

Faculty of Electrical and Electronic Engineering Technology



Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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DEVELOPMENT OF IOT BASED COVID-19 NON-CONTACT THERMOMETER

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A project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled "Development of Iot Based Covid-19 Non-Contact Thermometer" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

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DEDICATION

This thesis is dedicated to my parents and other family members who gave moral support and encouragement during the writing process. Additionally, I'd want to dedicate this to my friends and supervisor, who have always offered assistance when I've encountered challenges with this project.



ABSTRACT

Due to the spread of COVID-19 across the world and the increased need for non-contact thermometers to prevent the spread of disease, a new electronic thermometer has been designed and implemented for measuring human body temperature from a distance. This device is currently in use at building entrances to measure the body temperatures of employees, students, and customers. Due to the disadvantages of traditional mercury thermometers, such as longer measurement time and necessity of contact with the human body, a thermometer that uses infrared sensors to detect temperature without contact is designed. The Infrared temperature sensor MLX90614 is designed to collect human or object temperature by the NodeMCU to process the temperature into the LCD display, alarm when over-temperature and recorded in Google Sheet. To overcome such factors, we describe the assembly of a NodeMCU based digital IR thermometer with distance correction using the MLX90614 IR thermometer and HC-SR04 ultrasonic sensors.



ABSTRAK



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LIST OF SYMBOLS

°C - Degree Celsius



LIST OF ABBREVIATIONS

| IR | - | Infrared |
|------|---------------------------------------|--|
| IoT | - | Internet of Things |
| MAE | - | Mean Absolute Error |
| RMSE | - | Root Mean Squared Error |
| SSD | - | Single-Shot multibox Detector |
| FPS | - | Frame Per Second |
| ITMS | - | Intelligent pandemic prevention Temperature Measurement System |
| MQTT | - | Message Queuing Telemetry Transpot |
| PPAS | - | Pandemic Prevention situation Analysis System |
| LCD | - | Liquid Crystal Display |
| CPU | a a a a a a a a a a a a a a a a a a a | Central Processing Unit |
| RAM | TEK | Random-Acess Memory |
| SDK | Eler | Software Development Kit |
| USB | - 33 | Universal Serial Bus |
| DSP | YE. | Digitl Singnal Process |
| SDA | _ | Serial Data |
| SCL | UNI | Serial Clock |
| PWM | - | Pulse-Width Modulation |
| JSON | - | JavaScript Object Notation |
| WiFi | - | Wireless Fidelity |
| CBTM | - | Continuous Body Temperature Measurement |

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CHAPTER 1

INTRODUCTION

1.1 Background

Designing and evaluating these small standalone sensors and actuators that gather limited quantities of energy necessitates the use of unique tools and approaches. For example, to record, quick and accurate measurement tools are necessary. In addition, the necessity for real-world investigations drives compact and portable equipment to undertake in-situ power measurements and environmental logging.

1.2 Problem Statement

In recent years, the Internet of Things (IoT) has gained traction as a new research topic across many academic and industrial disciplines, particularly in healthcare. The Internet of Things revolution reshapes modern healthcare systems by integrating technological, economic, and social perspectives. It transforms traditional healthcare services into more personalized systems, making it easier to diagnose, treat, and monitor patients.

IoT-connected devices are being used in the case of COVID-19 to reduce the risk of the virus spreading to others. Reading the temperature and recording the data at the same time proved to be a challenge. Simultaneously, paper consumption will decrease, potentially saving the environment.

Medical care, environmental monitoring, and personal health are all areas where noncontact infrared thermometers are commonly used. This project aims to create a temperature measuring device that can quickly detect a person's body temperature. The process includes collecting sensor data and gaining access to Google Sheet. The intelligent device can empower smart device manufacturers to develop automated body temperature monitoring devices and solutions that can replace human resources, reducing staff exposure risks, and improving screening quality.

1.3 Project Objective

Specifically, the objectives are as follows:

- a) To develop a non-contact portable thermometer that is capable of displaying the body temperature and record the data in real time to Google sheet.
- b) To conduct a functional analysis of the system which includes the ability of the ultrasonic sensor and non-contact thermometer to detect an accurate reading of the body temperature and record the information via wifi-connection.

1.4 Scope of Project

The scope of this project are as follows:

- a) Design a prototype to measure body temperature using NodeMCU ESP8266.
- b) Collect and record data of body temperature via Google Sheet.

1.5 Thesis Outline

The entire report is divided into five main chapters, each of which has sub-headings.

For each chapter, the following is a brief explanation:

Introduction (first chapter)

This chapter contains a background examination of the project's approach to the problem under investigation. In addition, this chapter provides a quick overview of the project's goal and scope of research.

Review of the Literature (Chapter 2)

This chapter examines the literature on a particular topic by evaluating a variety of sources. This chapter will include various sources from the internet, research papers, books, and other sources to help understand and research. In addition, the researcher's work will be cited to recommend appropriate methods and search for new approaches for the project.

The methodology is covered in Chapter 3.

A set of logical steps must be followed to conduct a systematic investigation. The research process is divided into three stages: decision, planning, and execution. This chapter for research design contains procedures, equipment, and materials. The research organization creates a process flow for the project overview from the ground up.

Chapter 4: Conclusions and Recommendations

This chapter aims to summarise the project's collected data and the results of the analytic process. For different purposes, the methodology's results are presented in the form of a collection of photographs and a data table.

Conclusions in Chapter 5

The conclusion is the report's final chapter, which concludes with a decision of its own. First, the project's summary is presented, and the study's findings are discussed and simplified. Recommendations for a better outcome are included after the chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Every existing project has its advantages and disadvantages, and each one employs a different approach while still pursuing the same goal. This project aims to be mobile and user-friendly, which sets it apart from other similar projects. Several project designs were investigated, and the findings will be used to develop new enhancements for this project.

2.2 Literature Review

2.2.1 Design And Development Of A Low Cost, Non-Contact Infrared Thermometer with Range Compensation

Incorrect temperature readings can have a direct impact on infection control procedures, resulting in false negatives. So they set out to construct and calibrate an Arduinobased thermometer capable of adjusting for different measurement distances from the forehead to more reliably detect body temperature. Non-engineers may now manufacture their own devices in times of scarcity, like the 2020 COVID-19 pandemic, thanks to off-the-shelf electrical sensors and microcontroller kits. They have decided to make their findings public for the community to improve the accuracy of their own built thermometers. Temperature differences between the centers and laterals of the forehead were noticed and remained even after correction adjustments.

The mean wet forehead temperatures in the second experiment set were often lower than the dry forehead temperatures, with a few exceptions. Compared to alternative and more expensive non-contact IR devices, the IR thermometer achieved higher precision. It was unquestionably more accurate with distance adjustments. Because oral temperature readings are routinely used to detect body temperature non-invasively, readings of the forehead temperature can be utilized to define a threshold in fever screening.

This non-contact thermometer is handier than tympanic or rectal thermometers. The measured temperatures were found to be well within a 0.29 °C range of their oral temperature across a distance of 2 to 4 cm, achieving comparable performance to commercial thermometers. Therefore, it is possible to conclude that the suggested control system has good validity for measuring human forehead temperatures at different distances.

2.2.2 A Thermal Camera Based Continuous Body Temperature Measurement System

Body temperature is the most crucial indication of the human body. Continuous body temperature monitoring is limited by reaction time, movement noise, and labor needs. Using deep-learning face detection, object tracking, and calibrated conversion equation, they can successfully extract the subject's front temperature in real-time. Experimental results show that the total mean absolute error (MAE) and root-mean-squared error (RMSE) of our suggested framework are 0,375°C. Hospitals indicate body temperature.

The main goal is to measure the long-term temperature reliably. This work chooses the thermal camera to view body temperature as an image and measure temperature at various spots across a specific area. Use IR and thermal cameras to measure body temperature.

Machine Learning-based methodology can be used to modify IR-image visual domain methods. Training data from this database, however, is too distinct to camera specifications. The proposed continuous body temperature measuring system can be applied to image processing to detect a subject's face in a thermal image. Current CBTM technology is primarily limited by reaction time, motion noise, and whether it can be automated. Therefore, they used non-contact CBTM thermal imaging sensors.

They combined a neural network-based face-detection approach and object-tracking technology. Their techniques are based on NVIDIA Jetson TX2 with C++ language and OpenCV library.

$$Face = Rect(x, y, w, h)$$
(1)
$$ROI = Rect(ROI_x, ROI_y, ROI_w, ROI_h)$$
(2)

They decided to train a new model based on deep-learning techniques by using Single-Shot-Multibox Detector (SSD) and MobileNet. If any face is discovered, the look is detected as (1) and (2). The data used in our analysis comes from the execution series, Figure 2.2.1 Deep-learning face detection can determine the face location in each frame. Still, the processing time is too high, reducing frames per second (FPS) to boost FPS.



Figure 2.2.1 The overview of detection network architecture

Here, classes indicates the number of classes, which is 2 (thermal face and background) in this paper. After face detection and tracking, facial location can be identified in successive frames. To assess body temperature, they define the front area as ROI (see Figure 2.2.3). Figure 2.2.2 shows the core algorithm flow, and Figure 2.2.3 shows the example ROI assignment diagram. When enabling radiometric mode, body temperature is monitored using Lepton 14-bit mode. The camera signal is linear within Lepton's radiometric band. Thus, flux is tied to the temperature of Planck's curve scene.



