IOT FACE THERMAL RECOGNITION SYSTEM DEVELOPMENT

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
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DECLARATION

I declare that this report entitled “IoT Face Thermal Recognition System Development” is the result of my own work except for quotes as cited in the references.

Signature :

Author : Nur Ain Syafiqah Binti Che Noh

Date : 25 June 2021

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : .....

Supervisor Name : Ir. Ts. Dr. Ranjit Singh Sarban Singh

Date : 25 June 2021

DEDICATION

Every challenging work needs self-effort as well as guidance of elders especially those who were very close to our heart. My humble effort I dedicated to my sweet and loving father, Che Noh B Che Moh, and my beloved family. Whose affection, love, encouragement and prays of day and night make me able to get such success and honor. Along with all hard working and respected, my Supervisor, Ir. Ts. Dr. Ranjit Singh Sarban Singh. Lastly to my Lecturers and Friends.

ABSTRACT

Coronavirus disease 2019 (COVID-19), also known as the coronavirus, or COVID, is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease has since spread worldwide, leading to an ongoing pandemic. The Covid-19 common symptom is fever which can be detected using infrared thermometer. Thermometers with infrared technology are widely used nowadays for fever screening, this type of thermometer, which is commonly used has a higher risk of exposing users to viruses. Since the virus has spread to almost all part of the world, a reliable system to detect Covid-19 infected people in crowds with fever is in high demand. IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data of an individual is necessary. As well as that, this information/data also should be able to be recorded into the system database to provide real-time health monitoring update of an individual. This research proposes a low-cost system because it is based on IoT technology, is capable of rapidly detecting the Covid-19 symptom. Furthermore, the proposed system can capture the detected temperature using Thermal module Amg8833 and recognize face using pi camera.

ABSTRAK

Penyakit Coronavirus 2019 (COVID-19), juga dikenali sebagai coronavirus, atau COVID, adalah penyakit berjangkit yang disebabkan oleh Koronavirus berkaitan sindrom pernafasan yang teruk 2 (SARS-CoV-2). Penyakit ini telah merebak ke seluruh dunia, menyebabkan pandemik yang berterusan. Deman adalah salah satu symptom Covid-19, simptom ini dapat dikesan dengan menggunakan termometer inframerah. Termometer inframerah adalah alat teknologi yang sering digunakan untuk pemeriksaan suhu badan pengguna. Termometer inframerah yang sering diguna di setiap premis lebih beriksiko dan pengguna mudah terdedah kepada Coronavirus. Oleh kerana virus ini telah merebak hampir seluruh pelosok dunia, pemintaan yang tinggi terhadap sistem ini adalah kerana ia boleh mengesan suhu badan seseorang yang dijangkiti virus Covid-19. Sistem pengecaman wajah dan suhhu dengan menggunakan IoT dengan kemampuan untuk terus memproses maklumat / data yang direkodkan / disimpan jika diperlukan. Selain itu, maklumat / data ini juga dapat dicatat ke dalam sistem pangkalan data untuk kemaskini pemantauan kesihatan seseorang. Penyelidikan ini mencadangkan sistem kos betaraf rendah yang dapat mengesan dengan cepat simptom Covid-19 dengan cara yang mudah berdasarkan teknologi IoT.

ACKNOWLEDGEMENTS

This study is wholeheartedly for my beloved father, Che Noh b Che Noh, who has been my source of inspiration and gave me the strength when I thought of giving up, who continually provide their moral, spiritual, emotional, and financial support.

To my beloved sisters and brothers, friends who shared their words of advice and encouragement to finish this study. Besides, I would like to gratitude to my supervisors, Ir. Ts. Dr. Ranjit Singh Sarban Singh for the endless support, advice, help and guidance throughout this research.

And lastly, I dedicated this thesis to Allah S.W.T, thank you for the guidance, strength, power of the mind, protection, and skills and for giving me a healthy life. All of these, I offer to you. Thank you to all of you again for the constant source of inspiration.

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LIST OF SYMBOLS AND ABBREVIATIONS

Ti	:	Thermal Imaging
OpenCV	:	Open Computer Vision
MP	:	Mega Pixel
SOP	:	Standard of Operating Procedure
IoT	:	Internet of Thing
W	:	Wireless
LCD	:	Liquid Crystal Display
I^2C	:	Inter-Integrated Circuit

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CHAPTER 1

INTRODUCTION

This chapter will provide a brief overview of the project where an explanation is given on the objectives of the project and the problems statements. The scope statement of the project is included in this chapter to indicate the range of work covered by the project and not covered by it. Also included in the methodology part is a brief explanation of the project flow to allow understanding of the methods used to complete the project and what will happen during this project development. A thesis statement to give an overview of each chapter in this thesis is also included at the end of this chapter.

1.1 Project Overview

The IoT Face Thermal Recognition System Development is one of the most important systems which is in demand throughout the CoVID-19 pandemic. There are also many off-the-shelf Face Thermal Recognition System available in the market which has its abilities and advantages. To enable effective monitoring which also complies with the Standard of Operating Procedure (SOP), an IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data of an individual is necessary. As well as that, this information/data also should be able to be recorded into the system database to provide real-time health monitoring update of an individual. The currently off-the-shelf available IoT Face Thermal Recognition System Development is connected to the network and unable to continuously process the reoccurrence of updated information which is seen as vital to capture the current health condition of a person.

The programming language used for this project is Python. As for the Python IDE, Thonny was selected due to free open-source, and it provides all significant features such as code inspection and debugging. The standard library use in this project is OpenCV and DLIB. The algorithm begins with face detection and face recognition. This project aims to develop a IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data, reoccurrence information/data recorded/stored, and automatically updated into the system.

1.2 Problem Statement

It seems like a long time ago people could enter places such as malls or office buildings freely, but with the Covid-19 pandemic lingering, each individual is required to record their presence and temperature is taken before entering any premises. As the Covid-19 is a concern, the temperature tracking system can be upgraded by making it easier for people to use. Many industries, companies, organizations, and institutions are trying to accommodate their premises with a temperature scanner. However, one of the common daily problems that the user must face is the tedious steps to scan the QR code from my Sejahtera apps which usually is quite time-consuming. Besides, from an organization management perspective, it means more work and more manpower to be deployed in conducting such outbreak prevention measures. Hence, if there is an automated system in place, not only can it provide accurate and efficient temperature measurements and contact tracing, but it also allows for minimal physical contact. The next problem is the current system is inefficient to recognize the low-risk or high-risk individual [1]. The current system is taking of the temperature is to find out if customers are symptomatic or not, if they have symptoms, they should not be allowed in, but it (temperature) is not compulsory to be recorded. Therefore, the purpose of this project is, IoT Face thermal recognition system Development provides fast and accurate thermal scanning while the bundled software enables systematic data storage for easier backtracking.

1.3 Objectives

To accomplish this project, there are several objectives to achieve as follows:

1. To develop the IoT Face Thermal Recognition System Development.
2. To integrate a real-time email processing and notification platform.
3. To validate (1) and (2) in the developed IoT Face Thermal Recognition System Development.

1.4 Scope of work

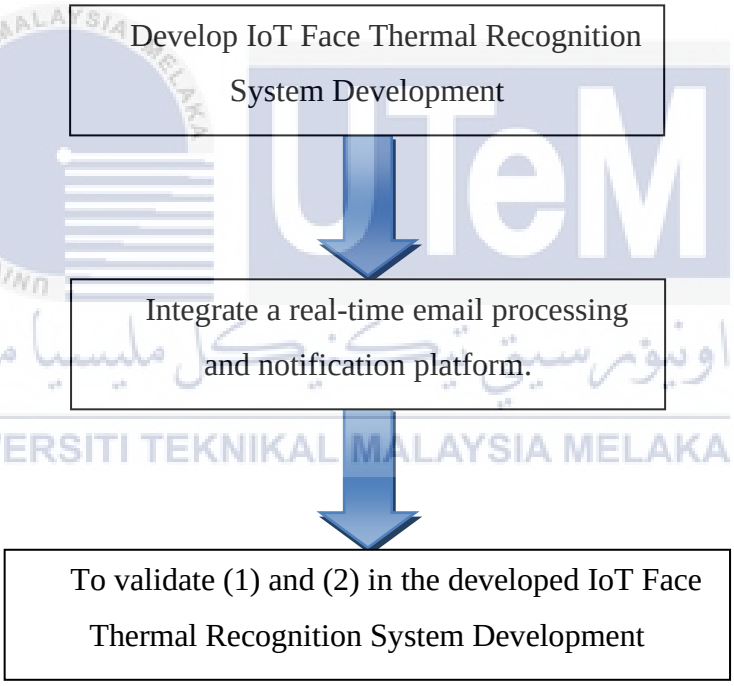


Figure 1.1: Propose IoT Face Thermal Recognition System Development

Task 1: To develop the proposed face thermal recognition system.

In this stage, a IoT Face Thermal Recognition System Development is proposed using Raspberry pi zero wireless, Thermal camera AMG8833, Raspberry pi Camera

8mp, LCD Display. The use of a thermal camera AMG8833 sensor is a non-contact device that can detect infrared energy (heat) to measures temperature. The raspberry pi zero wireless microcontroller is used to simultaneously process all the tasks while a scanning process being performed and the phyton programming language is used to develop the embedded software for the proposed system.

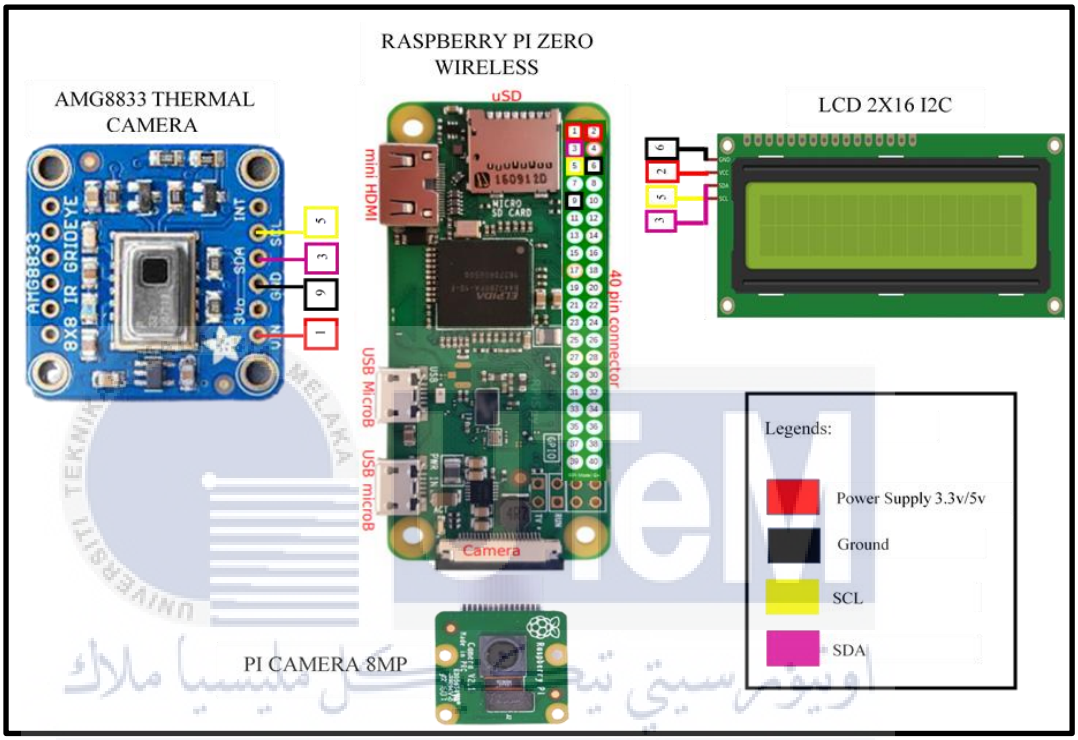


Figure 1.2: Conceptually Illustrated IoT Face Thermal Recognition System Development

Task 2: To integrate a real-time email processing and notification platform.

