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Development of Body Temperature Measurement and Face Mask Recognition System

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Abstract: The main purpose of this project is to develop a system that can measure human body temperature and can detect whether a person wearing a face mask or not from a certain distance. This project aims to reduce the rate of infection of this coronavirus 2019 (COVID-19) from spreading among workers. The system developed will be in a single package consisting of Raspberry Pi, infrared thermometer sensor, Raspberry Pi Camera V2 and an ultrasonic sensor to perform the above-mentioned functions. Through experiments, the project manages to achieve its objective successfully as it can perform the temperature measurement either normal which is between 36℃ to 37.5℃, otherwise the door will lock if the high-temperature measurement is more than 37.5℃ and face mask detection is captured in 10 seconds to display in screen with the accurate name of the employees. The outcomes of this project will make employers easier to monitor their employees' health status rapidly and contactless to avoiding COVID-19 from spreading.

Keywords: Face Recognition, Mask Detection, Body Temperature, Attendance Database.

1. Introduction

Since December 2019, the world has been shaken by coronavirus disease 2019 (COVID-19) or also known as the coronavirus pandemic. This pandemic of COVID-19 was caused by the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). China announced the first case in the world since the COVID-19 pandemic began. However, Malaysia announced its first COVID-19 case on January 25 involving three China tourists who had entered Malaysia via Johor from Singapore on January 23 [1]. Since the COVID-19 began in Malaysia, a new normal was introduced in which people have to wear face masks and keep a 1-meter distance from one another. It is important to ensure that people with symptoms are prohibited from entering public premises. Thus, all must wear a face mask, scan the MySejahtera QR code and check body temperature at the entrances [2]. However, a

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number of government or private industries use body temperature and face mask detection in one device. This technology gets less attention in Malaysia because of its relatively high price compared to manual body temperature without practical wearing a mask and using hand sanitizer for protection. Hence this project proposes a system that reduces contact with each other and practices the new normal to avoid infection [3].

1.1 Problem statement

There is a lack of a number of systems that can automatically measure human temperature and at the same time detect whether he or she wears a mask. In the context of workers who need to go to their offices to perform essential work, the task of measuring the workers' body temperature and checking face masks are done manually at the entrance by security guards. As this is done by humans who are prone to tiredness and loss of focus during performing their work, there might be an occasion when workers with high temperature or who are not wearing a mask are allowed to enter the office. Thus, it is necessary to develop an automatic system that can measure human body temperature and recognize face masks at the entrances of offices to avoid this occurrence [4]. If the temperature is above the allowed limit and no face mask is detected; the door of the office would not open then. To enhance its usefulness, the system should be able to record the details of the workers including their body temperature and face mask-wearing status.

1.2 Objectives

This project is to develop face image detection and recognition by using Amazon Web Services (AWS) Rekognition. Also, to design a body temperature by using ultrasonic and thermometer sensor from Raspberry Pi. In addition, to build the prototype of body temperature and face mask recognition system for attendance database by using Amazon Web Services (AWS) Dynamo DB**.**

2. Materials and Methods

In developing this system, Raspberry Pi, AWS Rekognition and Thermometer Sensor will be utilized as the main components that can help in solving the problem by achieving the objectives and scope of the project. Raspberry Pi, Raspberry Pi Camera V2, AWS Rekognition, ultrasonic sensor, thermometer sensor, AWS Dynamo DB and solenoid door lock will be used in this project. All of these components are required for the software and hardware to be functional.

2.1 Materials

The main component of this project which is the Raspberry Pi serves as the microcontroller of this project as in Figure 1. The AWS Rekognition purpose is to automatically extract metadata from faces and capture objects [5]. Next, ultrasonic and thermometer sensors are used to measure the distance and body temperature. Then, the AWS Dynamo DB will record the attendance and save it in the database [6]. Lastly, the solenoid door lock is used to unlock the door once the workers have recorded their attendance and passed the temperature check and wear face masks.

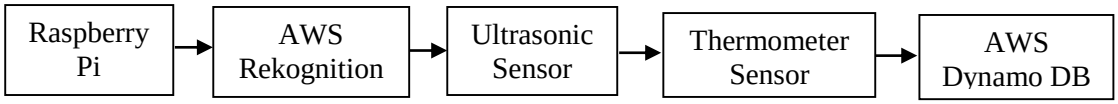


Figure 1: Block Diagram of body temperature and face mask recognition system.

2.2 Methods

This project methodology from the starting until the end process is shown in Figure 2, It comprises the activities of the project from the software installation by AWS Rekognition to hardware installation

by Raspberry Pi Imager using Python programming languages [7]. The AWS API Gateway is a managed service that can make it easy to create the request from other software such as AWS lambda with AWS Rekognition which is to extract the metadata from faces and capture objects that are received from postman software which is to save the images in base64 JavaScript [8]. AWS API gateway will request from the postman and send the instruction into AWS Rekognition so that the face and capturing objects of the mask will be received. Raspberry Pi has been used and directly connected with a VNC viewer which can be easily carried anywhere as it is highly portable.