Figure 2.2.2 General flow of KCF algorithm



Figure 2.2.3 The illustration diagram of ROI assignment

The temperature should be monitored at the source location. They were using Keysight U5855A thermal imaging camera with temperature-variety water to alter the heat **VERSITTEKNIKAL MALAYSIA MELAKA** source. In addition, they used FLIR Lepton 2.5 camera to capture thermal scene data. This camera's output is 14-bit pixel unstable instead of 14-bit unstable pixel. The camera measure subject at 40-80 cm.

2.2.3 Apply IOT Technology To Practice A Pandemic Prevention Body Temperature Measurement System: A Case Study Of Response Measures For COVID-19

The findings demonstrated that ITMS could be used to design technological concepts, hardware operations, and services. For example, users of the pandemic app can complete identification reaffirmation on mobile devices, view temperature safety records, and receive notifications for high-risk regions. Its primary tasks are radio frequency reading, QRID card scanning, warning light reminder, reminder, and data transmission. It consists of two modules: pandemic prevention app and pandemic protection app. The study was carried out at a Taiwanese University of Science and Technology. The first objective is to understand the system's components and comprehend the characteristics of each component entirely. The benefit is that the system size is reduced.

This study's integrated circuit board was mainly developed to feature two 74HC595 integrated circuits and stabilize circuitry. In addition, Lin et al. developed a plan for integrating ITMS and PPAS that comprised the integrated result of the circuit diagram, incorporating various components and all IoT components designed by the two.



Figure 2.2.4 PCB, IoT components, and circuit diagram

It was discovered that infrared distance sensors could cause false positives and false negatives when exposed to sunshine. ITMS employs the NodeMCU, primarily because the MCU has integrated the ESP8266 Wi-Fi module, allowing edge computing and data analysis to be performed on this version. The system threshold will be compared to the measured body temperature. Using the MQTT protocol, all data may be transferred to the cloud via the ESP8266 Wi-Fi module. The personal temperature will be displayed in real-time on the seven-section display. The voice module will guide the entire procedure. When the identity card is not available, the temperature can be monitored by scanning the QR-code with the mobile app. The campus app will indicate whether or not the campus app is shown in real-time. The high expense of infrared temperature sensors is utilized to measure the temperature of the campus's main entrances.



Figure 2.2.5 PPAS system structure

The general system structure of PPAS is depicted in Figure 2.2.5, divided into two parts: the cloud system and the user interface system. Data analysis tools, such as the ITMS measurement, will be used for data analysis. The module primarily collects body temperature data for pandemic prevention, as well as COVID-19 and ITMS data. According to the study, the PPAS analyses data acquired by ITMS and presents it in COVID-19 records.

The modules are divided into four categories: core modules, MQTT modules, web and web and API modules, and an AP Server module. The user interface system's two main modules are the pandemic prevention app module and the epidemiological analysis module. These two modules are thoroughly explored. Furthermore, the system provides a person privilege function that allows him to monitor the personnel data of his class. Implementing a pass-through certificate can considerably reduce the problem of frequent assessment of incoming and outgoing people. The certificate is only valid for 4 hours. Following that, it shows a pattern indicating an expired certificate. To acquire a fresh certificate, the user must re-measure using ITMS. The PPAS system framework includes some software components. The technique uses a pie chart to illustrate the temperature interval distribution of the number of people. When a confirmed case of COVID-19 is found, the system conducts extensive data analysis to identify high-risk infection groups.



The scatter diagram is used to depict the location of the high-risk infected person. The system is adaptable to any display interface, such as a smartphone, a giant screen, or a kiosk.

2.2.4 Non-Contact Infrared Temperature Acquisition System Based on Internet of Things For Laboratory Activities Monitoring

This paper introduces iRT, an Internet of Things (IoT) system for real-time temperature monitoring. The iRT employs an infrared temperature sensor module comprised of an MLX90614. A web application can be used to access the collected data. According to the authors, the acquired results are encouraging, making a substantial addition to infrared temperature monitoring systems based on IoT. The core idea behind the Internet of Things

(IoT) is the widespread availability of numerous devices that can communicate and collaborate to achieve a common purpose.

Monitoring the indoor air quality The Internet of Things design incorporates opensource technologies for processing and data transmission, as well as microsensors for data collection. Infrared temperature sensors have been used in a variety of scientific applications. For optical rehabilitation therapy, for example, a real-time non-contact temperature monitoring device for the human body's surface has been proposed. Finally, no one has studied the possibilities of infrared sensors in the sugar beet field through various applications utilising infrared temperature sensors that have been established in the past. The iRT is a non-contact temperature acquisition device based on IoT that was designed to be a low-cost solution that can be easily implemented throughout buildings.

The simple installation feature avoids the installation costs and privacy problems connected with home installations handled by qualified specialists. Furthermore, this technology allows for autonomous temperature monitoring in indoor environments, which is particularly useful for laboratory tasks. The major purpose is to provide accurate and consistent temperature monitoring. An all-in-one Wi-Fi system based on open-source technology is presented as a solution. Advantages over traditional systems include modularity, scalability, low cost, and ease of installation. The iRT includes a microcontroller with native Wi-Fi capability, a FireBeetle ESP8266 (DFRobot), and an I2C interface for connecting the sensor. .NET Web services are used to store the observed data in a database. iRTWeb gives access to real-time monitoring data as well as a list of anomalies. The solution has been tested in a Portuguese university's laboratory and can produce accurate ambient temperature measurements. In addition, the iRTWeb supports data visualization in both graphical and numerical modes. The information gathered can help in decision-making and can be used to analyze past data. The Web portal also makes it simple to retrieve collected data and allows for the more detailed study of parameter temporal change. The proposed system is simple to set up, requiring simply a power supply and a Wi-Fi connection.



Figure 2.2.7 iRT hardware prototype

The iRT allows for the collection and storage of ambient and object temperature data and real-time worldwide access to the monitored data. The system's versatility makes it simple to add new modules based on the demands of the plant. The primary purpose is to make technological enhancements, such as developing critical alerts to tell the user when the temperature reaches predefined setpoints. Because of wireless technology for communications, the iRT system has advantages in both installation and configuration. The solution offers flexibility and expandability. The user can begin with just one module and then add additional as needed. However, the proposed method has certain drawbacks and requires more experimental confirmation.

2.2.5 Infrared Thermometer on The Wall (iThermowall): An Open Source And 3-D Print Infrared Thermometer For Fever Screening.

The iThermowall is a low-cost non-contact thermometer that may be used in public locations without the need for an operator. The hardware can automatically measure human

body temperature when the distance between the sensor and the forehead is suitable. Body temperature monitoring is crucial, especially for detecting COVID-19 suspects early. Temperatures close to body temperature imply that temperature may play a role in the transmission and severity of COVID-19.

The iThermowall is a low-cost fever screening platform thermometer that is opensource and does not require an operator. The hardware can automatically monitor body temperature when the distance between the sensor and the forehead is suitable. It was designed to be simply replicated using a readily accessible module and 3-D printer.

For the infrared thermometer sensor, the GY-906 module, which employed the MLX90614 temperature sensor, was employed. The hardware was powered by two parallel Lithium-ion 18,650 batteries. As a result, a camera like the FLIR Thermovision or the OptoTerm Thermoscreen could be used to measure advanced human body temperature. The camera sensor system has the benefit of quickly measuring the temperature of a large number of people. Nonetheless, the camera sensor system can be costly. Figure 2.2.8 depicts the design.



Figure 2.2.8 iThermowall Infrared Thermomoter

2.2.6 Tympani Thermometer Design Using Passive Infrared Sensor

The Tympani Thermometer with external storage can help doctors diagnose patients more accurately. Because the tympanic membrane and hypothalamus have arterial blood flow, infrared thermometers in the membrane are deemed optimal. In addition, human body temperature varies substantially depending on where the reading is taken. The study aims to create a tympani thermometer with an inaccuracy of 0.7°C in the left ear and 0.24°C in the right ear. A mini-sensing circuit was created by printing temperature and humidity sensors with less than 11 mm on a flexible polyimide substrate.

The system had four sensors: An inductive sensor for metal detection, nine IMU sensors, a temperature sensor, a humidity sensor, and a microprocessor with radio frequencies. The data was transferred to the computer, where it was analyzed and shown using Matlab.

An LM35 temperature sensor, an ATMEGA8 microcontroller, and an LCD were used in the system. The ATMEGA 8 microcontroller processed the data from the LM35 sensor, which was then displayed on the LCD. A robotic system for measuring the temperature of the surroundings via direct tracking was investigated. The digital microcontroller-based gauge with GSM warning systems was investigated. The tool has the benefit of being able to detect the temperature of an object (ear canal), where the ear canal is directly connected to the central regulator of body temperature.



Figure 2.2.9 System block diagram

The ear measures the actual body temperature in seconds and outputs a unit of measured values. Figure 2.2.9 shows a block diagram of the infrared temperature design employing a passive infrared sensor. Temperature is measured via infrared wave emission by

the sensor. The LCD used is 2x8, and the battery serves as the system's voltage supply. The tympani membrane measures body temperatures, which assists doctors in diagnosing ailments in patients.

A thermometer is a device that detects infrared radiation energy and converts it to a temperature scale. The measurement test was carried out by comparing the thermometer module to an IT-903 digital thermometer. The average temperature of the 30 respondents' instrument modules was 36.47 °C with a 0.6 percent inaccuracy on the right ear and 36.36 °C on the left ear. With a variation tolerance of 1.5 °C, it can be inferred that the instrument is suitable for use.

