Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF IOT BASED COVID-19 NON-CONTACT THERMOMETER

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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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.

Signature :

Supervisor Name : IR. TS. DR. MOHD FAUZI BIN AB RAHMAN

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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

Oleh kerana penyebaran COVID-19 ke seluruh dunia dan peningkatan keperluan untuk termometer tanpa sentuh untuk mencegah penyebaran penyakit, peranti termometer elektronik baru telah dirancang dan dilaksanakan untuk mengukur suhu tubuh manusia dari jauh. Peranti ini sedang digunakan di pintu masuk bangunan untuk mengukur suhu badan pekerja, pelajar, dan pelanggan. Oleh kerana kelemahan termometer merkuri tradisional, seperti masa pengukuran yang lebih lama dan keperluan bersentuhan dengan tubuh manusia, termometer yang menggunakan sensor inframerah untuk mengesan suhu tanpa sentuhan dirancang. Sensor suhu inframerah MLX90614 direka untuk mengumpulkan suhu manusia dan disalurkan ke NodeMCU untuk memproses suhu ke dalam paparan LCD, penggera apabila suhu berlebihan dan direkodkan dalam Google Sheet. Untuk mengatasi faktor-faktor tersebut, kami menerangkan pemasangan termometer IR digital NodeMCU dengan pembetulan jarak menggunakan termometer IR MLX90614 dan sensor ultrasonik HC-SR04.

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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	-	Central Processing Unit
RAM	-	Random-Acess Memory
SDK	-	Software Development Kit
USB	-	Universal Serial Bus
DSP	-	Digitl Singnal Process
SDA	-	Serial Data
SCL	-	Serial Clock
PWM	-	Pulse-Width Modulation
JSON	-	JavaScript Object Notation
WiFi	-	Wireless Fidelity
CBTM	-	Continuous Body Temperature Measurement

LIST OF APPENDICES

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 non-contact 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 Arduino-based 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.

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

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.

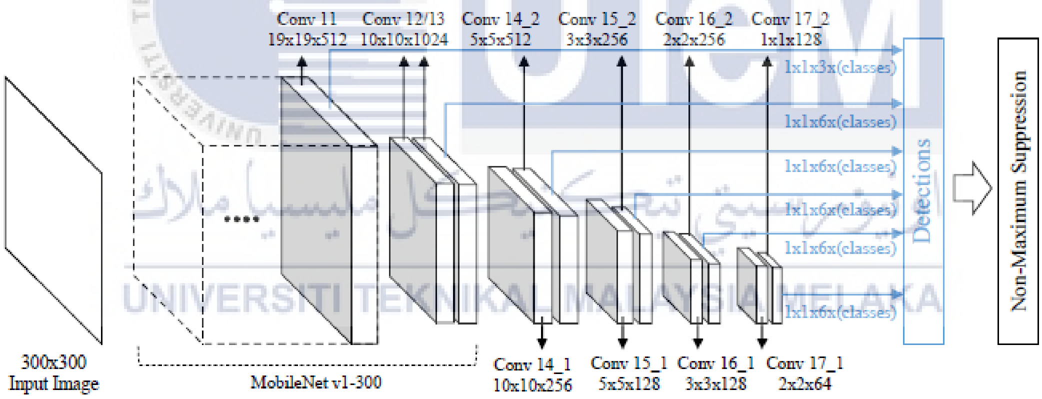

Figure 2.2.1 The overview of detection network architecture

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.