The next stage is to integrate a real-time temperature processing platform with email notifications. If the temperature below or equal to 37˚C, the attendance is marked. If the temperature higher or equal to 37.1˚C, simultaneously the system database is updated as well as email notifications will send to higher administration to inform the respective individual's health condition. Below is the detailed condition and temperature:

Table 1.1: Shown the condition and temperature [1]**.**

No	Condition	Temperature (˚C)
1	Low	35.0 - 37
2	High	37.1 - 40

Task 3: To validate [1] and [2] in the developed Face thermal recognition system.

Development in tasks [1] and [2] will be integrated to achieve a IoT Face Thermal Recognition System Development, to performance of the system was validated to determine whether this system is valid or not. In task three also must fulfill this project aim of this project is to develop a IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data, reoccurrence information/data recorded/stored and automatically updating into the system database.

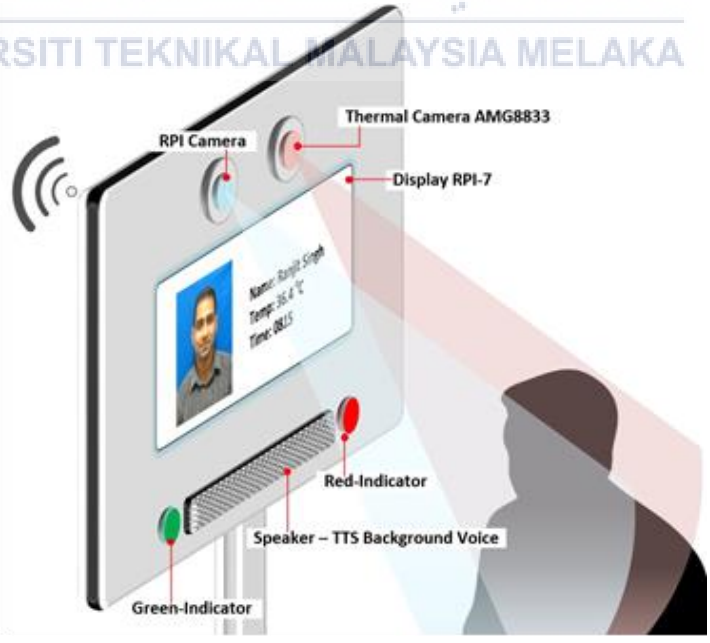


Figure 1.3: The expected outcome of the project

1.5 Project Significance

Face Thermal recognition system project is enabling effective monitoring which also complies with the Standard of Operating Procedure (SOP), a IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data of an individual is necessary. As well as that, this information/data also should be able to be recorded into the system database to provide real-time health monitoring of an individual. This project is to solve the problem where the user must face is the tedious steps to scan the QR code from any apps which usually is quite time-consuming.

The IoT Face Thermal Recognition System Development is one of the most important systems which is in demand throughout the CoVID-19 pandemic. This project can be the most effective equipment to reduce and prevent the risk of virus transmission. It is designed to use at malls, office buildings, or premises suitable use to take the temperature. The project has the potential to be commercialized because of all types of locations where people congregate to enforce social distancing and identify individuals with high temperatures because of COVID-19.

The IoT Face Thermal Recognition System Development durable and used continuously over a long time. According to the WHO, the coronavirus expected the COVID-19 outbreak will last between 18 and 24 months. Therefore, this system can comply with the Standard of Operating Procedure (SOP) [2]. The developed project will be simply environmental friendly because this project doesn’t use any type of chemical or any wiring is required.

1.6 Chapter review

This chapter will provide a brief overview of the project where an explanation is given on the objectives of the project and the problems statements. The scope statement of the project is included in this chapter to indicate the range of work covered by the project and not covered by it. Also included in the methodology part is a brief explanation of the project flow to allow understanding of the methods used to complete the project and what will happen during this project development. A thesis statement to give an overview of each chapter in this thesis is also included at the end of this chapter.

Chapter 2 is a literature review. Numbers of articles and journals have been reviewed as a reference for this study. Topics that are related to the study are being gathered and discussed here in this chapter to achieve the aim of the project and solve the stated problem. The chapter review includes the history of face recognition and thermal, a method to detect and recognize, Paper that correlates to this paper has been summarized in this section.

Chapter 3 methodology of the project. Implementation to achieve the project objectives are described in this chapter. Software, hardware, and diagram have been detailed. Besides, every phase of the flowchart is carefully discussed. The technique or algorithm used in each phase is clearly stated.

Chapter 4 is the results and discussion. In this section, the result of each step to complete the project are shown. The result of the face recognition method, temperature detection method, and notification receive method is shown in this section. The usage of the methods and algorithms are discussed in this section as to why the project uses any of the chosen methods to complete the project. The results

comparison between the computer and the raspberry pi module are also discussed in this section to justify the difference between the two platforms.

Chapter 5 concludes the results and discussion that are obtained from the experimental process. This chapter discuss the proposed future work that can be done to improvise the system and the limitation that needs to be overcome in the future.

CHAPTER 2

BACKGROUND STUDY

This chapter presents the literature review for the current and previous developed IoT Face Thermal Recognition System Development. The literature review has been developed based on the available journals, articles, and technical paper which explain the analytic system.

2.1 IoT Face Thermal Recognition System Development

IoT Face Thermal Recognition System Development is a common system that is currently hugely available in the market due to the Covid-19 pandemic. Many industries, companies, organizations, and institutions are trying to accommodate the premises with Face Thermal Recognition System which can provide instant information of their employees' daily health condition, if possible, updated regularly.

The available off-the-shelf Face Thermal Recognition System detects the body thermal of a person, and the scan information/data is processed instantly and recorded/stored in the system to inform the scanned person's health condition. Even though this is seen to be sufficient but keeping the information/data locally in the installed system would not help to update a person's health condition. Hence, the IoT Face Thermal Recognition System Development project is proposed to scan a person's health condition and continuously update the person's scanned health information/data automatically update into the database system. Person detection, tracking, and face recognition have been brought to the forefront of the news media in recent months because of the Hong Kong protests, and a variety of novel techniques have emerged to fool face detection and recognition algorithms (aside from the obvious full-face masks), such as special sunglasses or make-up. There are many cases where certain types of clothes can fool face detection algorithms [3].

Thermal cameras were used as a screening solution to detect infections at business entrance and in many factories that remained open during the global pandemic in the situation of COVID-19 [4]. Some thermal surveillance solutions have also developed, although in general, person presence detection is still required, while recognition is more difficult to do. The argument is that a thermal camouflage of the whole body is rarely seen in public areas and is beyond the scope of the study. Concerning health data privacy, some researchers have developed unique thermal sensor-based systems for monitoring human temperature in indoor elderly patients [5]. The thermal sensors were the low-cost AMG8833. Others evaluated and concluded that the use of low-cost sensors in medical facilities is sufficiently good for the purpose intended rather than pricey thermal monitoring solutions. A multi-

low resolution thermal sensor configuration is employed for monitoring patients that respect the privacy of the patient [6]. Thermal sensors were used to track the lecturer during video classes in order to avoid losing concentration on the subject [7].

Finally, in [2] investigates the effectiveness of thermal sensors for human detection in the automotive industry in worst-case scenarios involving the usage of a full-body cover (hijab), for a range of body weights and distances. All the previous research highlights the thermal camera object tracking capabilities for user privacy and good results even for low-cost thermal cameras. Image processing projects, such as video tracking or face recognition, require a camera. In raspberry pi zero wireless board, it is official camera support for Raspberry Pi Zero W. The camera can be easily mounted at the side of the board using a cable [8].

2.2 Review available monitoring IoT Face Thermal Recognition System Development.

Figure 2.1 shown The AMG8833 thermal camera, OV7670 optical camera, and GPS Module were used in the implementation. The GPS Module was connected to the Arduino Atmega as the microcontroller to control the module to capture data every 5 seconds. The Arduino IDE is used to programme the microcontroller's configuration for obtaining and evaluating collected data. Every five seconds, the code collects data from the modules (optical camera, thermal camera, and GPS module). The library required for each module is also installed during this process. The library is used for a microcontroller to access the data of the module and to control them to capture the data for a set period of time. The Arduino board manages the data, that is then uploaded to the cloud using a Wi-Fi module (ESP8266) [2].

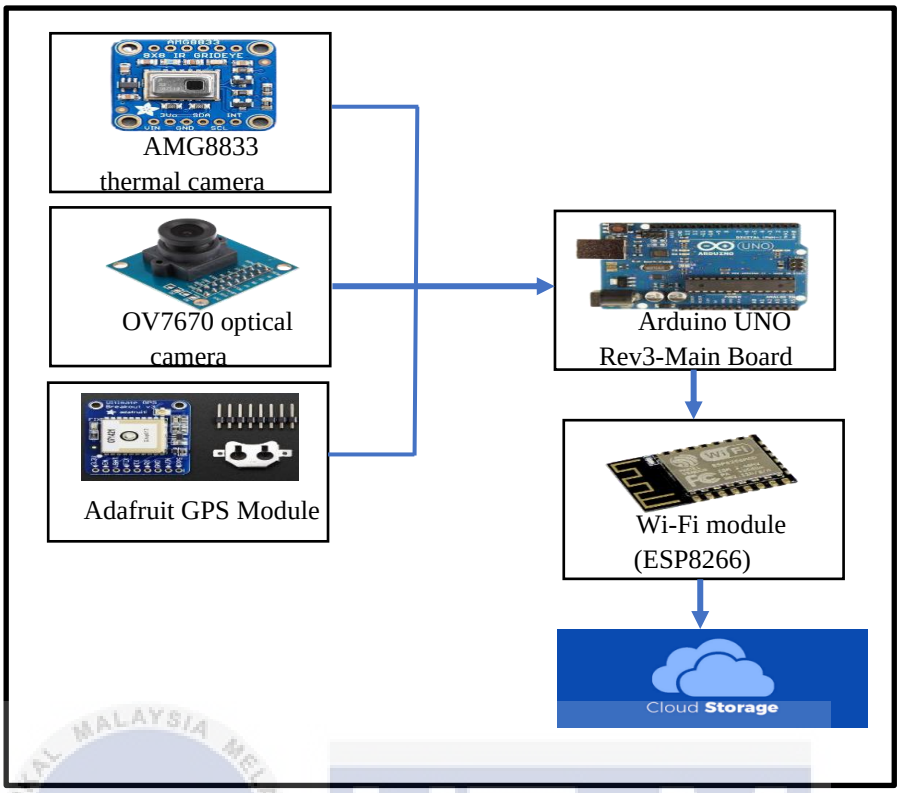


Figure 2.1: The configuration of hardware for thermal screening

Figure 2.1 shown the hardware mainly used in the implementation is AMG8833 thermal camera, OV7670 optical camera, and GPS Module that connected to the Arduino Atmega as the microcontroller to control the module to capture the data for every 5 seconds. The configuration of the microcontroller to obtain and evaluate the captured data is coded in the Arduino IDE. The code aims to get data of the modules (optical camera, thermal camera, and GPS module) every five seconds. This process also includes the installation of the library needed for every module. The library is used for a microcontroller on accessing the module's data and control them to capture the data for a certain length of time. This data is managed by the Arduino board and uploaded to the cloud using a Wi-Fi module (ESP8266) [2].

Figure 2.2 showing the design of the system that can automatically detect the coronavirus from a thermal image with less human interactions using a smart helmet

with a Mounted Thermal Imaging System [9]. Thermal camera technology is integrated into the smart helmet and combined with IoT technology for real-time data monitoring of the screening process. Furthermore, the system is integrated with facial-recognition technology and can display the pedestrian's personal information as well as take their temperatures automatically. The healthcare system has showed interest in this design, which may help to reduce the spread of the coronavirus from spreading wider.