2.2.7 2019 Novel Coronavirus Disease (Covid-19): Thermal Imaging System for Covid-19 Symptom Detection Using Iot Technology

It can detect sensed temperatures using the Thermal Module and see faces with the optical camera. Thermal imaging is used to screen out those who have a fever or a higher-thannormal body temperature. People suffering from pandemic fever, for example, can utilize the Covid-19 Symptom Detection Using IoT Technology, which has the same symptoms as SARS, to locate and identify others suffering from the sickness. The greater usefulness was made possible by subsequent research to improve the helmet, drones, and the drone itself.

This device's general usage is increasing, as it is widely used to monitor people's body temperatures. The cost of commercially available thermal imaging equipment was compared to the price of a prototype that utilized a commercial thermal module in the investigation. The thermal module was discovered to have saved a significant amount of money.

To detect fever in large groups of individuals, the proposed prototype will contain a thermal camera and a thermal module. This data includes a heat measurement, an image of the covered surroundings, and a point that indicates the device's location. Another feature of face detection is its use in the temperature screening process. The hardware's principal function is in implementation, where it is utilized for thermal cameras, optical cameras, and GPS Modules. The thermal camera module includes AMG8833, which serves as the thermal data acquisition module.

The Arduino board is used to configure this project, and the Wi-Fi module is used to transport data to the cloud (ESP8266). The optical camera is used to recognize faces in collected photos to identify suspected persons of being infected. Due to the limited resolution of the thermal camera, only one picture of the acquired surroundings is taken, resulting in 8x8 pixels. To access and control the module's data, they utilize the library to access the module's data and apply various rules to record the data for a set time. An optical camera can be used to picture people, allowing their faces to be visible. The GPS module is utilized to determine the system's location.

In addition, the identified faces will be matched to thermal data to estimate the temperature value of that spot. The ESP8266 Wi-Fi module will connect to the cloud storage over the internet and upload data. The acquired data will be stored in the real-time database supplied by Firebase. They needed a capture resolution of 640x480 pixels to capture the image of OV7670. This pixel has 307200 different color values. The face recognition machine learning approach uses ML Kit, an SDK that supports machine learning on mobile devices.

Developers can utilize Google's machine learning expertise to enhance their Android and iOS apps using the ML Kit. The algorithm will return the identified facial area as well as the location of the region's center. The thermal image is saved in an array that stores the temperature value of each pixel. Figure 2.2.10 depicts the outcome of the face detection method. The blue dot inside the colored square represents the point of face detection from where the measurement began.



Figure 2.2.10 The hardware arrangement for thermal screening

Cameras, though necessary for photography, must be situated at the same angle of vision. As a result, the cropped image with 480x480 pixels is performed in the optical picture's center. The algorithm will locate all of the detected face points and all of the face array points, which will then be matched to the heat sensor array that covers that face area. Figure 2.2.11 depicts the image of the covered optical. It's simply a 480x480 pixel picture. As a result, one pixel of thermal imaging coverage results in a temperature of approximately 60 degrees Fahrenheit on the pixel being scanned.



Figure 2.2.11 The hardware arrangement for thermal screening

The AMG8833 thermal camera can detect human faces from a distance of up to 7 meters. Temperatures of 0 to 80 degrees Celsius can be measured (32 to 176 degrees

Fahrenheit)). The device has a temperature range of 2.5 degrees Celsius. The calibration procedure involves taking an actual temperature measurement with the IR thermometer and comparing it to the array value. The temperature value will be determined using the temperature used as a reference point. The calibration step evaluates whether the result matches the predicted result—the hardware configuration for thermal screening.

AMG8833 may recognize human figures at a distance of seven meters. A thermal camera measures the temperature of an item at various distances to see if it changes. The thermometer's sensor is linked to a lower reference temperature than the current temperature being compared. As can be seen, the difference is just about 2.5°C because it is the precision determined by the thermal module. As a result, there is a 2.3°C error in this data set, with the minor difference being 0.8°C.

The precision of the thermal module is 2.5° C, indicating that the data may not be correctly identified. Both Covid-19 and SARS have been identified in fever patients as causes of fever. The temperature is currently 2.3°C. When a person's temperature rises to 40.3 °C, it is apparent that he or she has a fever. Potential vaccines, as well as various specific medical therapies, are all being explored at the moment.

Infrared thermometers are now being used everywhere, especially in areas with a high population density, to measure general body temperature. The thermometer gun under consideration for possible deployment in the United States is currently undergoing extensive testing by some of the world's most prestigious medical research institutions. In addition, an Internet-based technique for promptly detecting suspected patients with fever in crowds is being developed. The device can save the findings of temperature monitoring using face detection. A fever is the most obvious sign, but other symptoms such as a runny nose and watery eyes can also suggest the presence of a fever.

2.2.8 Body Temperature—Indoor Condition Monitor and Activity Recognition by MEMS Accelerometer Based on IoT-Alert System for People in Quarantine Due to COVID-19

The Temperature indoor and relative humidity are two critical factors in preventing the spread of COVID-19. Quarantine monitoring system using an ambient sensor, the quarantined person's temperature and humidity are updated every 5 seconds. Based on the sensor data, the room condition sensor can adjust the room temperature by modifying the air conditioner, heater, or air humidifier. In addition, the system uses an infrared thermometer to monitor the thermal body of people in quarantine.

The overview of designed system shown at Figure 2.2.12. The sensor is non-contact. It has a lens that directs infrared (IR) energy to a thermopile detector, which converts heat energy to an electrical signal. There are two sorts of thermometers: contact and non-contact. Contact thermometers use the heat transfer phenomena to determine temperature. In the meantime, an infrared sensor measures the level of infrared emissions to calculate body temperature.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA


It has a lens that directs infrared (IR) energy to a thermopile detector, which converts heat energy to an electrical signal. Unlike the infrared thermometer, the digital temperature sensor requires physical contact with the user to detect an electrical signal. This sensor type is suitable for long-term contact as a wearable device because quarantined people can use it frequently. Using a bandgap temperature sensor circuit, the MCP9808 provides an analog voltage proportional to temperature. An inbuilt analog to digital converter is utilized to transform the analog voltage into a digital world.

This sensor type is suitable for long-term contact as a wearable device because quarantined people can use it frequently. Unlike the infrared thermometer, the digital temperature sensor requires physical contact with the user to detect an electrical signal. The MLX90614 is also embedded with the device, allowing the quarantined individual to quickly take the device to measure his or her body temperature. The main thermometer is MCP9808, linked to the wearable device and directly measures body temperature through physical contact. During charging or when the user wishes to remove the device, an infrared sensor is used.

The infrared thermometer MLX90614 is also embedded in the device, allowing the quarantined person to take it quickly. The measured temperature data will be automatically sent to the cloud or the shared device based on the programming implementation. The contact thermometer achieves higher accuracy due to long-term measurement. Still, the infrared sensor has the advantage of quick measurement with no contact required—weighting coefficient to reduce noise exponentially to near-zero levels. Traditionally, a glass thermometer is used to check one's body temperature.

The temperature calibration process consists of two significant steps. First, the digital sensor is attached to the wrist, and the glass thermometer is placed inside the body at the same time. Second, the calibration of a digital thermometer is accomplished by averaging N samples from raw data (Traw). This average (Tavg) result includes any bias, such as skin heat. The difference between Tref and Tavg is used to calculate the bias that should be removed from Traw. The calibration successfully removed the bias from the digital measurements in this manner.

2.2.9 Non-Contact Portable Infrared Thermometer for Rapid Influenza Screening

The vast majority of SARS/H1N1 cases have been reported among tourists returning from abroad. Infrared thermography is a non-contact and rapid way of detecting body temperature. Simple, quick, and low-cost diagnostic tests can help healthcare practitioners execute efficient infectious disease screening at a student health center. University officials should be concerned about this recognition because of the vast number of faculty, students, and visitors. Unfortunately, the vast majority of thermography equipment is both expensive and stationary.

We developed a non-contact handheld infrared thermometer to test for fever in persons with infectious illnesses. To summarise and print the acquired body temperature and symptoms, a tiny thermal printer is employed. The screening summary will then be brought with each individual when they see the doctor for additional assessment. This scenario is designed to save time that would otherwise be spent during a doctor-patient interview.

The smaller the target—the bigger the ratio number, the greater the thermometer resolution, and the smaller the measuring area—the closer the measurement should be done. For example, an infrared thermometer with a 5° field of vision would measure the temperature of a circular spot 23cm away from a spot 1cm in diameter. As a result, the most significant distance at which temperature can be accurately monitored is 40 cm.

Anything else that falls within this distance is also measured beyond it. mercury-inglass thermometers have been used for hundreds of years. On the other hand, infrared tympanic thermometers may be handier because the ear is ideal for monitoring temperature. The thermometer should be constructed on a 5 cm diameter target with a d:s ratio of 8:1. (distance:spot).

The system is based on a microcontroller, which is coupled to and controlled by sensors and peripherals. Each individual will have infrared body thermometry measuring the forehead body temperature to detect fever. The MLX90614 infrared thermometer from Melexis is used to assess body temperature. To obtain the actual temperature reading, optical fiber was used.

The thermometer has an accuracy of 0.5 °C and a resolution of 0.02 °C for object temperatures ranging from 0 to 60 °C. A generic input-output pin connects the device to a microcontroller. The display is a 1.6-inch monochrome LCD with a resolution of 84x48 pixels.

The analog joystick is utilized for rapid menu navigation, mainly while entering symptoms. In addition, the central push-button of the joystick is used to do a one-touch temperature measurement.

Two ADC channels are used to track joystick movement. The majority of the system's components are built to work with a 3.3 V power supply. The battery pack produces around 8.4 V when completely charged. However, when drained, the voltage may be closer to 6.4 V. The thermal printer is modest in size and uses thermal paper that is 57 mm wide.

