Faculty of Electrical and Electronic Engineering Technology

Development of Face Recognition Door Lock System using ESP32 for Home Security

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEVELOPMENT OF FACE RECOGNITION DOOR LOCK USING ESP32 FOR HOME SECURITY

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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 (Telecommunications) with Honours.

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Supervisor Name : TS. ELIYANA BINTI RUSLAN

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DEDICATION

Special dedication to my beloved parent,

LIAN BIN LIUN

and

TAN SEK GEOK

My lovely brothers and sisters,

(AARON BIN LIAN)

(KENT ROLAND BIN LIAN)

(MATHILDA NICOLE BINTI LIAN)

(JESLYN GRACE BINTI LIAN)

My supportive and kind hearted Supervisor,

TS. ELIYANA BINTI RUSLAN

PN. NORLEZAH BINTI HASHIM (PREVIOUS SUPERVISOR)

ABSTRACT

Security concerns are an integral aspect of daily living. Identification of individuals entering a room is a crucial element in the security chain. This article presents the prototype of a facial recognition-based room access control system. The system consists of a camera for face detection and a solenoid door lock for room entry. Every person recognized by the camera will be compared to the system's database to ensure compliance. If the user has authorization, the solenoid door lock will unlock, and the user will be able to enter the room. If the user is not identified, the solenoid lock will remain locked. ESP32-CAM is the primary control circuit for this system. In this research, we apply the Multi-Task Cascaded Convolutional Neural Networks face detection algorithm as well in an image analysis of a user's face to achieve highly accurate face detection.

ABSTRAK

Kebimbangan keselamatan adalah aspek penting dalam kehidupan seharian. Pengenalpastian individu yang memasuki bilik adalah elemen penting dalam rantaian keselamatan. Artikel ini membentangkan prototaip sistem kawalan akses bilik berasaskan pengecaman muka. Sistem ini terdiri daripada kamera untuk pengesanan muka dan kunci pintu solenoid untuk kemasukan bilik. Setiap orang yang dikenali oleh kamera akan dibandingkan dengan pangkalan data sistem untuk memastikan pematuhan. Jika pengguna mempunyai kebenaran, kunci pintu solenoid akan dibuka dan pengguna akan dapat memasuki bilik. Jika pengguna tidak dikenal pasti, bagaimanapun, kunci pintu akan tetap tertutup. ESP32-CAM ialah litar kawalan utama untuk sistem ini. Dalam penyelidikan ini, kami menggunakan algoritma Multi-Task Cascaded Convolutional Neural Networks yang juga untuk analisis imej muka pengguna untuk mencapai pengesanan muka yang lebih tepat.

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LIST OF ABBREVIATIONS

Wi-Fi	-	Wireless Fidelity
IDE	-	Integrated Development Environment
Volt	-	Voltage
Mbps	-	Megabits Per Second
Gbps	-	Gigabytes Per Second
Kbps	-	Kilobits Per Second
Bps	-	Bits Per Second
GHZ	-	Gigahertz
MJPEG	-	Motion JPEG
CAM	-	Camera
TTL	-	Time-To-Live
UART	-	Universal Asynchronous Receiver-Transmitter

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CHAPTER 1

INTRODUCTION

1.1 Background

One of the most common characteristics of human vision is our way of differentiating between distinct faces, even when they appear similar, and recognizing many different individuals with little effort. Automated facial recognition is a subfield of Computer Vision inspired by this ability. Biometric identification systems are experts at extracting faces from static photos and video frames and determining if they match a list of identified individuals. The computer will compare the living person in front of the camera to its image store data during this process. If the face matches one of the data files, the person will be recognized by their ID or name. If it does not match, the individual will be rejected.