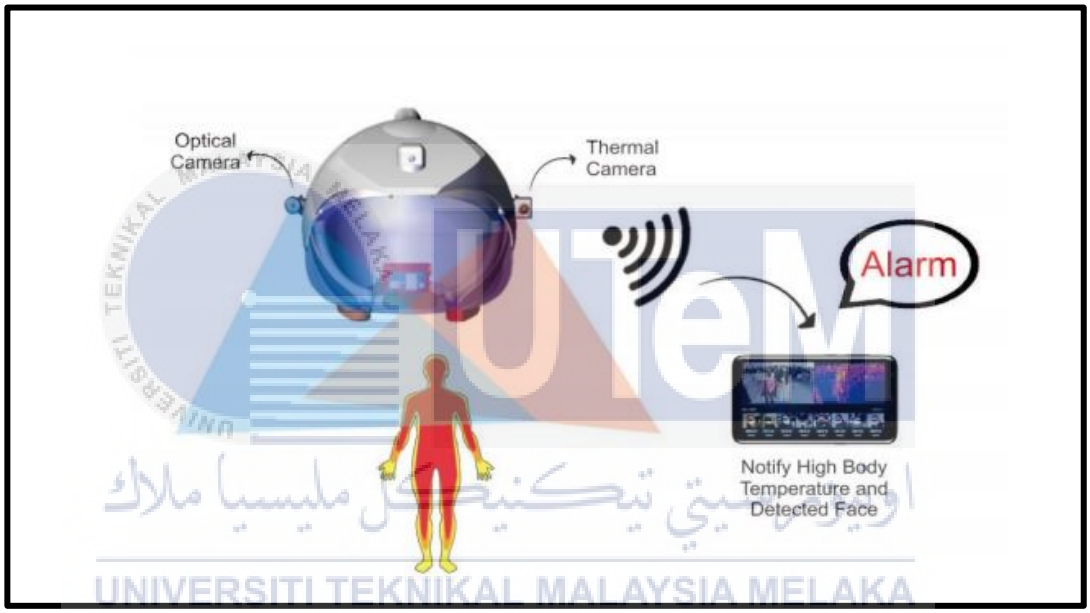


Figure 2.2: The configuration of hardware of Smart Helmet System Work

After receiving information from Arduino, including the recognized face, body temperature, and GPS position, the microcontroller (type NodeMcu) had these values uploaded to it over the Web, allowing it to provide independent online worldwide access to this data. For this reason, an exterior server called Blynk was utilized. When a high-temperature body is detected by the thermal camera. The technology sends a message to the authorities, alerting them to the threat. The technology will also take a photograph and send it to the health officer at the same time [9].

Figure 2.2 showing the to design a system capable of automatically detecting coronavirus from the thermal image immediately, using smart glass technologies on IoT based interactions [10]. In furthermore, the design proposed would perform facial detection in the suspected situation of Covid-19 among people with high body temperature. The design will include information about the suspected virus carriers' visited locations via Google Location History (GLH) to provide reliable data on the detection process.

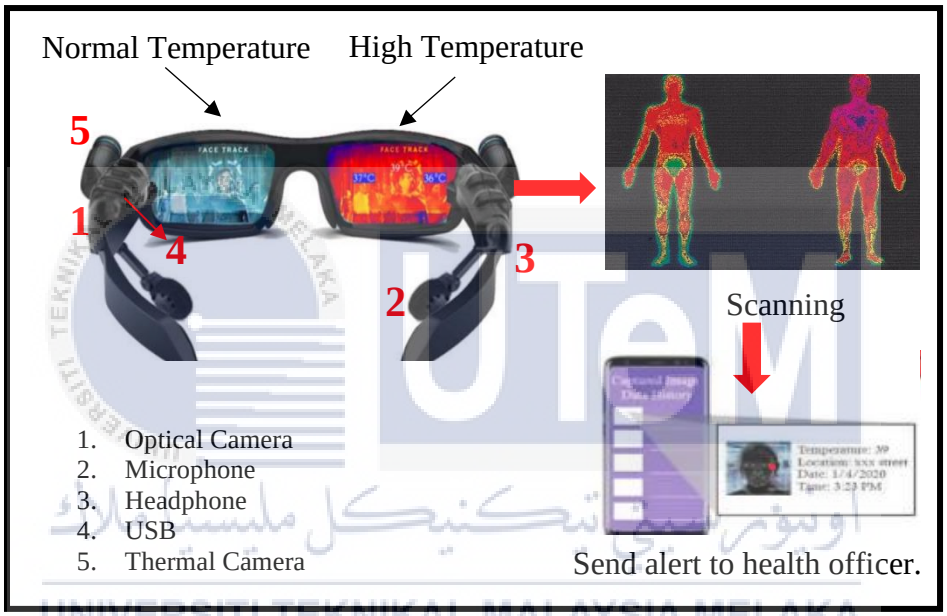


Figure 2.3: The configuration of hardware of Smart glasses System Work

The smart glass is designed with two types of cameras, allowing detailed information to be gathered from the optical camera to capture detected faces and the thermal camera to capture body human temperature. Thermal cameras are used for hot body detection and recognition by using high temperature variability in compared to other things within the scanned space. This module discusses an image segmentation based on temperature data and coloured images taken by thermal and optical cameras. The GPS module determines the position coordinates after tagging and records them with other faces and temperatures, so that data may be accessed via

smartphones by another officer [10]. The officer will get the face and temperature data to detect those showing COVID-19 infected by smart glasses, as shown in Figure 2.3.

2.3 Image Capturing and Attendance record.

Figure 2.3 showing the design of the system that scans a face and compares it to stored data of known individuals to detect and identify a human face from real-time video. Our method recognizes a person in a fraction of a second, completely disregarding any background impact.

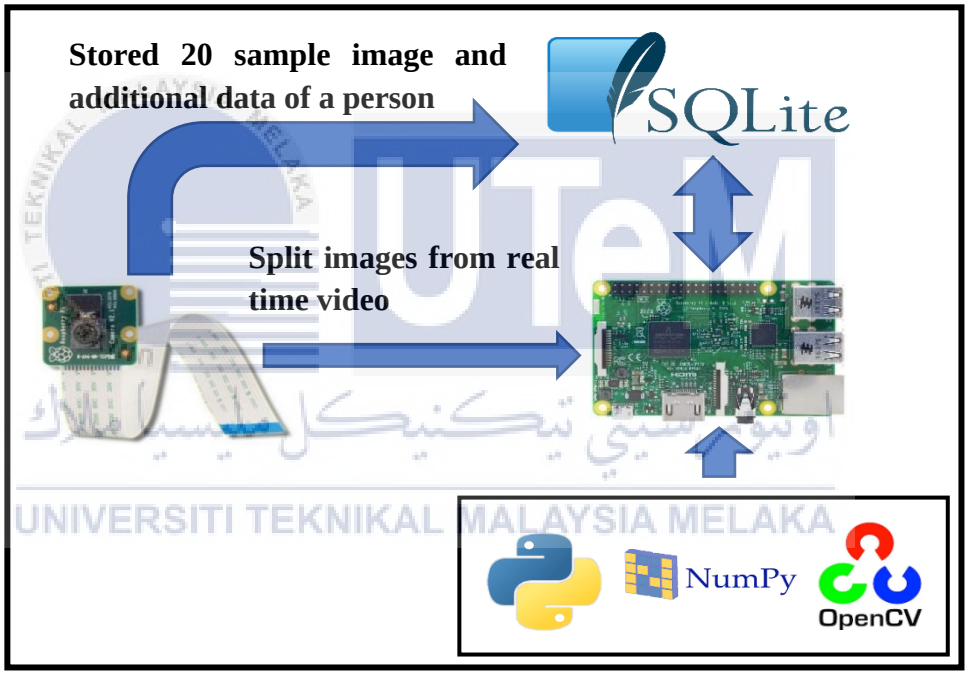


Figure 2.4: Configuration of Hardware for Face Recognition and Attendance System.

The camera sends real-time video to the microprocessor. The video is imported into the microprocessor's python code as a two-dimensional matrix. NumPy is a Python open-source library that makes it easy to compute multidimensional matrices. To reduce the effect of background in image processing, the part of the image containing the face is removed from the whole image and saved in a matrix [11]. The matrix is then altered and compared to the sample photos to see if there are any

matches. If a match is detected, the real-time video displays the identified person's name and additional information, along with a green square mark that tracks the person's recognized face. The SQLite database management system provided the additional data [11]. The system architecture is illustrated in Figure 2.3.

Figure 2.4 showing the design of the system that will automatically record the student's attendance. The student database is collected, and it contains information such as student names, images, and roll numbers. Initially, a video clip of the classroom is captured and stored in the database, and after that the video is converted to an image, faces are detected using face detection techniques, and features are extracted using the Histogram of Oriented Gradients and the Local Binary Pattern algorithm [12].

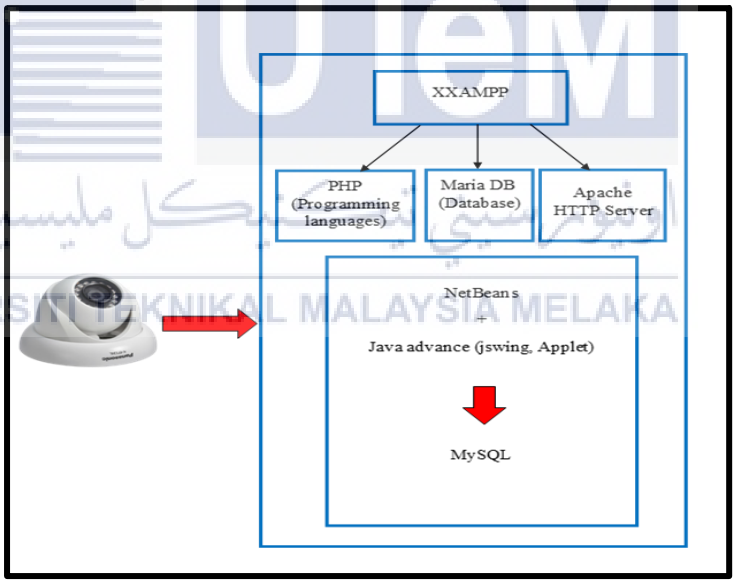


Figure 2.5: The configuration of hardware and software for Automatic Attendance by the using of Face Recognition

Figure 2.5 revealed a way for a student attendance system in the classroom that uses Discrete Wavelet Transforms and Discrete Cosine Transforms to extract the features of the student's face, followed using the Radial Basis Function to classify the facial components [9]. When he enters the classroom and uses the Personal

Component Analysis technique to extract the image and records the attendance. The report will be sent to the faculty as well as the parents using the Simple Mail Transfer Protocol.