2.2.10 An Open-Source Non-Contact Thermometer Using Low-Cost Electronic Components

The system comprises seven major components:

- An Arduino UNO microcontroller
- An infrared thermometer for non-contact temperature measurements
- An infrared motion sensor
- A real-time clock
- A micro-SD storage board for storing device audio instructions
- A LCD 16x2 for display result
- A digital power amplifier (PAM8403 module),

The Arduino UNO comes with everything their need to run the microcontroller. Connect it to a power source device via a USB cable to get started, or power it with a DCadapted power supply or battery. Because this low-cost chip is inexpensive, tampering with the Arduino UNO is straightforward. The key advantages of this sensor are its small size, low cost, and low integration rate. The MLX90614 also has a low noise amplifier, a 17-bit ADC, and a sturdy DSP module, which allows it to achieve high precision and accuracy. The PAM8403 is a class-D 3 W audio amplifier with high-definition sound. The DS3231 module is a low-cost, high-accuracy real-time clock that can store hours, minutes, seconds, and day, month, and year data. A regular CR2032 3V battery can power the module for more than a year. Data storage is one of the most important aspects of any project of this scope. The device speaks English or Arabic in addition to displaying results on the LCD screen.

In the hardware, open-source sensor controllers are used (Arduino). The module is simple to operate and low-cost to manufacture. It is compatible with a wide range of current platforms and microcontrollers. The device is designed to be simple to use and capable of taking temperature readings without the assistance of a specialist. A user merely needs to place their hand 5cm to 15cm above the prototype device meter to test it. The thermometer detects thermal radiation emitted by the measuring object and displays the temperature value on the LCD screen. The device either enables the user to enter (if the temperature is appropriate) or asks them to try three times before rejecting them, depending on the temperature measured.

2.2.11 Development of a Non-contact Infrared Thermometer

The sensor is designed to capture human or object temperature, which is subsequently analyzed by the SCM and shown on the LCD, and provides an alert when the temperature surpasses a particular threshold. The temperature resolution is 0.1 degrees Celsius, and the temperature range is 0 to 55 degrees Celsius. Non-contact measurement is possible with the smart thermometer; insert the thermometer in the forehead for a few seconds to receive the body temperature. If the value is exceeded, the thermometer will notify you. Infrared thermometers are based on the concepts of black body radiation.

It is safe and straightforward to use, with accurate measurements and a short measurement time. Its infrared sensors only collect infrared light emitted by the human body. The temperature range of the thermometer is -40 to +125°C; calculate and save ambient and

object temperatures in RAM. It has a low-noise amplifier, a 17-bit A/D converter, and advanced DSP processing. As a result, it can survive temperatures as low as -40°C and as high as 125°C.

Infrared radiation signals are converted into electrical impulses by the infrared sensor. It is then transformed into digital signals that are proportional to the temperature. Finally, the digital signals are sent to the microcontroller to be processed. An infrared temperature measurement circuit is shown in Figure 2.2.13.



Figure 2.2.13 Infrared temperature measurement circuit

The alarm circuit will ring if the body temperature exceeds the preset value. The display circuit is based on the well-known LCD1602. An active buzzer activates the alarm when the body temperature exceeds a specified threshold. The course is straightforward, low-cost, and has a high cost-performance ratio.

It has a programmable 8-bit CPU and an in-system programmable Flash. The software **UNIVERSITI TEKNIKAL MALAYSIA MELAKA** is built using the Keil uVsion4 compilers. The main program, the infrared temperature measuring program, the display program, the alarm program, and the test thermometer are the four major components of the design. The basic program flow chart is depicted in Figure 2.2.14.



Infrared thermometer findings will contain some measurement inaccuracies due to measurement inaccuracies. The infrared radiation emitted by the human body, on the other hand, may be utilized to calculate its temperature. Infrared thermometers can also be used to determine the temperature of an object and the passage of time. An infrared thermometer is a novel form of a non-contact thermometer. It boasts a faster response time, superior safety, and other advantages over a mercury thermometer. It also includes an alarm, an LCD, and other valuable functions.

2.2.12 12An IR Sensor Based Smart System to Approximate Core Body Temperature

The suggested system is highly energy-efficient, requiring only 165 mW of power and running on a 5 VDC source. The implemented method uses an industrial-grade IR

thermographic sensor and an AT Mega 328 breakout board. With a slight adjustment, the provided model can be coupled to a remotely situated IoT cloud service, which may help inform and anticipate the user's core body temperature via a probabilistic view. The proposed approach may be helpful as a wearable gadget attached to a cap. It can also be used to monitor the human body.

An IR sensor situated 1.5–30 cm away from the human forehead produced no meaningful findings during the experiment. The range of the IR sensor is the primary cause of such an occurrence. The suggested approach is critical in storing raw data, visualizing graphics, and perceiving thermography. The proposed resolution would benefit from mobility, use, and adaptability all at the same time. This approach could be used to predict the occurrence of future health concerns. The main disadvantage of this technology is the complexity of the signal generation circuit, which results in a high cost and renders it unsuitable for field application.

BCT monitor, typically 1.5–30 cm from the human brow. The resulting data are compared to the CoreTemp CM-210 sensor, which differs by 0.7 °F from the average BCT value.

2.3 Comparison Between IOT Based COVID-19 Non-Contact Thermometer System

| Articles | Method | | |
|------------------------|-----------------|-----------------|----------------------|
| | Microcontroller | Sensor | Function |
| (Jia-Wei Lin, Ming- | NVIDIA Jetson | Thermal Camera | A Continuous Body |
| Hung Lu, Yuan-Hsiang | TX2 | | Temperature |
| Lin,2019) | | | Measurement System |
| | | | based on Thermal |
| | | | Cameras |
| (Nicholas Wei-Jie Goh, | Arduino Nano | Infrared sensor | Infrared Thermometer |
| Jun-Jie Poh, Joshua Yi | | (MLX90614) | with Range |
| Yeo, Benjamin Jun-Jie | | | |

Table 2.3.1 Comparison Between Method

| Aw, Szu Cheng Lai, | | | Compensation at a |
|---|---|--|--|
| Jayce Jian Wei Cheng, | | | Low Cost |
| Christina Yuan Ling | | | |
| Tan and Samuel Ken- | | | |
| En Gan,2021) | | | |
| (Wei-Ling Lin , Chun- | NodeMCU | Infrared thermal | IoT technology is |
| Hung Hsieh, Tung- | | imaging temperature | being used to develop a |
| Shou Chen, Jeanne | | | pandemic-prevention |
| Chen, | | | body temperature |
| Jian-Le Lee and Wei- | | | monitoring system. |
| Chung Chen,2021) | | | |
| (Gonçalo Marques and | FireBeetle ESP8266 | Infrared sensor | Infrared Temperature |
| Rui Pitarma,2019) | | (MLX90614) | Measurement System |
| | | | That Doesn't Need To |
| | | | Be Touched |
| (Tomy Abuzairi a, Nur | Arduino Nano | GY-906 module | Fever-screening |
| Imaniati Sumantri b, | 100 | (MLX90614) | infrared thermometer |
| Ahli Irfan a, Ridho | R. | | |
| Maulana 📙 | | | |
| Mohamad,2020) | | | |
| | | | |
| (Nur Hudha Wijaya, | ATMEGA2560 | Infrared sensor | Tympani Thermometer |
| (Nur Hudha Wijaya, Zanella Oktavihandani, | ATMEGA2560 Arduino Uno | Infrared sensor (MLX90614) | Tympani Thermometer Design Using Passive |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed | ATMEGA2560 Arduino Uno | Infrared sensor (MLX90614) | Tympani Thermometer Design Using Passive Infrared Sensor |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong | ATMEGA2560 Arduino Uno | Infrared sensor (MLX90614) | Tympani Thermometer Design Using Passive Infrared Sensor |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) | ATMEGA2560 Arduino Uno | Infrared sensor (MLX90614) | Tympani Thermometer Design Using Passive Infrared Sensor |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) سبيني نيو MALAYSIA M OV7670 optical | Tympani Thermometer Design Using Passive Infrared Sensor |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) مسيني نيوك MALAYSIA M OV7670 optical camera | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 M5stickC | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) مسيني نيكي MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio Pietrosanto,2021) | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition using a MEMS |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio Pietrosanto,2021) | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 M5stickC | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition using a MEMS accelerometer |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio Pietrosanto,2021) (Daniel Santoso, F. | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 M5stickC | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition using a MEMS accelerometer Non-Contact Portable |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio Pietrosanto,2021) (Daniel Santoso, F. Dalu Setiaji,2015) | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 M5stickC | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 Infrared sensor (MLX90614) | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition using a MEMS accelerometer Non-Contact Portable Infrared Thermometer |
| (Nur Hudha Wijaya, Zanella Oktavihandani, Kunal Kunal, Elsayed T. Helmy, Phong Thanh Nguyen,2020) (Eddy Yusufa,b*, Halim Syamsudinc, M. N. Mohammedd, S. Al- Zubaidie, Sairah A.K.f,2020) (Minh Long Hoang, Marco Carratù, Vincenzo Paciello and Antonio Pietrosanto,2021) (Daniel Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar | ATMEGA2560 Arduino Uno RSITI TEKNIKA Arduino Uno Rev3 M5stickC ATmega8A Arduino UNO | Infrared sensor (MLX90614) MALAYSIA M OV7670 optical camera The MCP9808 Infrared sensor (MLX90614) Infrared sensor | Tympani Thermometer Design Using Passive Infrared Sensor ELAKA IoT Technology Thermal Imaging System for Detection of Covid-19 Symptoms Based on the IoT-Alert System, an indoor condition monitor and activity recognition using a MEMS accelerometer Non-Contact Portable Infrared Thermometer Low-cost electrical |

| Chisab , Azhar M. Al- | | | create a non-contact |
|-----------------------|---------------------|-----------------|----------------------|
| Rawi, Adnan Hussein | | | thermometer. |
| Ali , | | | |
| Alex Van den | | | |
| Bossche,2021) | | | |
| (Partha Pratim | AT Mega 328 Arduino | Infrared sensor | A Smart System Using |
| Ray,2017) | Uno | (MLX90614) | Infrared Sensors to |
| | | | Estimate Core Body |
| | | | Temperature |
| (Jing Zhang, 2017) | SCM. STC89C52RC | Infrared sensor | Non-contact Infrared |
| | | (MLX90614) | Thermometer |