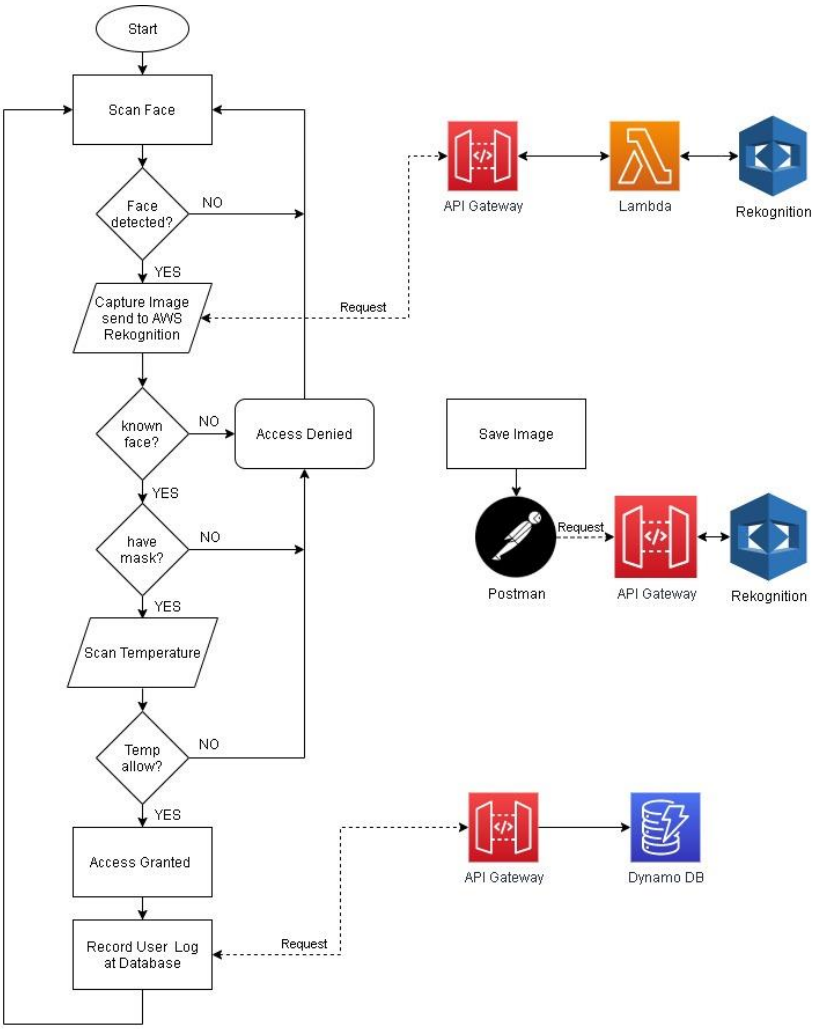


Figure 2: Process of development of body temperature measurement and face mask recognition system.

3. Results and Discussion

This chapter discusses and demonstrates the results of the developed project. It also analyses the results and evaluates the effectiveness of the project. Raspberry Pi has been used as the microcontroller that can program the code by using a python programming language. It can also create and build a system of online wireless face masks and body temperature detection systems that have been popular nowadays since the COVID-19 pandemic started. In order for the project to be successfully developed, Raspberry Pi Camera, infrared thermometer sensor, ultrasonic sensor, relay, battery 18650 and solenoid [9] has been used. The purpose of this project is to help an employer to follow the standard operating procedures (SOPs) imposed by the government. Also, it will help workers to scan their attendance without close contact with others.

3.1 Results

To demonstrate the proposed project, employees must first wear a mask before entering the premise as shown in Figure 3(a). Then they have to stop in front the screen until it displays their "Name" and "Face Mask" status as depicted in Figure 3(b). The camera captures the images and API Gateway will request to transmit then send it into AWS Rekognition so that the system will know who is behind the mask.