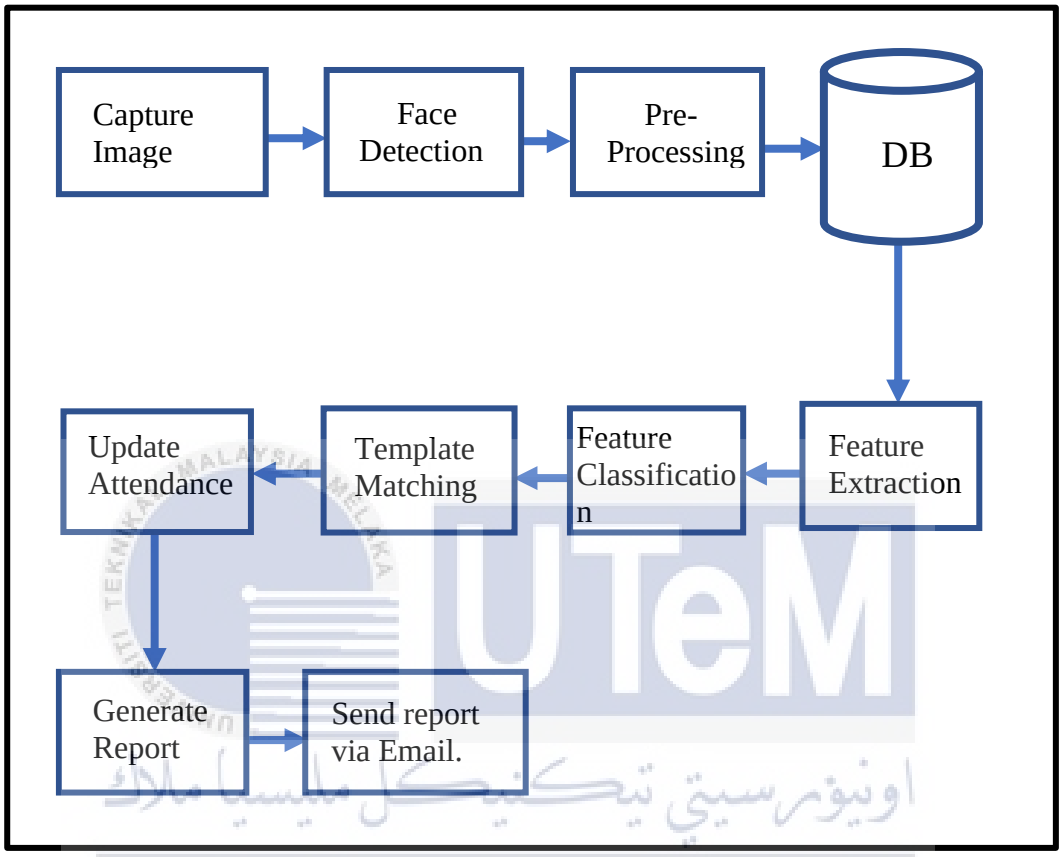


Figure 2.6: The System of Automatic Attendance using Face Recognition

Figure 2.6 shown the system's design how to take a student's act of victimization and recognize their face. The Open CV formula and the Camera are used to enforce facial recognition [12], [13]. The system will recognize a specific student's face and will automatically save the response in information. The system also has the capability of retrieving a list of students who are absent on a specific day. The varied data is recorded with the use of a camera attached to the front of the classroom that can continuously take video of students, detect the faces in the image and

differentiates appearances alongside the data, and record attendance. The Raspberry Pi is used in this project to identify the face with the help of OpenCV [13].

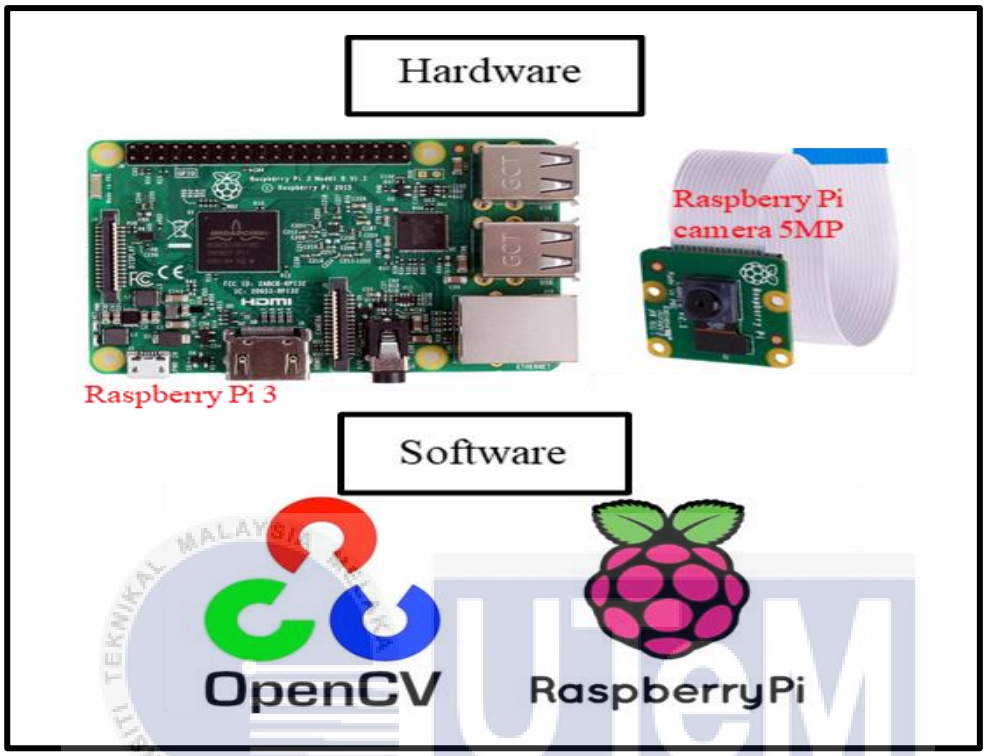


Figure 2.7: The System of Face detection and Face Recognition Automatic Attendance

Image acquisition, face detection, and face recognition are the three main phases of the project attendance system. Firstly, the system consists of a pi camera that captures images of the schoolroom and sends them to image pre-processing. Then that image is sent for face detection [13], [14]. The second method is Face Detection, which separates the facial area from the image background. When Face extraction will be further given, the face area unit keeps within the information and detects it. Face Recognition is the final stage, in which the face image is compared to the stored image. The face is identified if the image of the face matches the previously stored image. The attendance of that individual student is recorded [12], [15].

2.4 Summary for literature review for the current and previous developed.

Section 2.2 presents the review about the developed and available systems that are used for IoT Face Thermal Recognition System Development. Based on the conducted review, generally most of all developed project used Arduino Uno as a platform developing project. The disadvantage of the developed system seems to be the lack of limited memory, parallel power, and speed of the developed systems. For connectivity Internet access needs extra shields that are not cost-friendly. For example, although the developed systems are incorporated with the web application for information monitoring, the failure of the hardware system to store the information for comparison or backup causes higher risk of corrupt information, where if the stored information in the web database is corrupted, inaccurate information would be delivered into the web application. Besides that, most of the developed systems only scan face and temperature without have a person' s identity.

Looking at the limitation of the developed systems, IoT Face Thermal Recognition System Development have been proposed. The proposed system has been improvised in terms of develop the IoT Face Thermal Recognition System. Raspberry Pi Zero Wireless has been used as the control system because of the ability to also store sensed the code of IoT Face Thermal Recognition System Development. The capability to store code into the Raspberry Pi Zero Wireless SD Card Storage System helps to create another level of secure information if the information in neither storage is corrupted.

Thermal camera AMG8833, the use of thermal camera AMG8833 sensor is a non-contact device that can detects infrared energy (heat) to measures temperature. Also, The Raspberry Pi camera module can capture both high-definition video and

still photographs. It's simple to use for beginners, but it has a lot to offer advanced users who want to learn more [11]. Many examples of people using it for time-lapse, slow-motion, and other video tricks can be found online. With that also, this project has 2x16LCD I2C show makes this one of our smaller versions, perfect for small projects, wearables, and different portables. it can view its crispy blue images from a wide, 160-degree angle range. In this project 2x16LCD I2C uses to display the name, and temperature.

CHAPTER 3

METHODOLOGY

This chapter explains about the methodological system design and integration process of the proposed project. The project development methodology is divided into two phases. Phase one is focuses on the hardware development which consist of 1) integration of pi camera to perform the face detection and recognition and 2) integrate the thermal camera sensor to measure the human body temperature. The integration of pi camera is conducted to perform the face detection and recognition via the existing image that has been preloaded into the Raspberry Pi Zero Wireless SD-Card Storage. Upon the successiveness of the face detection and recognition, the thermal camera sensor is activated to measure the human body temperature. Then the recognized human as well as with the measured temperature is stored into the Raspberry Pi Zero Wireless SD-Card Storage.

Second phase focuses on the embedded software development for the 1) face detection and recognition, 2) measure the human body temperature and 3) configuring email notification. The face detection and recognition perform the real-time face recognition based on the preloaded images in the Raspberry Pi Zero Wireless SD- Card Storage. Upon detection the human face, the thermal camera sensor measures the respective human body temperature and stored the measured temperature into the Raspberry Pi Zero Wireless SD- Card Storage. Meanwhile, while the recognized face and human body temperature information is being recorded, a process of comparing measured temperature with the preset temperature value is performed to detect normal and high risk measured temperature. With that, if the measured temperature is above the preset temperature value, an email notification of the human is delivered to the authority.

3.1 IoT Face Thermal Recognition System Integration

The IoT Face Thermal Recognition System development for human body thermal measurement and recording is a low-cost system that has been developed to assist in detecting a person with possible CoVID-19 symptom. Since the human body temperature is one of the easily recognizable symptoms that helps to possibly predict if a person is infected with CoVID-19, hence having a IoT Face Thermal Recognition System that is integrated with PI Camera and AMG8833 Thermal Camera Sensor as well as other features such as ability to record the HIGH temperature for an email notification has been developed in this research.

3.1.1 Integration of Pi Camera

In the phase 1, the integration of pi camera to perform the face detection and recognition is conducted as shown in Figure 3.1. The pi camera is connected to the Raspberry Pi Zero Wireless via the Camera Serial Interface (CSI) connector. The integrated pi camera has the capability to capture a real-time image of 8 Megapixels which will be used to perform the facial detection and recognition with the image stored in the Raspberry Pi Zero Wireless SD-Card Storage. Figure 3.1 shows the CSI pi camera connector description as well as the CSI camera connector at the Raspberry Pi Zero Wireless.

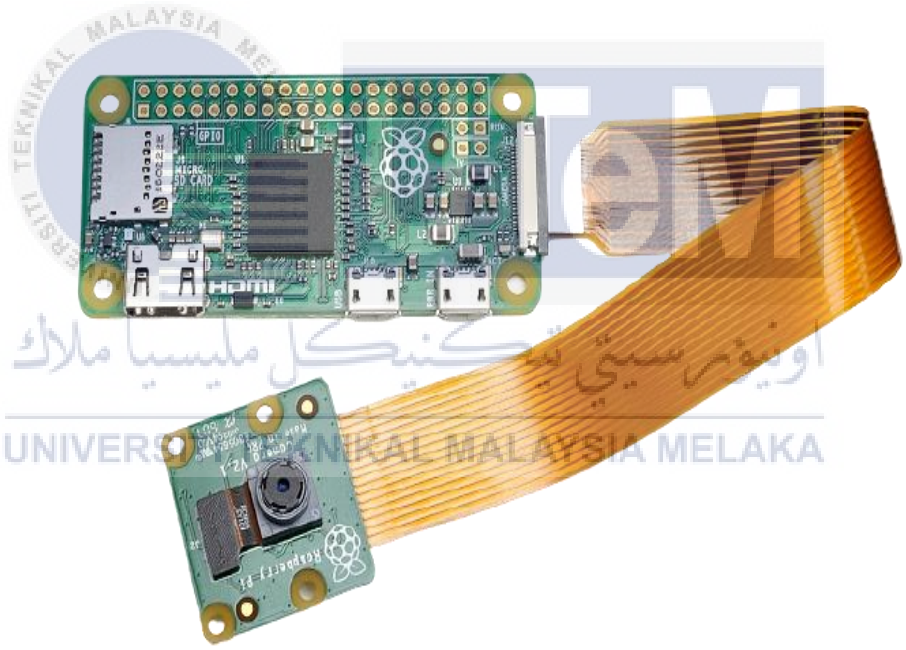


Figure 3.1: Hardware Pi Camera and Raspberry Pi Zero Wireless Connection

Table 3.1: CSI Connector Description – Raspberry Pi Zero Wireless CSI Connector

Pi Camera – CSI Connector	CSI Connector Description	CSI Camera Connector -Raspberry Pi Zero Wireless
1	GND	Port Camera
2	CAM1_DN0	
3	CAM1_DP0	
4	GND	
5	CAM1_DN1	
6	CAM1_DP1	
7	GND	
8	CAM1_CN	
9	CAM1_CP	
10	GND	
11	CAM_GPIO	
12	CAM-CLK	
13	SCL0	
14	SDA0	
15	VCC (3.3V)	

3.1.2 Integration of AMG8833 Thermal Camera Sensor

This section describes about the AMG8833 Thermal Camera Sensor connectivity with the Raspberry Pi Zero Wireless as shown in Figure 3.2. The AMG8833 Thermal Camera sensor connectivity is shown in Table 3.2. The General-Purpose Input/Output (GPIO) port 2 and port 3 are respectively connected to the Serial Information (SDA) and Serial Clock Line (SCL). The power source (VCC) is connected to 3.3 Volt at port 1 and the ground is connected to port 9.