Table 2.3.2 Comparison Between Sensor Temperature

| Sensor | Advantages Disadvantages | | Articles | |
|---------------------------------|--------------------------|------------------------|--|--|
| Thermal Camera | There is no need for | The processing time is | (Jia-Wei Lin, Ming- | |
| 1 Alexandre | any skin tissue contact | too long | Hung Lu, Yuan-Hsiang | |
| Ĕ | throughout the | | Lin,2019) | |
| 2 | operation. | | | |
| Infrared sensor | Have high | During screening, wet | (Nicholas Wei-Jie Goh, | |
| (MLX90614) | reproducibility for | weather can cause | Jun-Jie Poh, Joshua Yi | |
| shla | measuring temperature | false negatives for | Yeo, Benjamin Jun-Jie | |
| 2700 | بالمست | fever. | Aw, Szu Cheng Lai, | |
| UNIVE | RSITI TEKNIKA | L MALAYSIA M | Jayce Jian Wei Cheng, Christina Yuan Ling | |
| | | | Tan and Samuel Ken- | |
| | | | En Gan,2021) | |
| Infrared thermal Non-Contact | | High cost | (Wei-Ling Lin, Chun- | |
| imaging temperature thermometer | | | Hung Hsieh, Tung- | |
| | | | Shou Chen, Jeanne | |
| | | | Chen, | |
| | | | Jian-Le Lee and Wei- | |
| | | | Chung Chen,2021) | |
| Infrared sensor | Low noise amplifier | Has some limitations | (Gonçalo Marques and | |
| (MLX90614) | | | Rui Pitarma,2019) | |
| GY-906 module | Has I2C | Must install libraries | (Tomy Abuzairi a, Nur | |
| (MLX90614) | communication | | Imaniati Sumantri b, | |
| | | | Ahli Irfan a, Ridho | |

| | | | Maulana |
|--|--|-------------------------------|--|
| | | | Mohamad,2020) |
| Infrared sensor | It can detect the | Temperature reading | (Nur Hudha Wijaya, |
| (MLX90614) | temperature of an | on the forehead is | Zanella Oktavihandani, |
| | object (ear canal) | affected by the room | Kunal Kunal, Elsayed |
| | | temperature | T. Helmy, Phong Thanh |
| | | | Nguyen,2020) |
| OV7670 optical | Clear picture | The thermal image | (Eddy Yusufa,b*, |
| camera | | will cover an area of | Halim Syamsudinc, M. |
| | | 480x480 pixels. | N. Mohammedd, S. Al- |
| | | | Zubaidie, Sairah |
| | | | A.K.f,2020) |
| The MCP9808 | Low-cost and stable | Requires physical | (Minh Long Hoang, |
| | measurement | contact | Marco Carratù, |
| | with less noise | | Vincenzo Paciello and |
| MA | LAYSIA | | Antonio |
| 1 Street | - 12 - | | Pietrosanto,2021) |
| Infrared sensor | Provide valid readings | Need certain technique | (Danial Santosa, F |
| 2 | The vide valia readings | 1 | (Damer Santoso, F. |
| (MLX90614) | within seconds | | Dalu Setiaji,2015) |
| (MLX90614) Infrared sensor | within seconds Small size | The range read | (Mohannad Jabbar |
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| (MLX90614) Infrared sensor (MLX90614) | within seconds Small size | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- |
| (MLX90614) Infrared sensor (MLX90614) | within seconds Small size | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein |
| (MLX90614) Infrared sensor (MLX90614) | within seconds Small size | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , |
| (MLX90614) Infrared sensor (MLX90614) | within seconds Small size | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den |
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| (MLX90614) Infrared sensor (MLX90614) JJJC UNIVE Infrared sensor | within seconds Small size بیکل ملیسیا RSITI TEKNIKA Highly | The range read temperature | Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den Bossche,2021) (Partha Pratim |
| (MLX90614) Infrared sensor (MLX90614) UNIVE Infrared sensor (MLX90614) | within seconds Small size RSITI TEKNIKA Highly accurate for industrial | The range read temperature | Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den Bossche,2021) (Partha Pratim Ray,2017) |
| (MLX90614) Infrared sensor (MLX90614) UNIVE Infrared sensor (MLX90614) | within seconds Small size محکل ملیسیا RSITI TEKNIKA Highly accurate for industrial use. | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den Bossche,2021) (Partha Pratim Ray,2017) |
| (MLX90614) Infrared sensor (MLX90614) UNIVE Infrared sensor (MLX90614) Infrared sensor | within seconds Small size RSITI TEKNIKA Highly accurate for industrial use. Not damaging the | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den Bossche,2021) (Partha Pratim Ray,2017) (Jing Zhang, 2017) |
| (MLX90614) Infrared sensor (MLX90614) UNIVE Infrared sensor (MLX90614) Infrared sensor (MLX90614) | within seconds Small size RSITI TEKNIKA Highly accurate for industrial use. Not damaging the human body | The range read temperature | (Dahler Santoso, F. Dalu Setiaji,2015) (Mohannad Jabbar Mnati a, Raad Farhood Chisab , Azhar M. Al- Rawi , Adnan Hussein Ali , Alex Van den Bossche,2021) (Partha Pratim Ray,2017) (Jing Zhang, 2017) |

2.4 Microcontroller for IoT Non-Contact Thermometer

The main component for completing this project is a microcontroller. This is because the microcontroller functions as a brain, determining the user's decisions. As a result, many factors must be considered when making a decision. The NodeMCU ESP8266 is a popular board that meets the criteria required for this project.

2.4.1 NodeMCU

The NodeMCU is an open-source software and hardware development environment built around the low-cost ESP8266 SoC. It incorporates all of the modern computer's components, such as the CPU, RAM, wifi, and a current operating system and SDK. The NodeMCU is a fantastic alternative for IoT applications due to its low cost and capabilities. The board includes a USB port connected to the chip, a hardware reset button, a wifi antenna, an LED, and standard-size GPIO pins that can be connected to a breadboard. Figure 2.4.1 depicts the NodeMCU board.



Figure 2.4.1 Picture of NodeMCU board

2.5 Temperature Sensor for IoT Non-Contact Thermometer

According to our study, the MLX90614 sensor is the best fit for this project. This is due to the inexpensive cost of the sensor as well as the accuracy of the temperature reading.

2.5.1 MLX90614

The MLX90614 is an infrared thermometer that monitors temperature without the use of a probe. Both the signal conditioning ASIC and the IR-sensitive thermopile detector chip are housed in the same TO-39 package. In addition, the MLX90614 includes a low noise amplifier, a 17-bit ADC, and a powerful DSP unit to ensure the thermometer's high accuracy and resolution. Figure 2.5.1 depicts the MLX90614.



The applications and technologies widely employed in developing IoT non-contact UNIVERSITITEKNIKAL MALAYSIA MELAKA thermometers are discussed and analyzed in this chapter. Based on the available literature, it can be concluded that each of the methods and technologies used contributes to the system's benefits and limits by completing the IoT non-contact thermometer.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The applications and technologies widely employed in developing IoT non-contact thermometers are discussed and analyzed in this chapter. Based on the available literature, it can be concluded that each of the methods and technologies used contributes to the system's benefits and limits by completing the IoT non-contact thermometer.

3.2 Overview of Project Methodology

The project methodology is depicted in Figure 3.2.1. Preliminary investigation, information analysis and identification, decision making, software and hardware development and analysis, and testing of developed projects are the five stages of the project methodology. The goal of developing this project methodology is to ensure that the project runs smoothly.



Figure 3.2.1 Flow chart illustrating the general project methodology

The purpose of the preliminary investigation is to learn more about project title selection. For the understanding of the project, research will be conducted on the selected project title. The problem statement and project objective can be derived from the findings of the preliminary investigation. The stage design should be closely followed because if any stages are skipped, the project will fail. We look through existing papers in stage 2, Information analysis and identification, to see what method or technique was used in this paper. The process and technique will be listed so that they can be compared. This information will be recorded in the section on Literature Review. The selection of hardware and software in stage 3 decisionmaking should be based on the research conducted in stage 2. After better understanding, comparing the method and technique used in the previous paper, the research in stage 2 makes the selection in stage 3 easier. Following the selection of hardware and software, project development planning must be completed to progress successfully. The development of the system can begin during stage 4, which includes software and hardware development. The outcome of stage 4 should be in line with the paper's goal. Stage 5 will consist of analyzing and testing the developed project, as well as validating the results. This can be accomplished in various ways, including analyzing raw data from the project or comparing the results to those of a previous paper.

3.3 Hardware Implementation

In this paper, eight pieces of hardware are used for hardware implementation. The NodeMCU ESP8266, LCD, infrared thermometer, I2C LCD, ultrasonic sensor, battery holder, switch, and buzzer were used as the hardware. The hardware in this project will be described in terms of its specifications and functions..

