared thermometer sensor**

MOTIVATION: Physical/Social distancing of 1 meter has been recommended as one of the best solutions to stop the spread of COVID-19[2]. The coming in and out of people in public entrance and exit gates is one of the scenarios wherein people tend to come in close contact with each other. Moreover, in the Philippines, human body temperature is simply monitored manually in every public entrance. This poses additional risk of contacting the virus with the social distancing being held at stake. Thus, this proposal of automating the social distance and body temperature monitoring in public entrance gates using robotics emerged.

1. INTRODUCTION

The COVID19 pandemic which started in Wuhan, China last December 2019 has brought on a new era and new way of life- a new reality wherein social distancing has become a must for survival. With a markedly high worldwide infection of 15, 012, 731 confirmed cases and 619, 150 deaths[3], as well as markedly increasing national infections and deaths, the Philippines COVID-19 control and prevention demands the wearing of masks and a social distancing of 1 meter between individuals as the virus can spread through the saliva and through human contact.

A major challenge to prevent the COVID19 infection is imposing social distancing especially in public places. Thus, we have come up with an automated social distancing gate and body temperature machine using Arduino Uno driven ultrasonic, infrared and infrared thermometer sensors.

2. LITERATURE SURVEY

The use of Arduino Uno has been proposed to solve environmental and health issues like the segregation of garbage[4][5][6] and health monitoring with LM35 temperature sensor[7]. Shinde et al.(2019) also used the same type of body temperature sensor with NodeMCU and their data were stored in the Cloud thereafter. [8] While the use of LM35 is cost-effective, its direct contact sensing feature makes it a possible medium for virus contagion when used for mass body temperature monitoring.

Today, with the COVID-19 pandemic, non-contact body infrared thermometers have become widely available in the market. The accuracy of these thermometers has already been proven to fit health care needs in febrile persons for obtaining body temperatures [9][10][11].

Moreover, social distancing gadgets are available in the market to help prevent the spread of the COVID-19 virus. However, despite the effectiveness of these social distancing gadgets, the cost of purchasing such gadgets per person could be a burden. Therefore, a social distancing system installed in public places is much more practical such as the Raspberry pi-driven, OpenCV system that was proposed to monitor social distancing on pedestrian lanes [12].

This paper proposes a cost-effective, Arduino-driven, automatic social distancing and human body temperature monitoring system using ultrasonic, infrared, and non- contact, infrared thermometer sensor, to help prevent the spread of COVID19 at the entrance of all public places such as malls, markets, government buildings, schools and hospitals.

3. METHODOLOGY

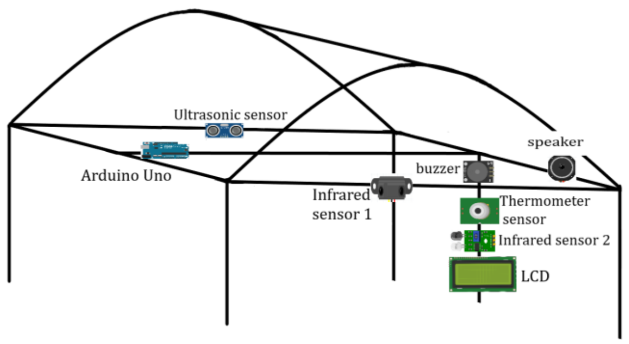

Figure 1: circuit for social distancing gate with body temperature monitoring

In Figure 1, a long range-infrared sensor 1 points to the ground to detect an incoming person, person 1, at the social distancing gate's entrance. An ultrasonic sensor then detects this person after the point of entry. The speaker sends a tone when another person, person 2, enters within the social distancing limit of 1 meter after the point of entry, directly behind the first person.

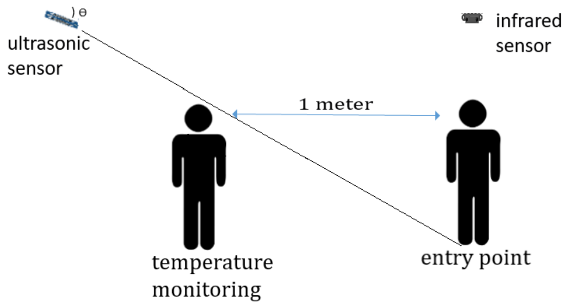

Figure 2: 1 meter social distancing

In Figure 2, the speaker sounds to notify person 2 and the gate personnel that the social distancing of 1 meter be maintained. Here, due to the minimal memory of the Arduino Uno, the speaker is only capable of sending a tone and not some warning in the form of words. Moreover, the ultrasonic sensor is placed at angle θ with respect to the horizontal.