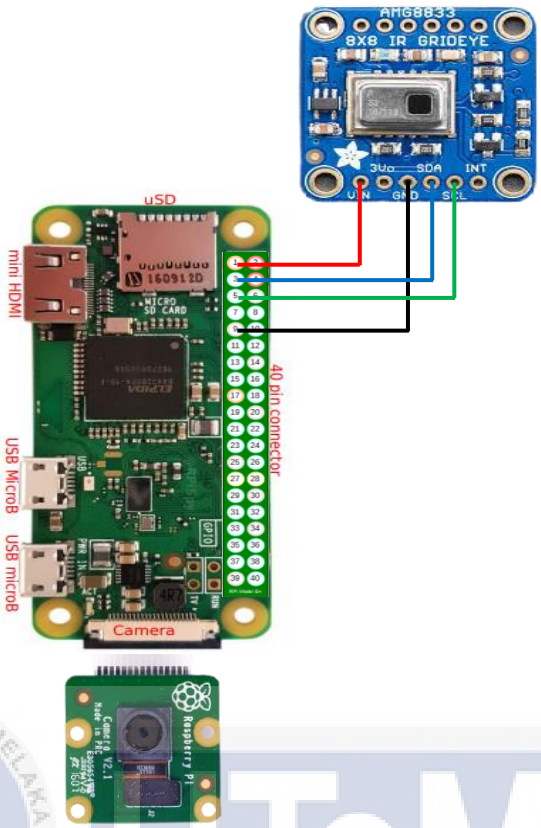


Figure 3.2: AMG8833 Thermal Camera Sensor Connectivity – Raspberry Pi Zero Wireless

Table 3.2: AMG8833 Thermal Camera Sensor Ports Connectivity with Raspberry Pi Zero Wireless Ports

Thermal Camera sensor AMG8833 port	Port Description	Raspberry Pi Zero Wireless-port	Port Description
SCL	SCL- (Serial Clock Line)	5	GPIO 03
SDA	SDA- (Serial Information)	3	GPIO 02
VCC	VCC	1	3.3V
GND	Ground	9	GND

3.2 Software Design and Development

This section explains about the software development for the face detection and recognition that is performed by the integrated pi camera. Also, explain about the software development for the human body temperature sensing and measurement using the AMG 8833 Thermal Camera Sensor. The software that is developed for the face detection and recognition uses the black and white images to perform the image comparison. The black and white images are used because it provides a quick search of unknown face that is capture in an image as well as perform quick comparison with all the images in the database. In the process of performing face detection and recognition the algorithm, firstly the algorithm captures the person's image using the integrated pi camera. After capturing the image, the algorithm will load a similar face image that is store in the Raspberry Pi Zero Wireless SD-Card Storage. Then, the captured image is compared with loaded image to confirm the similarity, otherwise the algorithm will perform a different search. Upon the captured image similarity is confirmed, the captured image is encoded to extract the important measurement parameters as shown in Table 3.3. All these important measured parameters define the captured person's identity and hence, shows the person's information as reference to the pre-stored information.

Table 3.3: All these important measured parameters

Number	Important Measurement Parameters
1	Size of each ear
2	Spacing between the Eyes
3	Length of the nose

Next, the software for the AMG8833 Thermal Camera Sensor that is connected using the Inter-Integrated Circuit (I^2C) bus is developed. The software development of the AMG8833 Thermal Camera Sensor is combine into the developed face detection and recognition software. At the initial stage of the AMG8833 Thermal Camera Sensor software development, the AMG8833 Thermal Camera Sensor is tested to detect cool temperature which represents the blue and purple colours tone. Whereas, when AMG8833 Thermal Camera Sensor detects yellow and red, it shows the warm temperature colours tone. This process is conducted to perform the test on the AMG8833 Thermal Camera Sensor and when it is success the main software algorithm of temperature sensing and measurement is developed. The software algorithm draws a green rectangle box on the scanning image and when the scanning image is centered into the green rectangle box, then a red dot which appears at the center forehead will perform the temperature scanning as shows in Figure 3.3. Then the human's face temperature is sensed and measured as well as stored into the Raspberry Pi Zero Wireless SD-Card Storage. Also, the person's name and scanned temperature information is displayed on the LCD. During the process of sensing and measuring the human temperature, a measured temperature condition comparison is conducted to detect if the measured temperature is at "" NORMAL" or "HIGH" condition. If the measured temperature is above the NORMAL pre-set temperature, the software algorithm generates an email that will be sent to the authority to inform the authority of the person's condition.

Figure 3.3: Illustrated of algorithm recognize face in rectangular box.

3.2.1 Embedded Software Algorithm – Face Detection and Recognition

According to section 3.1.1, the proposed system starts to integrate the pi camera to perform the face detection and recognition using the Raspberry Pi Zero Wireless. Therefore, to perform the face detection and recognition a suitable algorithm has been proposed to perform the face detection and recognition. Figure 3.4 shows the steps developed to perform the face detection and recognition. A detail embedded software algorithm is also shown in Figure 3.5. According to Figure 3.4 and Figure 3.5, when the integrated pi camera is active the pi camera will acquire a real-time image which will be compared with an image stored in the Raspberry Pi Zero Wireless SD-Card Storage. Upon confirming the real-time acquired image, the embedded software algorithm will perform face recognition to confirm the person's identity as well as provides the recognized person's name. Once the person's name has been confirmed, the name will be recorded into the attendance list.

With that, once the integrated pi camera able to perform as it has been explained, the development of the embedded software algorithm for the integrated thermal camera sensor has shown in section 3.1.2 is conducted.

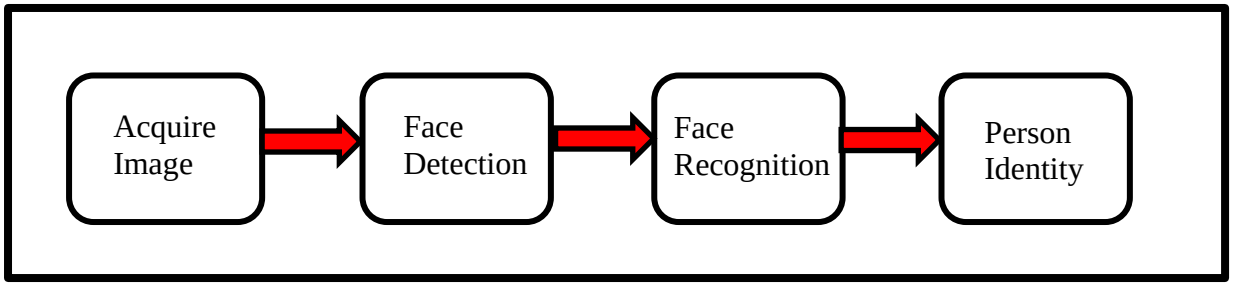


Figure 3.4: Steps of Face Detection and Recognition

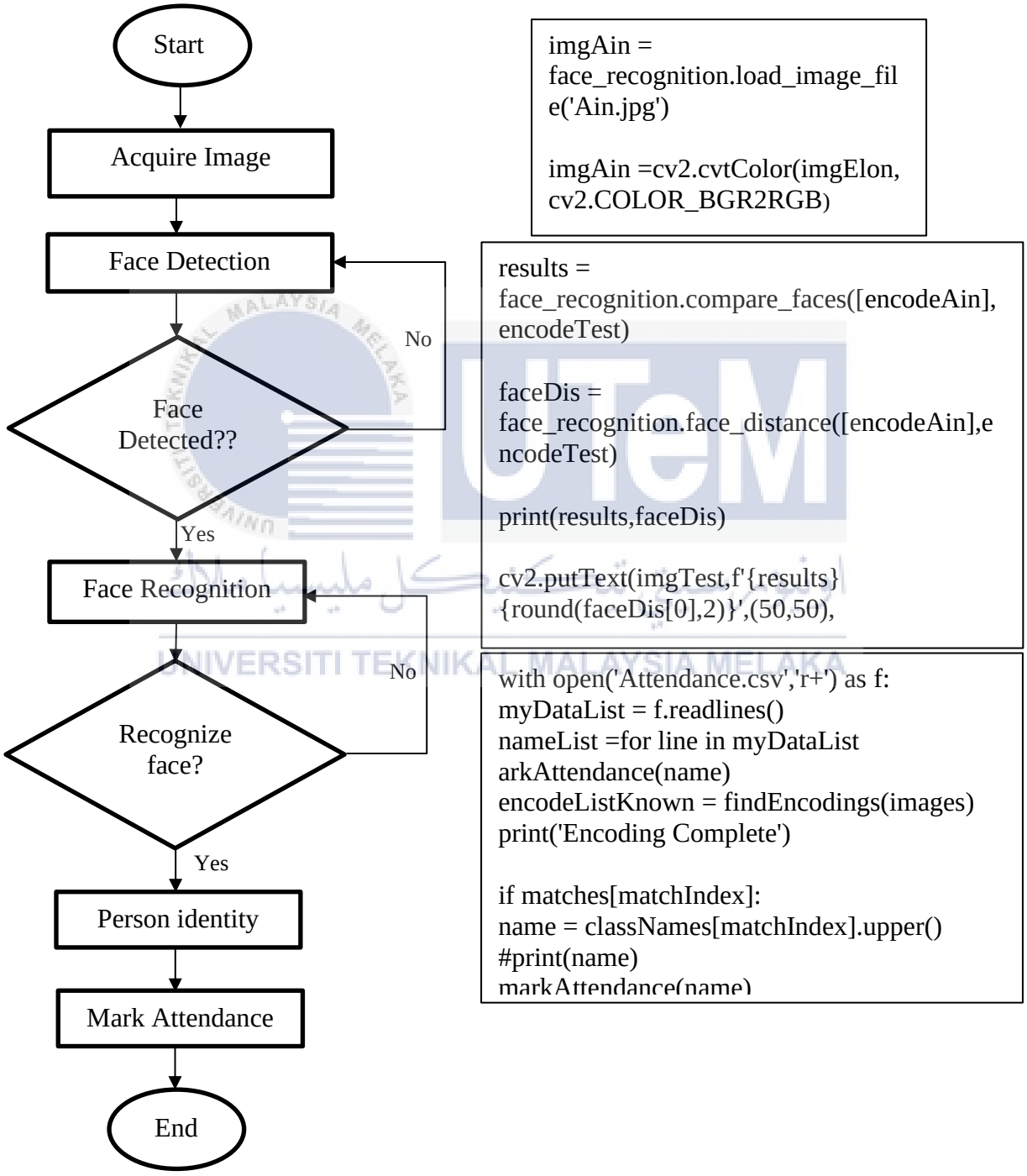
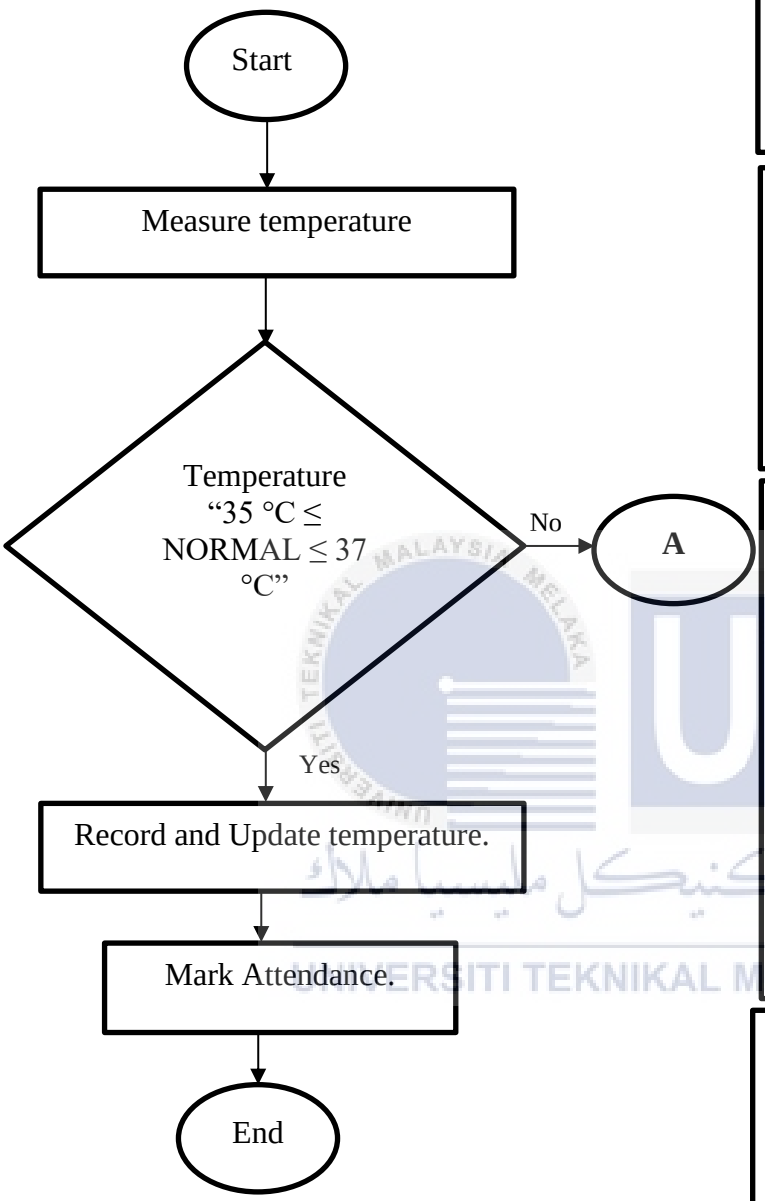


