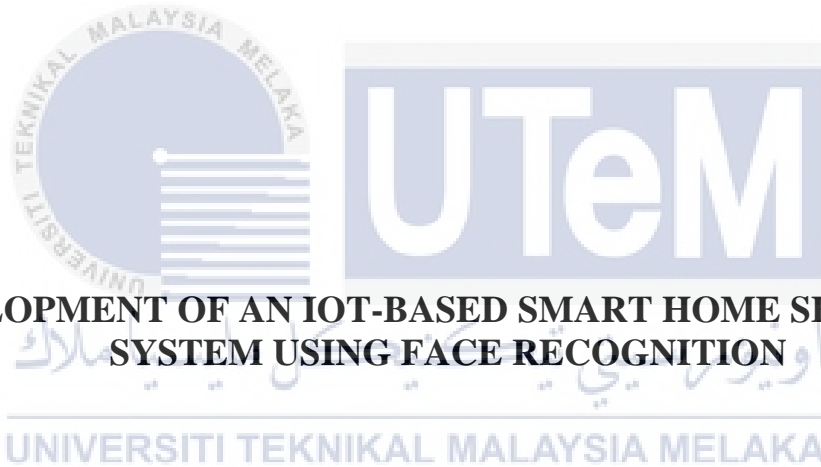




Faculty of Electrical and Electronic Engineering Technology



**DEVELOPMENT OF AN IOT-BASED SMART HOME SECURITY
SYSTEM USING FACE RECOGNITION**

MOHAMAD AIMAN HAKIM BIN MOHAMMAD HASSAN

**Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)
with Honours**

2022

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SYSTEM USING FACE RECOGNITION**

MOHAMAD AIMAN HAKIM BIN MOHAMMAD HASSAN

**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics)
with Honours**



Faculty of Electrical and Electronic Engineering Technology

اويورسي تي بيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

**Tajuk Projek: Development of An IoT-Based Smart Home Security System Using
Face Recognition**

Sesi Pengajian : 2022/2023

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(TANDATANGAN PENULIS)



Ts. MASLAN BIN ZAINON
Pensyarah Kanan (Senior Lecturer)
(COP DAN TANDATANGAN PENYELIA)
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik
Universiti Teknikal Malaysia Melaka

Alamat Tetap: Blok B-3-07, Quarters
Hospital Sultan Ismail, Taman Mount
Austin, 81100, Johor Bahru, Johor

Tarikh: 27 Januari 2023

Tarikh: 28/01/2023

DECLARATION

I declare that this project report entitled “Development of An IoT-Based Smart Home Security System Using Face Recognition” is the result of my research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

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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 Electrical Engineering Technology with Honours.

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DEDICATION

*This study is wholeheartedly dedicated to my beloved parents, who have been the source of inspiration and gave me strength when I thought of giving up, who continually provide their moral, spiritual, emotional, and financial support.
To my brothers, sister, friends, and course mate who shared their words of advice and encouragement to finish this study.*



ABSTRACT

The home security system has become a requirement in every residence. Previously, the majority of doors were accessed with conventional methods such as keys, RFID cards, passwords, or patterns. However, incidents such as key loss have resulted in numerous unpleasant cases, including burglary and identity fraud. In order to solve this significant problem, a facial recognition system for home security was developed. The ESP32 module and the Internet of Things (IoT) were employed in this project to develop a highly effective door access control system. In addition to the on/off relay for door access, an ESP32 module was implemented to provide control. ESP32-Cam operates as the facial recognition module, it is employed as a vision sensor. In the meantime, IoT connectivity was mainly used to connect and transmit information that enables the end user to control door access using facial recognition live streaming. The door will normally open automatically if the system recognizes an authorized individual. Otherwise, the homeowner will be alerted and have the authority to determine whether or not to open the door through the virtual lock widget in the Blynk application. Up to 85% accuracy for the facial recognition system is the expected outcome of this project. At the end of this test, the researcher manages to get an accuracy of 86% for this face recognition development. This implementation is capable of achieving greater accuracy than the researcher's target accuracy of 85%. In conclusion, facial recognition and IoT security systems have been successfully implemented. By using face recognition, this project has effectively produced a high-quality security system.