3.3.1 NodeMCU ESP8266

On the NodeMCU ESP8266 development board, the ESP-12E module contains an ESP8266 chip with a Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at a customizable clock frequency of 80MHz to 160MHz. In addition, the NodeMCU has 128 KB of RAM and 4MB of Flash memory for storing data and programs. This project will consist of a microcontroller that displays an LCD, reads temperature from a sensor, detects object distance using a sensor, and sends data to a database over wifi.



Figure 3.3.1 Picture of NodeMCU ESP8266

Table 3.3.1 NodeMCU Pin Configuration

| Pin Category | Name | Description |
|--------------|------------------------------|---|
| Power | Micro-USB, 3.3V, GND, Vin | Micro-USB: The NodeMCU can be powered via a USB connector. 3.3V: To power the board, a regulated 3.3V can be applied to this pin. GND: Grounding pins External Power Supply (Vin) |
| Control Pins | EN, RST | The microcontroller is reset via the pin and the button. |

| Analog Pin | A0 | Used to monitor analogue voltages in the 0-3.3V range. |
|------------|---------------------------|--|
| GPIO Pins | GPIO1 to GPIO16 | NodeMCU's board contains 16 general-purpose I/O pins. |
| SPI Pins | SD1, CMD, SD0, CLK | SPI communication is supported by four pins on the NodeMCU. |
| UART Pins | TXD0, RXD0, TXD2, RXD2 | UART0 (RXD0 & TXD0) and UART1 are the two UART interfaces on the NodeMCU (RXD1 & TXD1). The firmware/program is uploaded using UART1. |
| I2C Pins | HALAYSIA MC | I2C capability is supported on NodeMCU but you must identify which I2C pin it uses internally. |
| ALL TEKNIN | NAN ANA | UTeM |
| اک | کل ملیسیا ملا | اونيومرسيتي تيڪنيڪ |
| UN | IIVERSITI TEKN | IIKAL MALAYSIA MELAKA |

3.3.2 LCD (16X2)

A 16x2 LCD can display 16 characters per line on each of its two lines. Each character is represented by a 5x7 pixel matrix on this LCD. The 224 distinct characters and symbols can be displayed on the 16 x 2 intelligent alphanumeric dot matrix display.



Figure 3.3.2 Picture of LCD

| | 1 15010 3.3.2 | | |
|---------|---------------|------------|-----------|
| ALAYSI. | | | |
| WWWWWWW | | | |
| Ta | ble 3.3.2 LC | D Pin Conf | iguration |

| | S | |
|---------|-----------------|---|
| Pin No: | Pin Name: | Description |
| 1 | Vss (Ground) | The ground pin is connected to the system ground. |
| 2 | Vdd (+5 Volt) | The LCD is powered by $+5V (4.7V - 5.3V)$. |
| 3 | VE (Contrast V) | E Determines the display's contrast level. Grounded in order to achieve maximum contrast. |
| 4 | Register Select | Connected to a microcontroller for switching between command and data registers. |
| 5 | Read/Write | It is used to read and write data. When writing data to an LCD, it is normally grounded. |
| 6 | Enable | Connected to a microcontroller pin and toggled between 1 and 0 to acknowledge data. |
| 7 | Data Pin 0 | |

| 8 | Data Pin 1 | The data pins 0 through 7 comprise an 8-bit data line. |
|----|---------------------|---|
| 9 | Data Pin 2 | They may be linked to a microcontroller and used to convey 8-bit data. |
| 10 | Data Pin 3 | These LCDs can also work in 4-bit mode, in which case Data pins 4,5,6, and 7 are left unconnected. |
| 11 | Data Pin 4 | |
| 12 | Data Pin 5 | |
| 13 | Data Pin 6 | |
| 14 | Data Pin 7 | |
| 15 | LED Positive | Backlight LED pin positive terminal |
| 16 | LED Negative | Backlight LED pin negative terminal |
| | \$ 3AINO | |
| | مليسيا ملاك | اونيومرسيتي تيكنيكل |
| | UNIVERSITI T | EKNIKAL MALAYSIA MELAKA |

3.3.3 MLX90614(Infrared Thermometer)

The MLX90614 is a non-contact infrared temperature sensor. It has a precision of about 0.5 degrees Celsius and can monitor temperatures ranging from -70 to 380 degrees Celsius at room temperature. One of the sensor's advantages is its small size and low cost.



3.3.4 HC-SR04(Ultrasonic Sensor)

Ultrasonic sensors measure distance using ultrasonic waves. The sensor head emits an ultrasonic pulse, which the target reflects. Ultrasonic sensors use the time between emission and reception to calculate the distance to the target.

| HC-SR04 USE B 1. Vcc 2. Trigger 2. Trigger 3. Eho Figure 3.3.4 HC-SR04(Ultrasonic Sensor) pin diagram Table 3.3.4 Ultrasonic Sensor Pin Configuration | | |
|--|-----------------|---|
| Pin Number | Pin Name | Description |
| 1 UN | Vcc IVERSITI | The sensor is powered via the Vcc pin, which is TEKNIKAL generally powered by +5V. |
| 2 | Trigger | Input pin. This pin has to be kept high for 10us to initialize measurement by sending US wave. |
| 3 | Echo | Output pin. This pin goes high for a period of time which will be equal to the time taken for the US wave to return back to the sensor. |
| 4 | Ground | This pin is connected to the Ground of the system. |

3.3.5 I2C LCD

Γ



The I2C LCD is a simple-to-use display module that can make displaying easier.

| Pin Number | Pin Name | Description |
|------------|----------|---|
| 1 | GND | Ground pin and should be connected to the ground |
| 2 | VCC | Supplies power to the module and the LCD Use the microcontroller's 5V output or another power supply. |
| 3 | SDA | Pin for Serial Data. Both inputs and outputs require this cable. |
| 4 | SCL | Pin for serial clock. The Bus Master device provides this timing signal. |

3.3.6 Battery Holder

A battery holder, also known as a battery mount, is a chamber that may hold cells either integrated or separately.





3.3.7 Switch

A device used to open and close electrical circuits under typical load conditions that

are frequently operated manually by the user.



Figure 3.3.7 Switch 12V

3.3.8 Buzzer

A buzzer, often known as a beeper, is an auditory signaling device that can be mechanical, electromechanical, or piezoelectric in construction (piezo for short). Alarm clocks, timers, and confirmation of human input like a mouse click or keyboard are all typical applications for buzzers and beepers.



Table 3.3.6 Buzzer Pin Configuration

| Pin Number | Pin Name | Description |
|------------|----------|---|
| 1 | Positive | The (+) sign or a longer terminal lead distinguishes it. 6V DC can be used to power it. |
| 2 | Negative | Short terminal lead identifies it. Typically connected to the circuit's ground |

3.4 Software Implementation

The Arduino IDE, Google Sheets, and Google App Script are used for the software implementation in this work. The software's specification and use in this project will be explained further down.

3.4.1 Arduino IDE

The code was created in the C or C++ programming language in the open-source Arduino Software (IDE). The Arduino UNO board was programmed with a set of code that included all of the components, each with its function. The Arduino IDE operates on the Java Platform and has built-in functions and instructions for operating systems such as Linux, Windows, and Mac. In the existing context, the platform is essential for editing, debugging, and compiling code.

The sketch, also known as main code, written on the IDE platform will generate a Hex File, which will then be copied and uploaded into the controller on the Arduino UNO board, which will be used in this project. The Editor and Compiler are the two main components of the Arduino IDE environment. The Editor is used to write the required code, and the Compiler is then used to compile the code and upload it to the appropriate Arduino Module. It can also be used with the NodeMCU ESP8266.



Figure 3.4.1 Arduino IDE Interface

3.4.2 Google Sheets

Google Sheets is a web application that can be accessed using Google Chrome, Microsoft Edge, Mozilla Firefox, Internet Explorer, and Apple Safari. Users can view all spreadsheets and other files in one location by using the Google Drive service. Sheets' mobile website was updated in 2015 with a 'simpler, more consistent'' style. While users can peruse spreadsheets on mobile websites, those who want to update them will be sent to the mobile app, removing the ability to edit on the mobile web. It can also be used as a database to save sensor readings.

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| 5 | | | Drop-down item B | | | | |
| 6 | | | Drop-down item C | | | | |
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| 10 | | | | | | | |

Figure 3.4.2 Google Sheet Interface

3.4.3 Google Apps Script

A rapid application development framework for generating commercial applications that integrate with Google Workspace, Google Apps Script is available for download. Write code with current JavaScript and take advantage of built-in libraries for popular Google Workspace products such as Gmail, Calendar, Drive, and so on. The scripts are hosted on Google's servers, so there is no need to install any software.

A project manifest for Apps Script is a JSON file that specifies the essential project information that Apps Script needs to run the script properly. The Manifest structure describes the content of this file and the various JSON fields it can contain. This approach, for example, can be used to send data from the NodeMCU ESP8266 to Google Sheets.

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| ≣⊾ | Services | + | 11 12 | <pre>1 const API_KEY = ''; // < enter your google cloud project API key he 2 const TABLE_NAME = ''; // < enter your google tables table ID here</pre> | | |
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Figure 3.4.3 Google Apps Script Interface



Figure 3.5.1 Circuit diagram

The diagram above depicted how the circuit is constructed. The I2C LCD is linked to D1 (SCL) and D2 (SDA). SCL denotes the clock line. It is used to ensure that all data

transmissions on the I2C bus are in sync. SDA represents the data line. All devices share the SCL and SDA lines on the I2C bus. The infrared thermometer (MLX90614) will use the same I2C connection. This is since nodeMCU can read and write data on the same port for this connection. D5 (trigger) and D6 are connected to the ultrasonic sensor (echo). Ultrasonic sensors (also known as ultrasonic transducers) measure distance by delivering a sound pulse above the range of human hearing (ultrasonic) toward the target and measuring how long it takes for the sound echo to return. The amount of time it takes for a sound echo to return can be utilized to determine whether or not a target object exists. The buzzer is linked to D4 (positive). Because this project employs an active buzzer, the NodeMCU controls the time delay. Figure 3.5.2 depicts the system's block diagram more clearly to understand each component's link.