Figure 3.5: Embedded Software Algorithm Face Detection and Recognition

3.2.2 Embedded Software Algorithm – AMG8833 Thermal Camera Sensor and Email Notification

The AMG8833 Thermal Camera Sensor is integrated to measure the real-time human temperature. The AMG8833 Thermal Camera Sensor reads a real-time temperature value when a person approaches the face near to pi camera as well as the AMG8833 thermal sensor. Hence, when the face is recognized, the AMG8833 thermal camera sensor measures the person's body temperature and match the measured temperature with the person's name that is stored in the attendance list mention in section 3.1.2. If the person's name is matched, the person's name and measure temperature will be displayed at the integrated Liquid Crystal Display (LCD). Otherwise, the embedded software will continue to perform the person's name to record the measured temperature value. Also, during the temperature measuring, the embedded software algorithm for the AMG8833 thermal camera sensor will categorize if the measured temperature is "35 °C ≤ NORMAL ≤ 37 °C" or "37 °C < HIGH ≤ 40 °C". If the measured temperature is "35 °C ≤ NORMAL ≤ 37 °C", the temperature value will be displayed on the LCD as shown in Figure 3.6, otherwise a notification email will be sent to the high authority to inform about the person's condition as shown in Figure 3.7.

Besides that, the developed software algorithm shown in Figure 3.6 also can perform the rescanning operation if it is required. The rescanning operation can only be conducted to scan a person after a time lapse of 3 minutes.




```
i2c_bus = busio.I2C(board.SCL, board.SDA)
MINTEMP = 27.
MAXTEMP = 40.0
COLORDEPTH = 1024
os.putenv("SDL_FBDEV", "/dev/fb1")
pygame.init()
sensor = adafruit_amg88xx.AMG88XX(i2c_bus)
points = [(math.floor(ix / 8), (ix % 8)) for ix in range(0, 64)]
grid_x, grid_y = np.mgrid[0:7:32j, 0:7:32j]
```

```
if firstTimeMatch == 0:
 print('Searching and measuring your temperature')
 display.lcd_clear()
 display.lcd_display_string('Searching and measuring your temperature',1)
print('Please stand still')
 display.lcd_display_string('Please stand still',2)
```

```
    pixels = []
    for row in sensor.pixels:
    pixels = pixels + row
      pixels = [map_value(p, MINTEMP, MAXTEMP, 0, COLORDEPTH - 1) for p in pixels]
    pixels2 = pixels
    countX = 0
    for row in sensor.pixels:
    countX = countX+1
    if int(Xt)==countX:
    sampleTemp = float(row[int(Yt)])+offsetTemp
    noSample = noSample+1
     toTemp = toTemp+sampleTemp
    if noSample>maxNoSample:
    aveTemp = toTemp/noSample
```

```
if aveTempReady == 1:
#print(aveTemp)
 readyToMarkAttendance = 0
 aveTempReady = 0
 if aveTemp>sickTemp:
 print('Temperature is high!!!')
  toTemp = 0
   aveTempReady = 1
 #print(f'\nActual Temperature:{aveTemp}')
if aveTemp>30:
if aveTemp<sickTemp:
print('AttendanceMarked')
display.lcd_display_string('Attendance Marked',2)
personSick = 0
if(time.perf_counter()-
firstTimeTick)>matchingIntervalTime:
firstTimeMatch = 0
```


Figure 3.6: Embedded Software Algorithm AMG8833 Thermal Sensor

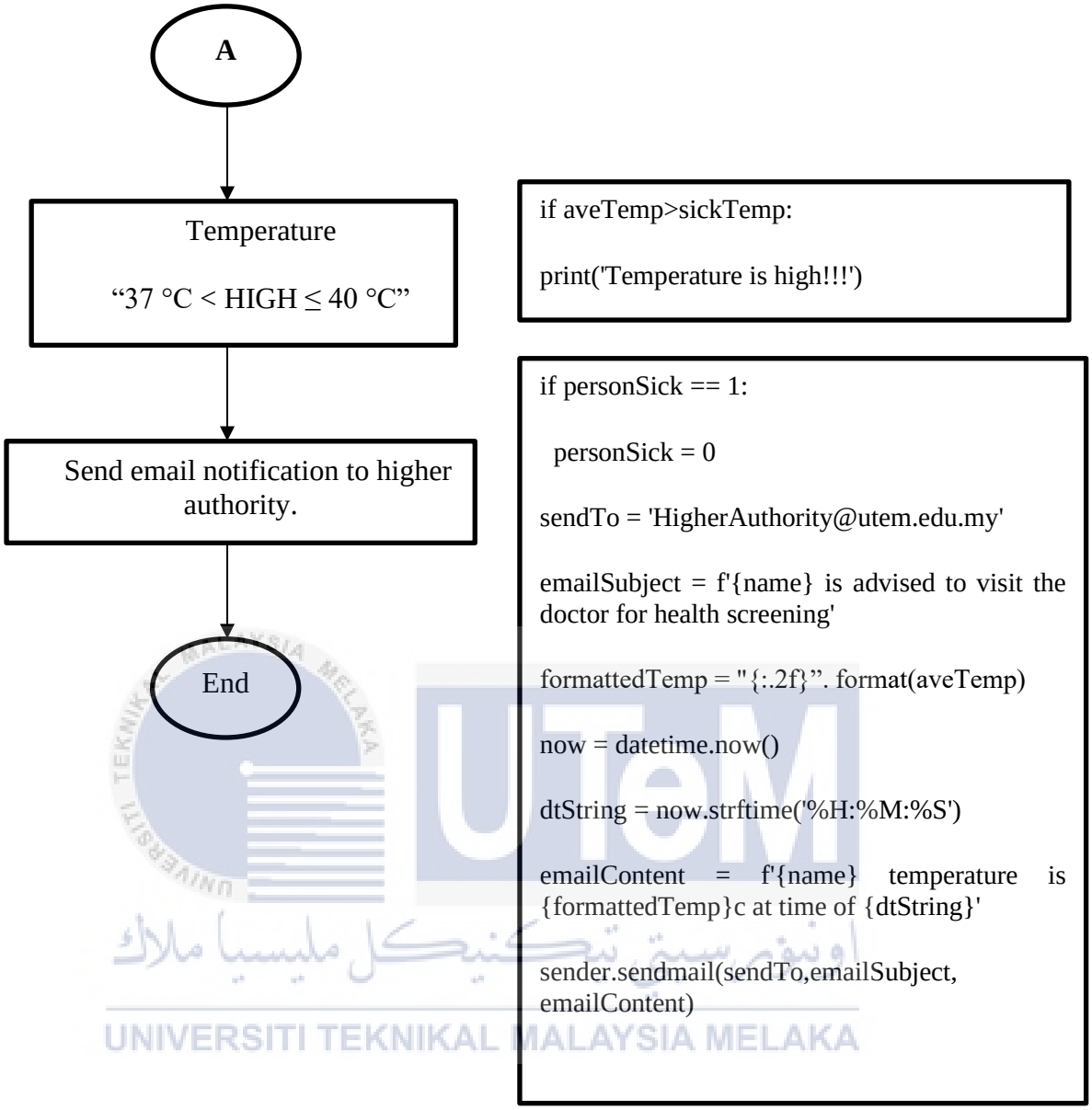


Figure 3.7: Embedded Software Algorithm - Real-Time Email Processing and Notification Platform

CHAPTER 4

RESULT AND DISCUSSION

In chapter 3 the hardware development and software algorithm methodology for the IoT Face Thermal Recognition System Development has been presented. Also, the operational of each sub-system of the IoT Face Thermal Recognition System Development such as integration of the Pi Camera and AMG8833 Thermal Camera Sensor are explained in terms of their operational and functionality. Besides that, the software algorithm that is embedded into the IoT Face Thermal Recognition System Development is explained of its operational when the PI Camera and AMG8833 Thermal Camera Sensor operates to detect the human body's temperature. Upon successfully having the sub-system of the IoT Face Thermal Recognition System Development operating, the sub-systems were integrated to produce a complete IoT Face Thermal Recognition System Development.

On that contrary, this chapter discuss the obtained results of the IoT Face Thermal Recognition System Development. The results are presented into the, 1) Developed Hardware System and 2) Operational of Developed Software Algorithm.

4.1 Developed Hardware System

Figure 4.1 shows the placement of the (1) AMG8833 Thermal Camera Sensor, (2) Pi Camera and (3) LCD. The AMG8833 Thermal Camera Sensor and Pi Camera is placed side by side to allow face detection and recognition when a face that is being scanned as well as effectively measure the scanned image temperature. Also, the detail such as name and temperature of the scanned face is displayed on the integrated LCD.

Another reason of placing the AMG8833 Thermal Camera Sensor and Pi Camera side by side is because the AMG8833 Thermal Camera Sensor picture size of 480 × 480 pixels is centered at the Pi Camera picture size is 640 × 480 pixels as shown in Figure 3.3. This allows the AMG8833 Thermal Camera Sensor to effectively scan the center of the forehead for temperature measuring as shown in Figure 3.3.