ABSTRAK

Sistem keselamatan rumah telah menjadi aspek penting untuk setiap rumah. Sebelum ini, kebanyakan pintu dibuka menggunakan cara tradisional seperti kunci, kad RFID, kata laluan atau corak. Bagaimanapun, insiden seperti kehilangan kunci telah membawa kepada banyak kes yang membimbangkan seperti rompakan dan penipuan identiti. Oleh itu, bagi mengatasi isu penting ini, keselamatan rumah menggunakan sistem pengecaman muka telah diperkenalkan. Dalam projek ini, modul ESP32, dan Internet of Thing (IoT) digunakan untuk melaksanakan sistem kawalan akses pintu yang cekap. Modul ESP32 digunakan untuk memberikan arahan, selain itu, geganti buka dan tutup untuk akses pintu. Manakala ESP32-Cam digunakan untuk berfungsi sebagai modul pengecaman muka. Sementara itu, komunikasi IoT digunakan untuk saling menyambung serta maklumat komunikasi yang membolehkan pengguna akhir mengawal akses pintu dengan bantuan penstriman langsung pengecaman muka. Secara amnya, jika orang yang dikenali diiktiraf oleh sistem, pintu akan terbuka secara automatik. Jika tidak, pemilik rumah akan dimaklumkan dan mempunyai kuasa untuk memutuskan sama ada mahu membuka pintu atau sebaliknya. Keputusan yang perlu dicapai untuk projek ini adalah sehingga 85% ketepatan untuk sistem pengecaman muka. Pada akhir ujian ini, penyelidik berjaya mendapatkan ketepatan 86% untuk pembangunan pengecaman wajah ini. Pelaksanaan ini mampu mencapai ketepatan yang lebih tinggi daripada ketepatan sasaran penyelidik sebanyak 85%. Kesimpulannya, pengecaman wajah dan sistem keselamatan IoT telah berjaya dilaksanakan. Dengan menggunakan pengecaman wajah, projek ini telah menghasilkan sistem keselamatan berkualiti tinggi dengan berkesan.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Beneficent and Most Merciful. Praised Allah for His guidance and for giving me a chance to complete this project. It is a great opportunity to acknowledge people who have been directly or indirectly involved in my thesis journey.

First and foremost, I would like to express my gratitude to my supervisor, Ts. Maslan bin Zainon for the precious guidance, words of wisdom and patience throughout this project. His patience and motivation helped me through this final-year project.

My highest appreciation goes to my parents, Mohammad Hassan bin Timin and Suraya Binti Baharom, and also family members for their love and prayer during the period of my study. An honourable mention also goes to Nur Ain Binti Norazman for all the motivation, support and understanding.

Finally, I would like to thank all my colleagues and classmates, as well as other individuals who are not listed here for being cooperative and helpful.



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LIST OF SYMBOLS

m	-	Meter
MHz	-	Megahertz
ms	-	Milliseconds
%	-	Percent
KB	-	Kilobytes
cm	-	Centimeter



LIST OF ABBREVIATIONS

V	-	Voltage
IoT	-	Internet of Things
IP	-	Internet Protocol
Wi-Fi	-	Wireless Fidelity
I/O	-	Input/Output
IDE	-	Integrated Development Environment
USB	-	Universal Serial Bus
GUI	-	Graphical User Interface
JSON	-	JavaScript Object Notation
NoSQL	-	No Structured Query Language
SPA	-	Single Page Application
API	-	Application Programming Interface
ABS	-	Acrylonitrile Butadiene Styrene
iOS	-	iPhone Operating System
Cam	-	Camera
ID	-	Identification
GNU	-	GNU's Not UNIX
SRAM	-	Static Random Access Memory
PSRAM	-	Pseudo-Static Random Access Memory
BLE	-	Bluetooth Low Energy
SoC	-	System-on-a-Chip
LWIP	-	Lightweight Internet Protocol
FreeRTOS	-	Free Real-Time Operating System
UART	-	Universal Asynchronous Receiver/Transmitter
SPI	-	Serial Peripheral Interface
I2C	-	Inter Integrated Circuit
PWM	-	Pulse With Modulation
ADC	-	Analog to Digital Converter
DAC	-	Digital to Analog Converter
COM	-	Common
NO	-	Normally Open
NC	-	Normally Closed
LED	-	Light-Emitting Diode
VCC	-	Voltage Common Collector
GND	-	Ground
GPIO	-	General Purpose Input/Output

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CHAPTER 1

INTRODUCTION

1.1 Background

Internet of Things (IoT) is a system of networked physical gadgets that may share data and communicate without the need for human intervention. Any physical product that can be assigned an IP address to enable data to pass over a network becomes part of an IoT method by integrating electronic components such as networking gear, software, and a sensor inside it. Home security is a good illustration of an Internet of Things (IoT) application.