In the middle of the social distancing gate, an automatic body temperature machine measures and displays on an LCD the incoming persons' temperature as soon as they place their forehead within the field of view (1cm) of the infrared thermometer sensor. The reading starts as soon as the infrared sensor 2, which is placed directly below the infrared thermometer sensor, detects the presence of an individual.

The buzzer alarms to notify the assigned gate personnel when the temperature reading is beyond that of an adult's forehead normal temperature, that is, 37.5 degrees Celsius or above for one who has a fever[13].

Both speaker and buzzer give off alarms when both social distancing and normal body temperature are breached.

4. BLOCK DIAGRAM

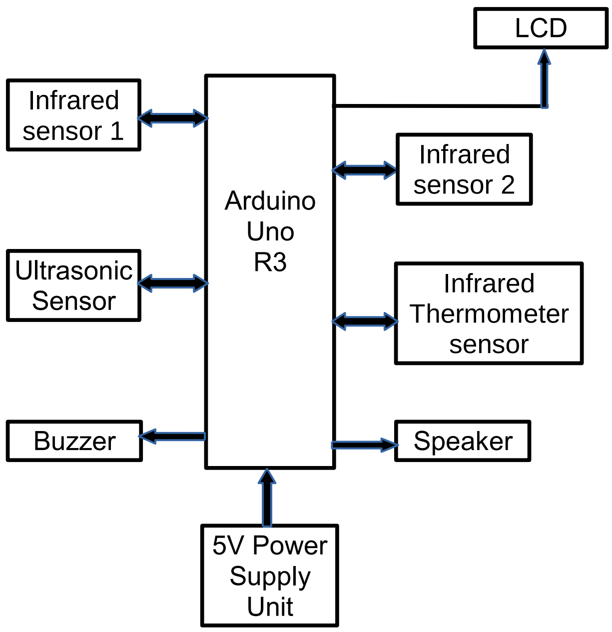

Figure 3: Block diagram for social distancing and body temperature monitoring

Figure 3 shows the overall block diagram for the social distancing and body temperature monitoring. The main blocks are the Arduino R3, infrared sensors, buzzers, ultrasonic sensor, infrared thermometer sensor, power supply and LCD display. The functions of each block will be explained in the next section.

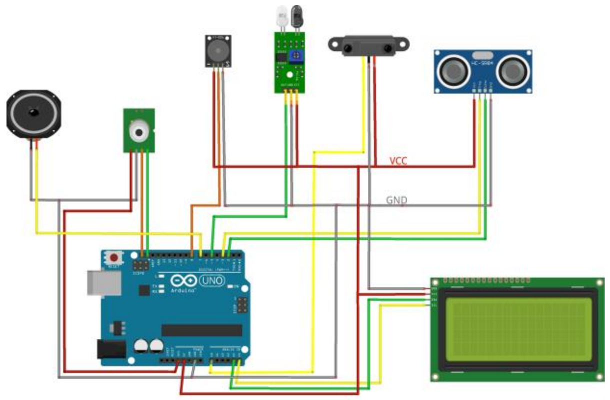

Figure 4: social distancing gate with temperature monitoring prototype.

The prototype of the automatic social distancing gate with non-contact thermometer is represented in Figure 4.

5. EQUIPMENT

5.1. Arduino UNO R3

Figure 5: Arduino UNO

Classified as an atmega series microcontroller, Arduino Uno has 14 input/output pins, specifically analog and digital inputs. It is programmed using an IDE environment with C or CPP.

5.2. Long range Infrared proximity sensor

Figure 6: infrared distance sensor

An infrared distance sensor GP2YOA21YK, with a sensing distance of up to 150 cm, is used to detect the presence of an incoming person at the social distancing gate's point of entry. The width of the gate is designed to only allow one person at a time at the entrance.

5.3. Ultrasonic sensor

Figure 7: ultrasonic sensor

Coupled with the long-range, infrared sensor, the ultrasonic sensor is primarily utilized for monitoring the social distancing of 1 meter between the people inside the gate. It emits a sound wave at a very high frequency undetectable by human ears. Functioning as a radar, it determines the object distance through frequency hits, returning as an echo.

5.4. Speaker

Figure 8: speaker

A 0.5 Watt, 8 Ohm speaker is used to send an alarm when the social distancing is violated.

5.5. Infrared proximity sensor

Figure 9: Infrared proximity sensor

The IR proximity sensor is placed below the thermometer sensor to detect the presence of an individual to start the temperature reading.

5.6. Infrared thermometer sensor

Figure 10: Infrared thermometer sensor

MLX90614ESF-BAA-000-TU-ND is a non-contact infrared thermometer sensor that is used to measure the body temperature with an accuracy of ±0.5 degree Celsius and a sensing distance within the field of view of the sensor.