Figure 3(a)

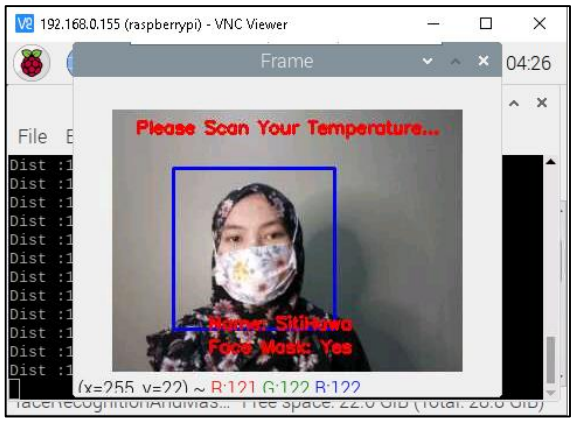


Figure 3(b)

After the system captures the images, the screen display will show "Please Scan Your Temperature". There is an ultrasonic sensor installed in the prototype which is to detect the object within a range of 8cm to 10 cm as shown in Figure 4(a). Then the infrared thermometer sensor will be triggered and measure the body temperature. The measurement of body temperature must be lower than 37.5℃. As depicted in Figure 4(b), the temperature is 36.47℃.

Figure 4(a)

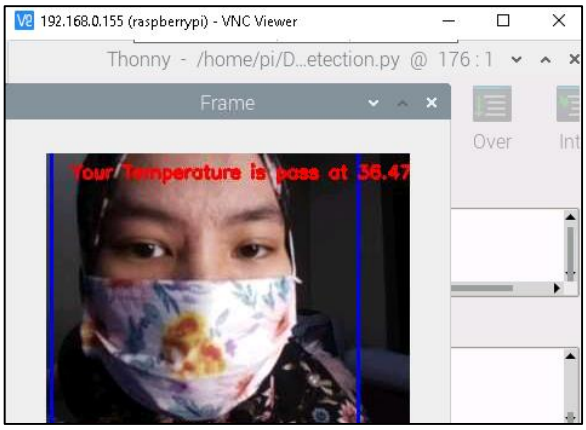


Figure 4(b)

Finally, when the measurement of body temperature has been done with lower than 37.5℃, the relay will trigger the solenoid to unlock the door as illustrated in Figure 5(a). Please note that a battery 18650 is used to supply a sufficient level of the current so that it can be triggered in a short time. The attendance will then be recorded and saved on AWS Dynamo DB as shown in Figure 5(b). It also shows the "FaceIdentity" which is the employees names, "TimeStamp" of the current date and "Temperature" of body detection.

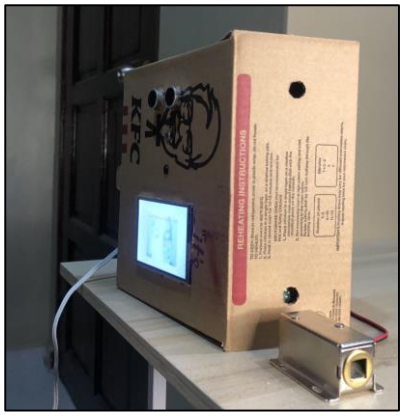


Figure 5(a)

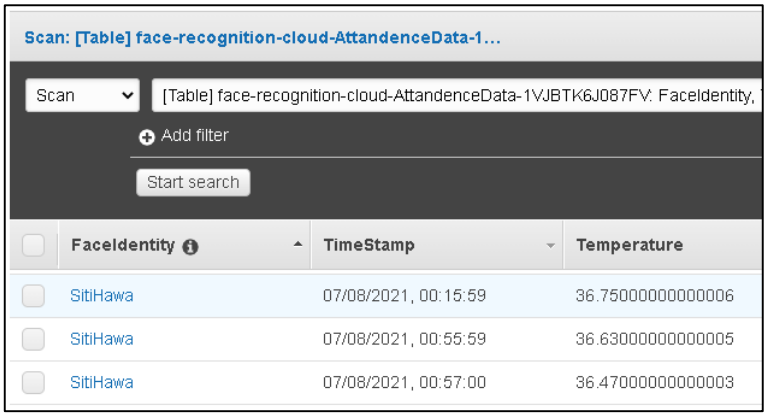


Figure 5(b)

3.2 Tables

Table 1 lists the examples of employees with face mask images that are requested on Postman and saved into AWS Rekognition. Table 2 shows the attendance that has been recorded when their face mask is on and body temperature is within the limit.

Table 1: List of example employees.

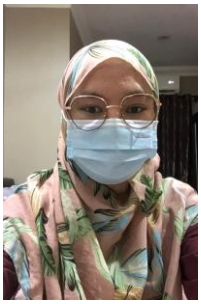
Roselee	SitiHajar	SitiRabiatulAdawiyah	SitiZulaikha	SitiHawa
				

Table 2: List of attendance records.