Home security has made great strides in the previous few decades and will continue to do so in the upcoming years. Home security systems used to be bound to an alarm system that would activate if a break-in occurred, but today's smart home security can do so much more. As a result, the study's primary objective is to develop a facial recognition system that can send a notification to users' smartphones when an intruder breaks in. The significance of face recognition is not just because it allows users to use their faces as keys, but it also allows computers to read users' expressions in real-time. More technologies are being developed as the Internet of Things develops, and face recognition has become more common. The most natural approach to human-to-human identification is face recognition. It is also the most extensively utilized biometric authentication feature, after fingerprint technology. The functions of this system will assist the user in taking the necessary activities.

1.2 Problem Statement

Nowadays, several articles and videos are circulating on social media about incidents involving burglary in Malaysia. From 2007 to 2017, 1,361,320 incidences of property crime were reported (Hakim et. al., 2022). Maintaining a solid home security system that can protect in the most optimal and secure method has been increasingly crucial in recent years (Januzaj et. al.,2015). Traditional home security systems are susceptible to compromise and are obsolete. This is because it is no longer effective to rely entirely on a door lock to protect the user's home and family. Integrated smart security systems are not frequently used because of their expensive price. In addition, the current smart home security system has the capability to offer a higher safety level while still fulfilling market demand, and it can be designed with inexpensive components. Facial recognition technology integrated into an Internet of Things-based home security system is one approach being researched. When an intruder is detected at the front door, it can send an alarm and a picture of the intruder to the owner, assisting in reducing some concerns.

1.3 Project Objectives

The main aim of this project is to propose a systematic and effective methodology. Specifically, the objectives are as follows:

- a) To design and develop an IoT-based circuit and hardware for a face recognition system.
- b) To apply a vision sensor (camera module) and a microcontroller as the main components of the face recognition system.
- c) To analyze the performance of the face recognition system in terms of its effectiveness and reliability as a home security system.

1.4 Scope of Project

This project involved a study procedure that included gathering data and information about the equipment and components to be implemented. To avoid any uncertainty in this project due to some limitations and constraints, these are the scope of work for the development of this project:

- a) The person needs to stand 0.4m from the camera.
- b) The project consists of microcontroller programming and IoT platform configuration.
- c) A camera module is proposed to do facial recognition.
- d) The system will be functioning in the Wi-Fi coverage range.
- e) Other factors, such as the system's speed, will not be examined in the study.
- f) The project focuses on integrating face recognition with an IoT application that will send a notification to the user.
- g) This system is limited to 7 users, but for this project, it will implement 1 user only.
- h) System will not be able to record live streaming video, only face recognition.

1.5 Report Structure and Organization

This study is organized into four chapters, as follows:

The background of the face recognition system is covered in Chapter 1. A few objectives are defined as a guideline for further reference based on the problem statement that was identified.

In Chapter 2, a literature review is carried out to acquire knowledge while an understanding of the other research is gathered in order to reduce unsolved problems and prevent any project repetition. The purpose of comparing prior research works is to analyze the benefits and drawbacks of various methodologies.

In Chapter 3, the methodology is formulated into four milestones that refer to the objectives of this project. The system architecture can be designed based on the previous research studies by selecting the right methods and the components that are included in this project. Testing and troubleshooting are evaluated based on the algorithm development in this system.

Following the description of the fundamental component testing, Chapter 4 displays the system's accomplishment. This outcome will be applied to determine the efficacy bachelor's degree project work.

Chapter 5 will complete the entire topic with a conclusion and recommendation as the final section. Future work will be highlighted, and the project's potential will be described.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews and summarizes the project's overall face recognition concept and theory using the Internet of Things (IoT). The main proposal of the whole chapter was to explain previous and current research. The theory and concept used to overcome the project's issue were discussed in this chapter. The major sources of information are journals and articles, which have been chosen for their resemblance to the project scope.

2.2 Development of Smart Home Security

The goal of a smart home has taken far away from traditional methods, and technological advancements have enabled the user to use the houses along with the technologies to their full potential. The majority of futuristic homes will most likely provide owners with efficient and enhanced security, as well as a smart home revolution. Home security and automation systems have grown in popularity, and they will continue to do so in the future. Not only that, but it is also affordable and ideal for people of all income levels and lifestyles (Sehgal & Singh, 2019). In smart home applications, security is a crucial factor or function as smart homes are a new and evolving concept that provides tenants with a comfortable, convenient, and safe environment. Traditional security systems provide an indicator in the form of an alarm to keep homeowners and their property safe from attackers. A smart home security system, on the other hand, has numerous advantages.