Figure 3.5.2 Block diagram of IOT based COVID-19 non-contact thermometer

3.6 Operation flow



system. Firstly, the nodeMCU board is started. It is sometimes required for this board to connect to the internet using wifi. After completing this process, the nodeMCU will send a command to the LCD to display the result. At the same time, turn on the ultrasonic and begin taking readings. NodeMCU will compare the products based on that reading. If the result is less than five, the infrared thermometer starts to read the temperature. NodeMCU will take the task, compare the outcome between more than 35 and less than 37. Then the result will send to the database and display the result at LCD. This process does not end here if the output gets an average temperature. It gives one beep sound. Otherwise, it provides an alarm sound. After this, it will repeat from nodeMCU read distance then compare and continuously repeat until the power turns off.

3.7 Summary

In this chapter, the IoT-based COVID-19 non-contact thermometer will be built by using NodeMCU ESP8266 based on various methods and processes that already discuss. NodeMCU is the central operating system running this project. The block diagram and flowchart of the project are designed. Both hardware and software development are related to each other, where C++ programming languages run the hardware. The result for this project will be a non-contact thermometer that can display and record. Users can read record data from Google Sheet.



CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This project is related to the IoT-based covid 19 noncontact thermometer, where it displays and records data using NodeMCU. A test set is performed to evaluate the performance of the IoT covid 19 noncontact thermometer and the accuracy of the infrared thermometer and data recorded. The performance of the IoT-based covid 19 noncontact thermometers is analyzed, and evaluated temperatures are successfully displayed



Figure 4.2.1 Test Circuit on Breadboard



Figure 4.2.2 LCD display



Figure 4.2.3 Front View and Side View



Figure 4.2.4 Back View and Inside View

The final product developed as a result of this project is discussed in this section of the report. The hardware connected to the NodeMCU is displayed on the breadboard, as shown in Figure 4.2.1. It includes, among other things, an LCD, an infrared thermometer sensor, an ultrasonic sensor, a buzzer, a battery holder, and a switch. For the sake of convenience, the I2C port on the LCD has been connected. It offers two different power source options: a battery and a USB port. Battery linked to Vin pin and USB power supply connected to a micro USB port, both of which are on board, provide sufficient power for this application. The display, as shown in Figure 4.2.2, will indicate the target temperature and the NodeMCU's WiFi connection. The buzzer will sound once if the temperature is between 34 and 37 degrees. If the temperature is between 34 and 37 degrees, the buzzer will sound once. Otherwise, the buzzer will beep six times. The final output is depicted in Figures 4.2.3 and 4.2.4.

4.3 The Configuration of IoT Non-Contact Thermometer

To configure NodeMCU, the Arduini IDE is used. Because the Google Sheet is being used in this project, the NodeMCU's wifi connection has been configured to allow the NodeMCU to connect with the Google Sheet. It can be seen in Figure 4.3.1 that the Wifi has been successfully connected and paired. Once the Wifi has been configured, it will automatically connect to the NodeMCU once the device is turned on.

To save the data, NodeMCU will use Google Sheet to store the data from NodeMCU. Then, the data will be transferred to a Google app script, which will then insert the information into a Google Sheet. As shown in Figure 4.3.2, the coding for reading data sent from NodeMCU and saving it to a Google Sheet is used.



Figure 4.3.2 Coding save data

4.4 Testing of IoT Non-Contact Thermometer

A series of test cases is carried out to ensure that the features required to achieve the functional requirements are available and functional. The test case included all functions, such as distance and temperature and information storage. For example, figure 4.4.1 depicts an LCD, which displays only the desired temperature and WiFi connection status.

The system was tested to ensure that the data was recorded continuously; the results are displayed in Figure 4.4.2. Following the data transmission to the database, an ultrasonic sensor will be used to determine the distance between the object and the sensor. First, the infrared thermometer will read the temperature if the distance between them is less than 5 cm. After that, the reading will be compared to see if it is a typical reading. If everything is normal, the buzzer will beep once. If not, the buzzer will beep six times. The information will then be sent to a Google Sheet. This process ran indefinitely until the power was turned off.



Figure 4.4.1 WiFi status

| Temp_Log ☆ ☜ ⊘ File Edit View Insert Format Data 1 | | | | | | |
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| 1 | • JX | DATE | | | | |
| | A | В | С | | | |
| 1 | DATE | TIME | TEMPERATURE | | | |
| 2 | 15/06/2021 | 20:04:00 | 33.87 | | | |
| 3 | 15/06/2021 | 20:04:56 | 33.05 | | | |
| 4 | 15/06/2021 | 20:08:35 | 38.37 | | | |
| 5 | 15/06/2021 | 20:08:56 | 32.67 | | | |
| 6 | 15/06/2021 | 20:09:10 | 34.31 | | | |
| 7 | 15/06/2021 | 20:10:58 | 35.35 | | | |
| 8 | 15/06/2021 | 20:11:27 | 33.61 | | | |
| 9 | 15/06/2021 | 20:13:59 | 35.53 | | | |
| 10 | 15/06/2021 | 20:15:04 | 37.71 | | | |
| 11 | 15/06/2021 | 20:15:21 | 34.17 | | | |
| 12 | 15/06/2021 | 20:15:31 | 34.91 | | | |
| 13 A | Y SI, 15/06/2021 | 20:16:57 | 36.23 | | | |
| 14 | 15/06/2021 | 20:17:42 | 34.93 | | | |
| 15 | 15/06/2021 | 20:17:52 | 35.01 | | | |
| 16 | 15/06/2021 | 20:18:10 | 35.09 | | | |

Figure 4.4.2 Recorded data in Google Sheet

4.5 Result Analysis

The system's performance is reviewed to determine if the system has performed satisfactorily or has failed. Analysis and generation of a graph are performed on the accuracy of temperature, distance, and saved data of the Covid-19 Non-Contact Thermometer system that uses the Internet of Things. Speed of wifi has an impact on the time delay of this sensor, which measures temperature as well as distance and saves data.
4.5.1 The Performance of the Developed System

Table 4.5.1 shows the result of the system testing where it involved three section in the testing process such as test case, expected outcome and actual outcome.

| Test Case | Expected outcome | Actual outcome | |
|-------------|--|----------------|--|
| Distance | The presence of an object is detected by sensors. After that, the temperature sensor will work. | Success | |
| Temperature | Temperature Temperature readings on the LCD display | | |
| Wifi | The WiFi connection and data that is displayed will be recorded in a Google Sheet. | Success | |

Table 4.5.1 Result of System Testing

According to the information in Table 4.5.1, the system is capable of displaying all of the features on the LCD display. As a result, not only does this system display the reading, but it also saves the reading.

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4.5.2 The Accuracy of Temperature Reading

To determine the accuracy of the temperature reading, several tests are carried out on the device. In the first scenario, the distance between the non-contact thermometer and the object determines the precision of the temperature reading. Following that, by making use of the surrounding environment. After that, it's time to enter data into a Google Sheet. The assessment procedure begins the moment the temperature sensor detects a temperature change.

4.5.2.1 The Effect of Distance

There are a total of ten distances that are investigated. The accuracy of a temperature reading is determined by comparing it to an inaccurate reading. Every distance was measured ten times in order to obtain an average result.



Table 4.5.2 Reading Effected by Distance

Figure 4.5.1 The Accuracy of Distance Graph

Fig. 4.5.1 shows the outcome of the test that was carried out. Table 4.5.2 serves as the basis for the creation of Figure 4.5.1. When the temperature sensor is less than 4cm away, the accuracy of the sensor is improved. This is due to the fact that, according to the data sheet, the

distance between the object and the sensor is 2cm-5cm (approx.). After the test, only readings less than 4cm are considered acceptable. It is due to the tolerance set by the manufacturer.

4.5.2.2 Response Time to Wireless Network Speed

Table 4.5.3 displays the data collected for the experimental setup to assess the reaction time for the network speed to preserve data, as well as the results obtained. Figure 4.5.2 represents the graph that was created based on the information gathered from Table 4.5.3. It is necessary to monitor response time after the readings from the sensor have been saved in a Google sheet.



Table 4.5.3 Average Response Time of Wireless Network Speed

Figure 4.5.2 Time Response for Saving Data Graph

When an internet connection is available, the system can preserve data based on the information gathered. When the internet is slow, it takes 9 seconds, and when it is fast, it takes

5 seconds. After the data was saved in a Google sheet, the system was ready to repeat the process for scanning the temperature and saving the results. The graph also demonstrates that when there is no internet connection, data cannot be saved. At the same time, internet access is required on the device for the system to be activated. If this is not the case, the device will not switch on. Otherwise, connect to the internet until the system is turned on, then turn off the wifi if you still want to use the scan temperature function.