5.7. LCD module

Figure 11: LCD module

A 4x20, blue LCD is used to display the person's body temperature detected by the infrared thermometer sensor.

5.8. Buzzer

Figure 12: buzzer

The buzzer is used to notify the assigned gate personnel by the alarm it makes the moment social distancing is violated and/or the adult's forehead temperature detected is above normal (greater than 37.5 degrees Celsius).

6. RESULTS

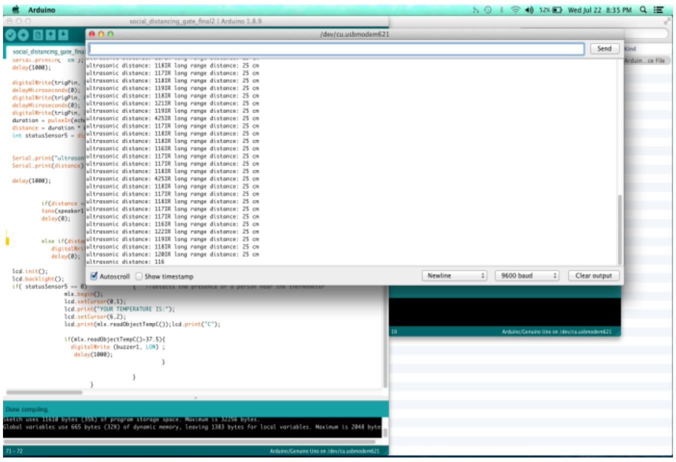

Figure 13: System simulation on the Arduino IDE

The simulation for the social distance monitoring using the ultrasonic and long range infrared sensor with automatic body thermometer on the IDE is shown in Figure 13.

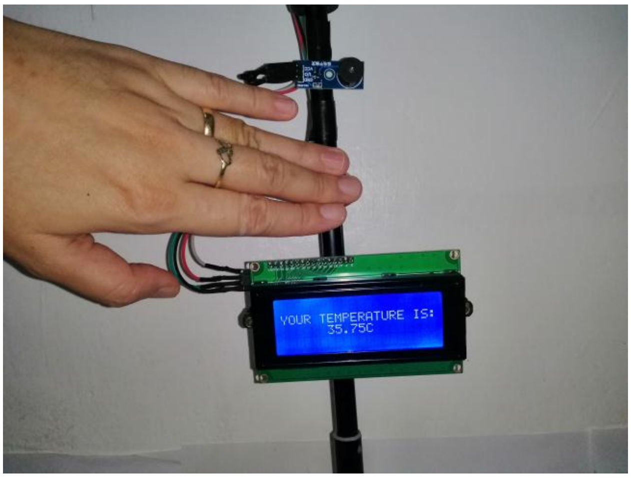

Figure 14: Temperature reading on LCD

Figure 14 shows the resulting temperature reading displayed on the LCD.

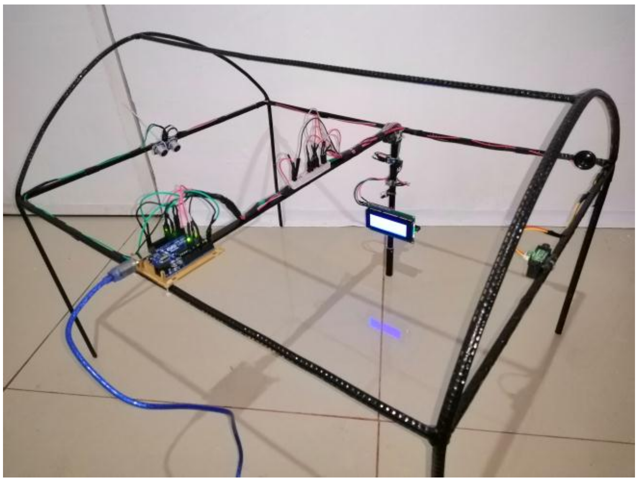

Figure 15: built system

Figure 15 is the working system for the proposed automated social distancing gate with non-contact thermometer.

7. CONCLUSION

Using this system, social distancing is maintained inside the gate and the body temperature of each individual entering is monitored automatically. The fully automated features of both social distancing and non-contact, body temperature sensing minimize person to person contact thereby preventing the spread of the COVID19 virus.

It is recommended that we also use this kind of system at all public exits with a simpler system of using the social distancing feature only. Moreover, the speaker can also be connected to an audio amplifier to increase its volume. Furthermore, a long range, higher accuracy, MLX90614ESF-DCx versions of the infrared thermometer sensor can be used.

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