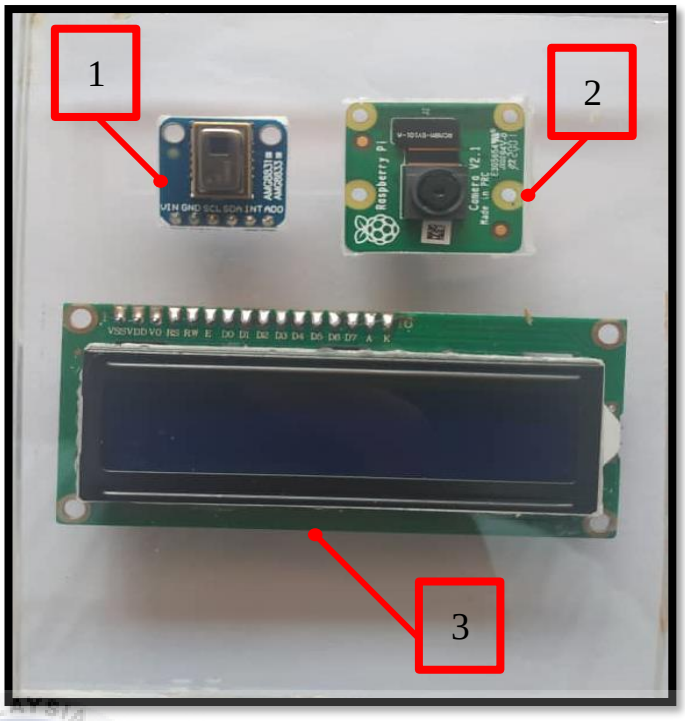


Figure 4.1: Placement of Integrated Pi Camera, AMG8833 Thermal Camera Sensor and LCD - IoT Face Thermal Recognition System

Upon completing the placement of the Pi Camera, AMG8833 Thermal Camera Sensor and LCD, the integration of these components into the Raspberry Pi Zero Wireless as shown in Figure 4.2 is completed. The Pi Camera and AMG8833 Thermal Camera Sensor are integrated into the Raspberry Pi Zero Wireless according to the connectivity shown in Figure 3.2 and Table 3.2. The LCD share the connection of the port 3 - SDA and port 5 - SCL as shown in Table 3.2

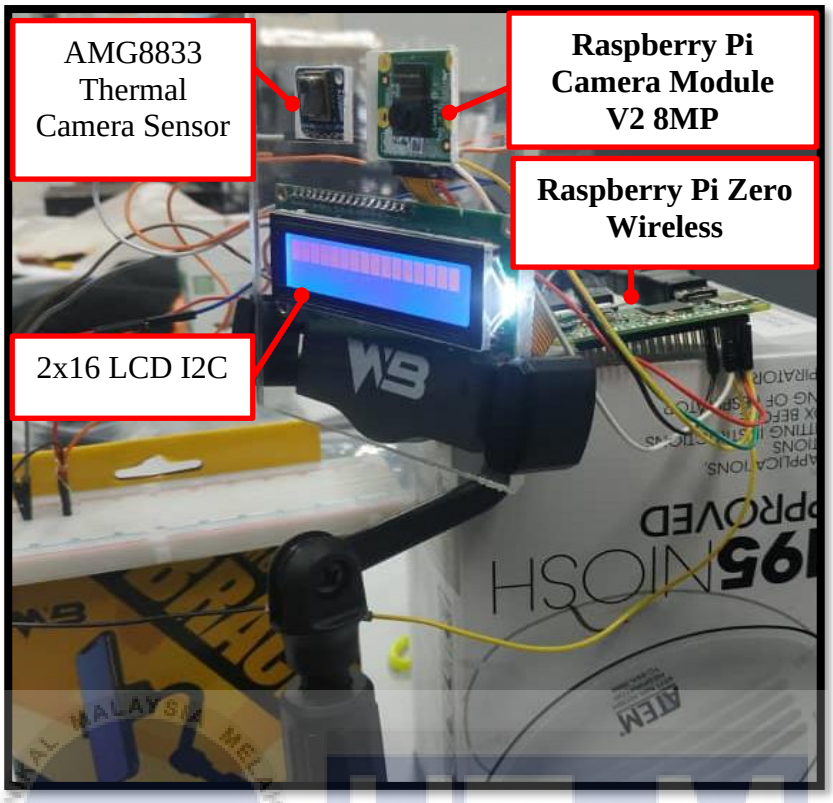


Figure 4.2: Integration of the Pi Camera, AMG8833 Thermal Camera Sensor and LCD – Raspberry Pi Zero Wireless

4.2 Software Design and Development

This section validates the developed software which integrates the Pi Camera and AMG8833 Thermal Camera Sensor with the Raspberry Pi Zero Wireless. Therefore, to perform face detection and recognition a suitable algorithm has been developed based on the embedded software algorithm that is shown in the Figure 3.5. According to the Figure 3.5, the developed embedded software algorithm for face detection and recognition that integrates the Pi Camera starts to acquire a real-time image via the Pi Camera. Then the real-image is used to compare with the stored image in the Raspberry Pi Zero Wireless SD-Card Storage. Upon confirming the acquired real-time image with the stored image, the embedded software algorithm performs face recognition to confirm the real-time image person's identity. Once the face is recognized, the AMG8833 thermal camera sensor measures the person's body

temperature and evaluate the measured body temperature based on the two pre-set temperature conditions as discussed in section 3.2.2. Once the measured temperature is confirmed which have to be based on either one of the pre-set conditions in section 3.2.2, the matched condition is processed accordingly based on the process shown in Figure 3.5. Therefore, if the measured temperature is NORMAL condition, the person's attendance is instantly recorded, whilst if the measured temperature is HIGH an email is send to the authority to inform the person's condition. Figure 4.3 shows the captured result from the python shell in the Raspberry Pi Zero Wireless as the program starts to execute, the results from the phyton shell is validated and as prove that the system can acquire the image that has been preloaded images in the Raspberry Pi Zero Wireless SD- Card Storage. When the system successfully detects the person's face, it displays the person' name and continues to measure the person's body temperature using the AMG8833 Thermal Camera Sensor. The measured temperature is then stored into the Raspberry Pi Zero Wireless SD - Card Storage. Figure 4.3 shows the captured name and temperature of the scanned person after the temperature scanning process.

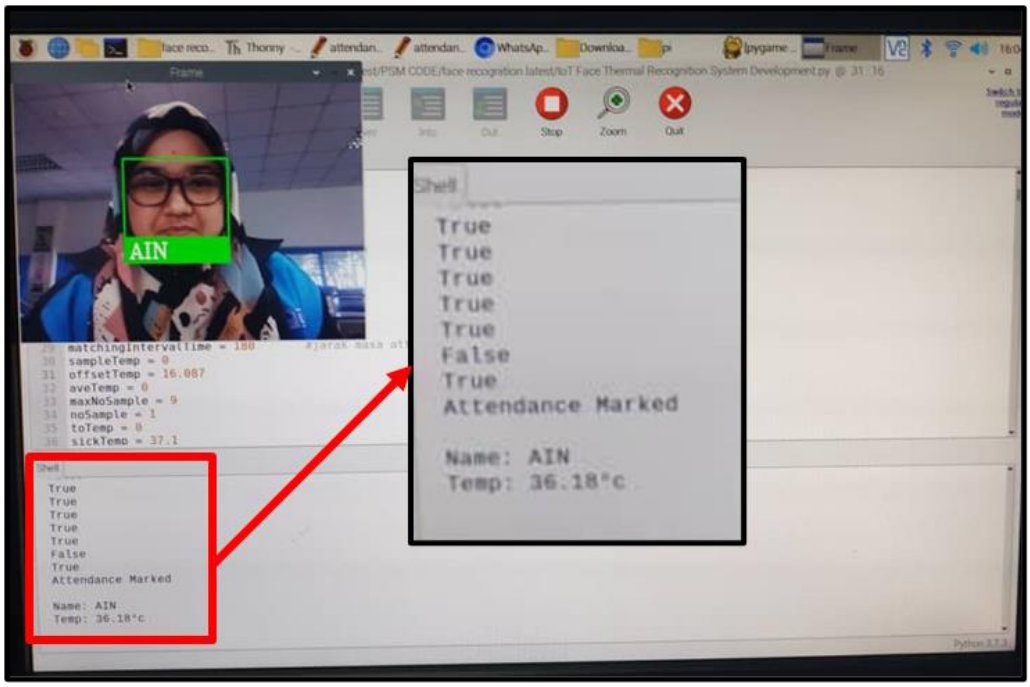


Figure 4.3: Name and Temperature Captured – Phyton Shell - Raspberry Pi Zero Wireless

Based on Figure 4.3, the AMG8833 Thermal Camera Sensor reads a real-time temperature value when a person face approaches to the Pi Camera. Hence, once the face is recognized, the AMG8833 Thermal Camera Sensor measures the person's body temperature and match the measured temperature with the person's name that is stored in the attendance list as mentioned in section 3.1.2. At the same time, the person's name and measure temperature is displayed at the integrated Liquid Crystal Display (LCD) as shown in Figure 4.4

Figure 4.4: Person's Name and Measured Temperature Displayed on the LCD

4.3 Condition of The System IoT Face Thermal Recognition System

When the face detection and recognition is successfully validated, the developed embedded algorithm continues to read the condition of the user which is through the temperature. As fever is one of the symptoms that is able to detect the present of CoVID-19, identifying the NORMAL or HIGH temperature according to the pre-set condition in section 3.2.2 is important to enable the person's condition. Also, according to World Health Organization (WHO) normal human body temperature ranges from 35.0°C to 37.1°C and the user should be allowed to enter the premise, otherwise the person need to be referred to medical team. According to the identification in patients of Covid-19 [16] and SARS [17], a person who has fever is defined as someone who has a body temperature greater than 37.1 °C and the person should not be allowed to enter into the premise. Generally, everywhere in the world this standard measurement that has been proposed by the WHO is being used to

allow a person to enter or not to enter a premise. Therefore, according to the available condition, the developed IoT Face Thermal Recognition System integrates two conditions as shown in Table 4.1.

Table 4.1: Condition and Temperature [1]

No	Condition	Temperature (˚C)
1	Normal	35.0 - 37
2	High	37.1 - 40

According to Table 4.1, there are two conditions in the system; Condition 1: Normal temperature and Condition 2: High Temperature. The condition 1 refers to body temperature "35 °C ≤ NORMAL ≤ 37 °C" and condition 2 refers to body temperature "37 °C < HIGH ≤ 40 °C".

4.3.1 Condition 1

As shown in Figure 3.5, the AMG8833 Thermal Camera Sensor reads the temperature of the person and if the measured temperature is "35 °C ≤ NORMAL ≤ 37 °C", temperature value is displayed on the LCD as an indicator to show the person's temperature when the person is entering a premise or building. Upon scanning, measuring, and reading the person's temperature, the person's name is matched as well as the person's name and measured temperature is displayed on the LCD. Otherwise, the embedded software algorithm continues to perform the person's name to record the measured temperature value.