Name	Date / Time	Temperature (°C)
Roselee	07/08/2021, 00:27:16	36.91
SitiHajar	07/08/2021, 00:34:00	36.63
SitiRabiatulAdawiyah	07/08/2021, 00:41:35	36.85
SitiZulaikha	07/08/2021, 00:46:04	36.81
SitiHawa	07/08/2021, 00:15:59	36.75

3.3 Discussions

For the sake of reliable analysis, these experiments have been tested more than five times with different scenarios (time, colour of scarf, t-shirt, spectacles). The camera managed to detect the faces accurately within 7 to 10 seconds. Then, the “Name” of employees will be displayed on the screen shortly afterward. In the meantime, the status of “Mask” will also be displayed on the screen as soon as it captures the faces. The accuracy of the system in detecting the faces and masks is 100% successful with no error while running the prototype.

To detect the body temperature, the ultrasonic will measure the object distance within a range of 8cm to 10cm. Then the infrared thermometer sensor will scan and measure the body temperature. Figure 6 shows the comparison between using MLX90614 and the current body temperature scanner. Thermometer sensor MLX90614 has been tested to detect the body temperature in a range of 36℃ to 36.9℃ while using body temperature scanner is between 36℃ to 37.5℃. This is because the components of MLX90614 temperature reading is not very accurate but the temperature reading is consistent. The measurement of body temperature is found to have high accuracy between a range of |0.2%| to |0.8%| with the error percentage is calculated using

$$\% \text{ error} = \frac{|\text{experiment value} - \text{expected value}|}{|\text{ expected value }|} \times 100\%$$

$$\% \text{ error} < |5\%| = \text{high accuracy}$$

$$|5\%| < \% \text{ error} < |10\%| = \text{moderate accuracy}$$

$$\% \text{ error} > |10\%| = \text{low accuracy}$$

In building the database system by using AWS Dynamo DB, it has been proved that the attendance has been recorded successfully. All the requirement record “faceIdentity”, “TimeStamp” and “Temperature” has been recorded and tested with actual and accurate 100%. The “TimeStamp” has been recorded by following Malaysia local time.

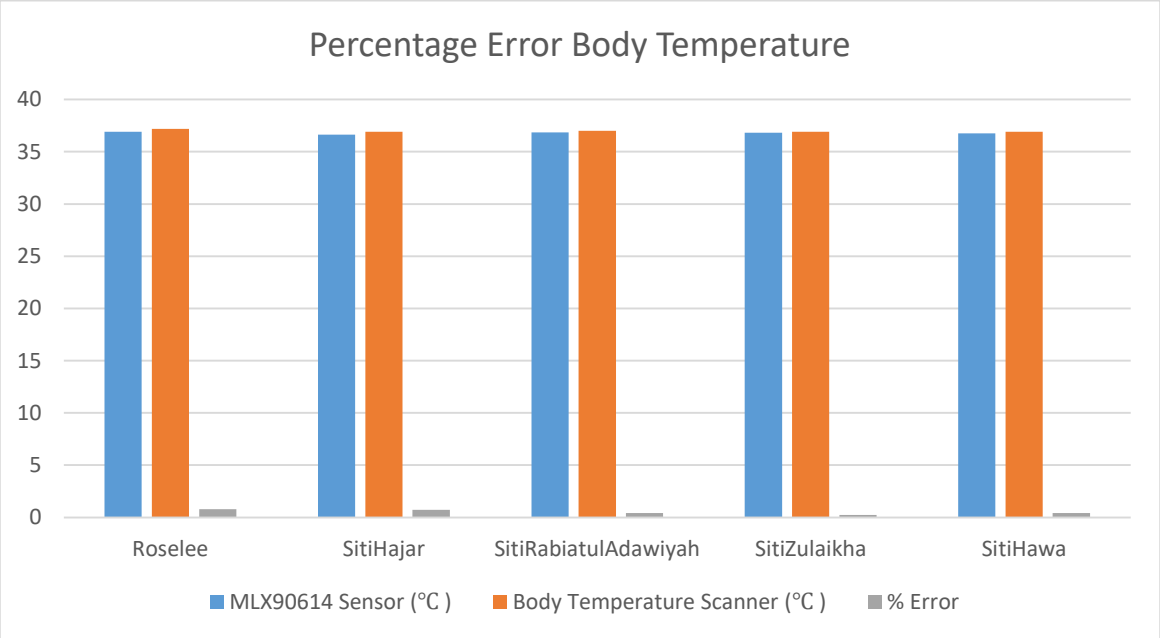


Figure 6: Comparison using MLX90614 Sensor and Body Temperature Scanner

4. Conclusion

This project managed to achieve the objective of developing of body temperature and face mask recognition system by using Raspberry Pi as a microcontroller and AWS as software that recognizes the faces. The project was successfully built with the help of python programming languages and a haar cascade classifier in OpenCV library for face detection. The proposed method was performed effectively in a short amount of time by taking face images and fulfilling the application of a security system. While infrared thermometer sensor is to detect measurement of body temperature. Then, the software of AWS will record the attendance successfully tested with a higher accuracy rate.

Acknowledgement

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