4.5.3 The Accuracy of Measure Distance

The accuracy of measuring distance is verified using a total of ten distances measured by hand and under two different environmental conditions. Table 4.5.4 contains the results of the accuracy-test that were gathered.

| 1 | | | | |
|------|--------------|-----------------------|-----------|-----------|
| 2 | Actual | Measured Distance(cm) | | |
| | Distance(cm) | Silent | Noisy | |
| de | 1 | / 1./ | . 1 | |
| 2) | to higulo, | 2 | 20, 22, 0 | اوىبو |
| | 3 * | 3 | 3 | |
| LINI | VERSTITE | CNIKA MAI | AVSIA MEL | ΔΚΔ |
| | 5 | 5 | 5 | - 11 12-1 |
| | 6 | 6 | 6 | |
| | 7 | 7 | 7 | |
| | 8 | 8 | 8 | |
| | 9 | 9 | 9 | |
| | 10 | 10 | 10 | |

Table 4.5.4 Average Measured Distance with Diffrent Environment





According to the graph, the ultrasonic sensor is capable of performing optimally in every situation. The accuracy is 100 percent since the waveform itself was not interrupted by any other voice. This is because the waveform formed by ultrasonic technology has a higher frequency that is above the range of human hearing ability.

4.6 Summary

The analysis of data obtained from the IoT Based Covid-19 Non-Contact Thermometer is presented in this chapter. To compute the performance as well as the accuracy of non-contact thermometers, ultrasonic and stored data sets, the Non-Contact Thermometer is designed in the following ways: To ensure that all of the features are available to meet functional requirements, a series of test cases is carried out. The results of the test cases described in this chapter indicated that the system was capable of reading temperatures, measuring distances, and storing information. The temperature of the human body is measured with a non-contact thermometer. When tested at 10 distances, the non-contact thermometer's accuracy is determined, and the response time of previously stored data is determined. As a result of the accuracy of the non-contact thermometer being affected by distance, the maximum distance at which the temperature can be read is 4 cm. This is due to the manufacturer's tolerances being too tight. The reaction time gathered for stored data demonstrates that a slow internet connection is the source of the time taken delay. The average amount of time required is 7 seconds. When the system is first turned on, the device must be connected to the internet via WiFi. Following that, the measure distance system has a 100 percent accuracy rating based on the data obtained and the actual distance. This is because the waveform formed by the ultrasonic can be as long as 10cm in length. Google Sheets was used to generating the database that was used for this project. It records the data from the sensor, as well as the date and time of the event. All of the sensors, including the NodeMCU, operated as intended, allowing this project to be considered a complete success.



CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The project is being undertaken to create an IoT-based Covid-19 Non-Contact Thermometer using the NodeMCU ESP8266 to give an immersive feature for data recording, hence minimizing the amount of time spent recording data. The central processing unit is the NodeMCU, which is supplemented by an ultrasonic sensor and a non-contact thermometer. This concept has the potential to be installed at every doorway because of the Covid-19 protocol. A temperature screening approach may be used to identify those who have a high temperature, which is one of the symptoms of Covid-19.

5.2 Conclusion

The system design process is separated into two key phases, each of which requires the development of both hardware and software—the combination of hardware and software development resulting in a fully functional Internet of Things Non-Contact Thermometer. The hardware side of the project is composed of five key components: a NodeMCU, an ultrasonic sensor, an infrared thermometer, a buzzer, and an LCD. Additionally, the software portion makes use of the Arduino IDE, Google App Script, and Google Sheet.

The non-contact thermometer developed in this research is capable of displaying the wifi connection and temperature readings effectively. The system's performance is evaluated using a variety of test cases. All of these objectives have been met since the system's successful development. A variety of tests are conducted to determine the overall performance and reliability of the system. Different methods are used to evaluate the accuracy of non-contact

temperature readings and ultrasonic measurements. The non-contact thermometer was evaluated by reading temperatures at various distances. The maximum distance required to obtain an accurate temperature reading is less than 5cm. The response time for data entry in Google Sheets is determined by the internet's speed. The average time required is seven seconds. Additionally, the effect of the ultrasonic sensor's accuracy in measuring distance. The system can readily detect objects within the specified range.

5.3 Future Works

According to the project's development process, one of the project's limits is that the system would not run without a WiFi connection. As a result, the project will make use of a NodeMCU and an Arduino nano. The Arduino nano is used to measure temperature, while the NodeMCU is utilised to upload data to a Google sheet. The design of an LCD display is a task for the future. For example, the system may be made more user-friendly by making it easier for customers to switch their WiFi connection.

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APPENDICES

APPENDIX A Coding for NodeMCU

```
#include <LiquidCrystal_I2C.h>
#include <ESP8266WiFi.h>
#include <WiFiClientSecure.h>
#include <Adafruit MLX90614.h>
#include <Wire.h>
WiFiClientSecure client:
const char* fingerprint = "46 B2 C3 44 9C 59 09 8B 01 B6 F8 BD 4C FB 00 74 91 2F EF
F6";
String GAS_ID =
"AKfycbxXgdY5w3DDEDNop53j0S2sXUkdiVEumyMROeatINKQsaNRS380Yo9qMx2f
6MGNEwFQ"; // Replace by your GAS service id
Adafruit_MLX90614 mlx = Adafruit_MLX90614();
LiquidCrystal I2C lcd(0x27,16,2);
const int trigPin = 14; //D5
const int echoPin = 12; //D6
const int buzzer = 2; //D4
long duration;
int distance;
String readString;
const char* ssid = "realme 7 Pro";
const char* password = "hishamuddin";
const char* host = "script.google.com";
const int httpsPort = 443;
void setup() {
 WiFi.mode(WIFI_STA);SITI TEKNIKAL MALAYSIA MELAKA
 WiFi.begin(ssid, password);
 while (WiFi.status() != WL_CONNECTED) {
 delay(500);
 Serial.print(".");
 }
 pinMode(buzzer, OUTPUT);
 lcd.init();
 lcd.clear();
 lcd.backlight();
 pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
 pinMode(echoPin, INPUT); // Sets the echoPin as an Input
 Serial.begin(9600); // Starts the serial communication
}
void loop() {
 wifi();
 digitalWrite(trigPin, LOW);
 delayMicroseconds(2);
```

```
digitalWrite(trigPin, HIGH);
 delayMicroseconds(10);
 digitalWrite(trigPin, LOW);
 duration = pulseIn(echoPin, HIGH);
 distance= duration*0.034/2;
 Serial.print("Distance: ");
 Serial.println(distance);
 float T = mlx.readObjectTempC();
 delay (1000);
 if(distance<3){
 if(34<T&&T<37){
  lcd.setCursor(0,1);
  lcd.print("Target: ");
  lcd.print(T);
  lcd.print(" C");
  digitalWrite(buzzer, HIGH);
  delay(500);
  digitalWrite(buzzer, LOW);
  delay(500);
  sendData(T);
  lcd.clear();
 }
 else{
  lcd.setCursor(0,1);
  lcd.print("Target: ");
  lcd.print(T);
  lcd.print(" C");
  for(int a=0;a<6;a++){
  digitalWrite(buzzer, HIGH);
  delay(500);
  digitalWrite(buzzer, LOW);
                                  EKNIKAL MALAYSIA MELAKA
  delay(500);
  }
  sendData(T);
  lcd.clear();
 }
 }
}
void wifi(){
 if(WiFi.status()==3){
 lcd.setCursor(0,0);
 lcd.print("WiFi Connected");
 }
 else{
 lcd.setCursor(0,0);
 lcd.clear();
 lcd.print("WiFi Fail");
 }
}
void sendData(float x)
```

```
client.setInsecure();
Serial.print("connecting to ");
Serial.println(host);
if (!client.connect(host, httpsPort)) {
 Serial.println("connection failed");
 return:
}
String string_x = String(x, 2);
String url = "/macros/s/" + GAS_ID + "/exec?value1=" + string_x;
Serial.print("requesting URL: ");
Serial.println(url);
client.print(String("GET ") + url + " HTTP/1.1\r\n" +
    "Host: " + host + "r^n +
    "User-Agent: BuildFailureDetectorESP8266\r\n" +
    "Connection: close\r\n\r\n");
Serial.println("request sent");
while (client.connected()) {
String line = client.readStringUntil('\n');
if (line == "\r") {
 Serial.println("headers received");
 break;
}
}
```

```
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```

APPENDIX B Coding for Google Apps Script

```
function doGet(e) {
 Logger.log( JSON.stringify(e) ); // view parameters
 var result = 'Ok'; // assume success
 if (e.parameter == 'undefined') {
  result = 'No Parameters':
 }
 else {
  var sheet_id = '1-otwURAsXXAlLBKWpjm7VM22nlN4T72453p1HvY88ug';
                                                                                     //
Spreadsheet ID
  var sheet = SpreadsheetApp.openById(sheet_id).getActiveSheet();
                                                                             // get
Active sheet
  var newRow = sheet.getLastRow() + 1;
  var rowData = [];
  d=new Date();
  rowData[0] = d; // Timestamp in column A
  rowData[1] = d.toLocaleTimeString(); // Timestamp in column A
  for (var param in e.parameter) {
   Logger.log('In for loop, param=' + param);
   var value = stripQuotes(e.parameter[param]);
   Logger.log(param + ':' + e.parameter[param]);
   switch (param) {
    case 'value1': //Parameter 1, It has to be updated in Column in Sheets in the code,
orderwise
     rowData[2] = value; //Value in column C
      result = 'Written on column C';
     break;
    default:
     result = "unsupported parameter";
   }
  Logger.log(JSON.stringify(rowData));
  // Write new row below
  var newRange = sheet.getRange(newRow, 1, 1, rowData.length);
  newRange.setValues([rowData]);
 }
 // Return result of operation
 return ContentService.createTextOutput(result);
}
function stripQuotes( value ) {
 return value.replace(/^["']|['"]$/g, "");
```