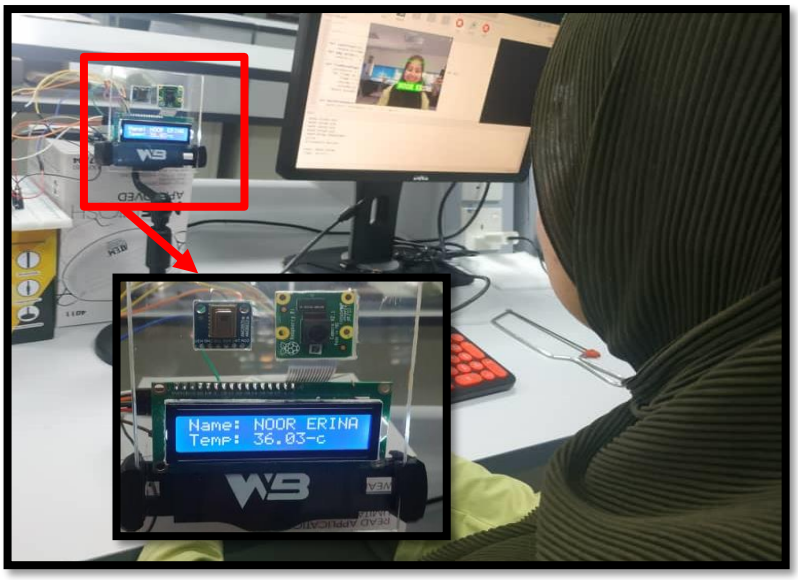


Figure 4.5: Condition of normal temperature

Once the person's name has been confirmed and the successiveness of AMG8833 Thermal Camera sensor read the person's temperature as "NORMAL", the person's name and temperature is recorded into the attendance list accordingly the ability to continuously process the recorded/stored information/data of an individual is necessary. As well as that, this information/data also should be able to be recorded into the system database to provide real-time health monitoring update of an individual. This attendance record can be sent to lectures or higher organization to report the attendance as shows in Figure 4.6.

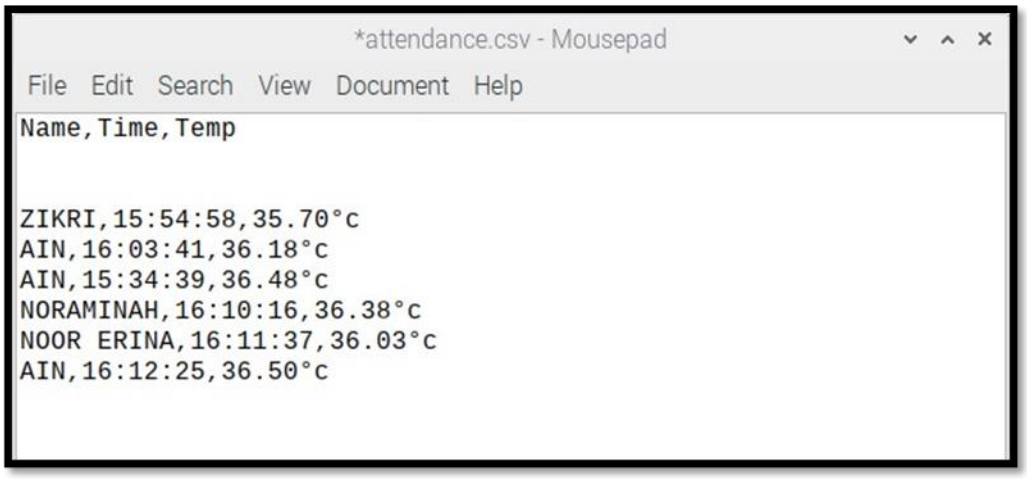


Figure 4.6: File CSV- Individual Name and Body Temperature Attendance list

4.3.2 Condition 2

As shown in Figure 4.7, the AMG8833 Thermal Camera Sensor reads the temperature of the person and if the measured temperature is between "37 °C < HIGH ≤ 40 °C", then the person is not allowed to enter the premise or building. Next, the person's information/data is sent through email notification to inform the higher authoritative of the person's condition. Also, during the temperature scanning, status as "Temperature High" is displayed on the LCD and at the same time the optioned outcome from the python shell in Raspberry Pi Zero Wireless as shown in Figure 4.7.

Figure 4.7 : Condition of High temperature

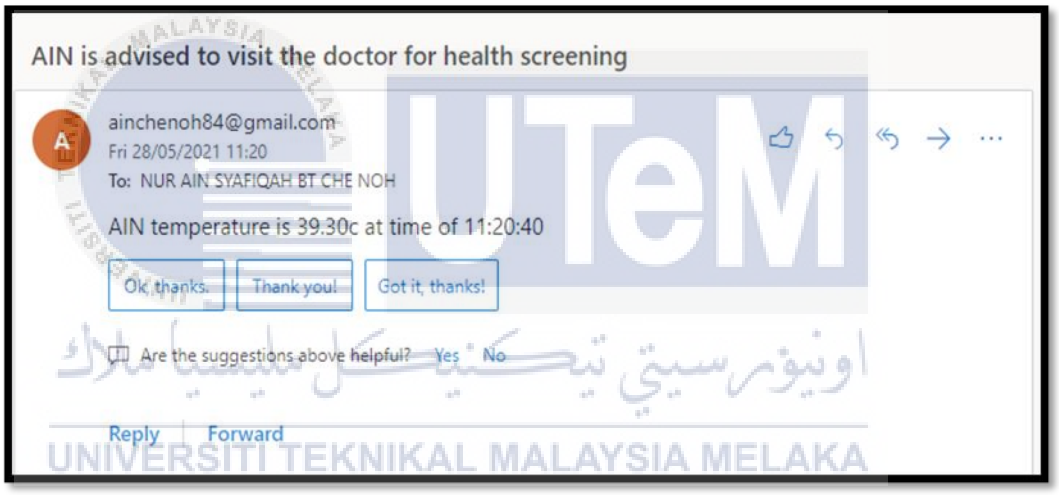


Figure 4.8: Email Notification for Higher Authority

Figure 4.8 shows an alert email containing information about the scanned person's temperature is recorded. The information that is shown in the email is to inform about the person's condition is sent to the high authority. Also, the person is not allowed to enter the premise or building.

4.4 Summary

The presented results in this chapter successfully validate the proposed research methodology in Chapter 3, the IoT Face Thermal Recognition System Development successfully develop the system in Python software based on the research methodology where the system successfully conducts the recognize face, measure the human body temperature, and send email notification to authority. Therefore, IoT Face Thermal Recognition System Development design and integration method can be used in any premise or building to prevent the Covid-19 from spread the infection to others and successfully validate the developed IoT Face Thermal Recognition System Development.

The system successfully operates as it is described in the research aim and objective based on the flowchart of the system where the fundamental research has been carried out and successfully implementing IoT Face Thermal Recognition System Development with the ability to continuously process the recorded/stored information/data of an individual is necessary. As well as that, this information/data able to be recorded into the system database to provide real-time health monitoring update of an individual.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

The major goal of the project is to develop the IoT Face Thermal Recognition System Development and to integrate a real-time email notification platform. This chapter discuss the proposed future work that can improve the system and the limitation that needs to be overcome in the future.

5.1 Conclusion

The global pandemic known as Covid-19 has become a major concern for many countries around the world. Probability to get the vaccine still underestimated. However, reducing the effect of Covid-19 can be achieved by preventing it from spreading further, with the Covid-19 pandemic lingering, everyone is required to record their presence and temperature is taken before entering any premises. Infrared thermometers are being used to check people's body temperatures in places where there are a lot of people. Besides that, one of the common daily problems that the user must face is the tedious steps to scan the QR code from my Sejahtera apps which usually is quite time-consuming. The proposed IoT Face thermal recognition system Development provides fast and accurate thermal scanning while the bundled software enables systematic data storage for easier backtracking. The project has the potential to be commercialized because of all types of locations where people congregate to enforce social distancing and identify individuals with high temperatures because of COVID-19.

The constructed system operates based on desired operation. The validation and analysis carried on CHAPTER 4, it can be concluded that the system is successfully when the system can recognize face, measure reading temperature and email notifications will send to higher administration to inform the respective individual’s health condition if the measured temperature is between “37 °C < HIGH ≤ 40 °C”. Thus, the project objective is achieved.

The developed project is simply environmental friendly because this project durable and used continuously over a long period of time because of the corona virus

expected the COVID-19 outbreak will last between 18 and 36 months [1]. Therefore, this system can comply to the Standard of Operating Procedure (SOP).

5.2 Future works recommendations

There are few recommendations and suggestions that can be considered to maintain and increase the performance of the project. This improvement is:

- First, this project can update person's name with the high temperature, the name will be recorded into the attendance list. The current project only update person 'name with normal temperature.
- Therefore, for the next research project recommendation, an improvement in the system with On-screen will be displays temperature reading and person's name with face recognize.
- In addition, for future system can therefore be used in real-time applications which require face-mask detection for safety purposes due to the outbreak of Covid-19. The current only recognize face without mask face.

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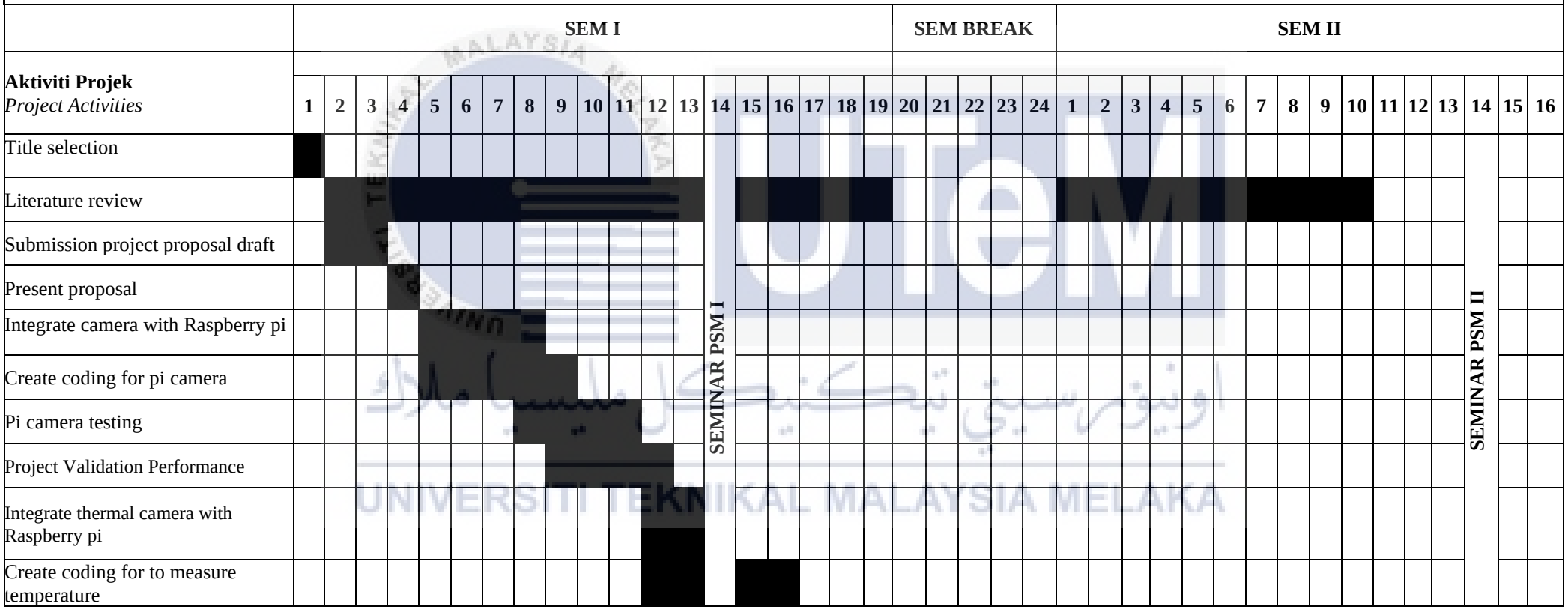
Appendix A

RANCANGAN PROJEK

PROJECT PLANNING (GANTT CHART)

Senaraikan aktiviti-aktiviti yang berkaitan bagi projek yang dicadangkan dan nyatakan jangka masa yang diperlukan bagi setiap aktiviti.
List all the relevant activities of the proposed project and mark the period of time that is needed for each of the activities.



Testing temperature sensor and measure	
Project Validation Performance	
Integrate Email and notification	
Create coding for Email and notification	
Testing Email and notification	
Project Validation Performance	
To validate face thermal recognition system and real time email processing and notification platform in the developed Face thermal recognition system	
Thesis Making	
Final Report Submission	