1.2 Problem Statement

Currently, the rate of crimes and identity thieves has increased and has become a major issue. Traditional methods of personal identification necessitate the use of an external element, such as a key, security password, RFID card, or ID card, to get access to a private item or enter a public space. The keys are highly crucial in some homes. However, there are some drawbacks to this system, including key loss and password forgetfulness. When it happens, it can be difficult to recover. This technology is gradually being supplanted by biometric technologies as a possible

solution to those challenges. This method is used in the vast majority of biometric applications needed the employment of special techniques such as fingerprint scanning, palm print barcode readers, and DNA analyzers to capture information, and the target objects had to touch the hardware to obtain information. Because biometrics is a technique for differentiating the bodily characteristics of persons, it has a large range of applications in security frameworks and is regarded as among the most secure ways. Therefore, this project is designed and developed by using ESP32-CAM as the main module microcontroller, as well as the Multi-Task Cascaded Convolutional Neural Networks for the face recognition algorithm.

1.3 Project Objective

Door locks can be opened using systems that include face detection. The system consisted of a camera that detects facial and a solenoid door lock that unlocks the door. The objective of this project is:

i. To develop a face detection system for the door lock.

ii. To evaluate the accuracy of the face recognition in ESP32-CAM.

1.4 Scope of Project

The suggested facial recognition door lock security system was developed to prevent burglary in highly secure places such as the home environment while using less electricity and providing more dependable independent security features for both intrusion detection systems and door protection. The ESP32-CAM and UART TTL Programmer are used to power up this system.

1.5 Thesis Outline

The introduction to this project is the first chapter of this thesis. This chapter contains the project background, problem statement, objectives, and project scope. This chapter assists the reader in comprehending why this project was created.

The literature review will be the next chapter. The related research conducted by the other researcher will be examined and analyzed one by one in this chapter. The research will be compared and reviewed to determine the benefits and drawbacks of each project.

The methodology, which is the method and technique used in this project, is discussed in Chapter 3. In addition, the design of the procedure used on this project, which represents the hardware and software processes will be included.

In chapter 4, all of the results obtained throughout the software simulation analysis will be displayed and explained. In facial recognition software, the results may also include several associated data and images. Then, the results' specific information will be discussed.

The final chapter of the project is chapter 5, covering the conclusion and recommendations for future work. It will summarize the results obtained and the report's objectives in a single sentence.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Some studies have been reviewed for this chapter to apply knowledge, technique, and method from previous research to this project. Problems or issues that arise in other people's projects can be identified by evaluating their projects. So that the same problems do not arise in this project. Furthermore, reading other people's literature will allow you to compare, contrast, summarize and evaluate specific people's works. This chapter will look at 5 different pieces of literature. The literature was gathered through a search of related door lock security projects.

2.2 Development of Secured Room Access System based on Face Recognition [1]

This project is done by Asep Najmurrokhman, Kusnandar Kusnandar, Arief Budiman Krama, Esmeralda Contessa Djamal, and Robbi Rahim in 2018. For this project, they create a framework for a protected room access system. The purpose of this project is when the room's user wishes to enter, a camera put on the door will record the user's face. If the face is identified, the Raspberry Pi is utilized to transmit a relay instruction to unlock the solenoid door lock on the room's door [9]. The main controller will trigger the buzzer and transmit a notice as well as the picture of an unauthorized face via Telegram if it detects an unknown person, which is an Android-based messaging software [9]. Telegram is a

cloud-based mobile and desktop messaging service with a high degree of security, speed, and access to other platforms. This software is incredibly famous for increasing communication between people and robots. If the user of the room confirms the face that has been supplied to the Telegram, the door will unlock after the user enters the command signal into the solenoid door lock. Solenoid door lock will shut the door once the room user enters. This project required an internet connection to work as the Raspberry Pi system needs to send the captured face and information to their telegram [10].

2.3 RFID-Based Digital Door Locking System [2]

This project is done by Shubham soni, Rajni Soni, and Akhilesh A. Waoo in 2021. The author's aim for this project is to achieve a shorter time than other technologies that have previously been employed as this project is also very protected and keeps track of who's coming and going. This project's circuit includes three components: a scanner, a microcontroller, and a motorized door lock. A reader scans RFID tags in this circuit, and a microcontroller takes the data from the RFID reader and regulates the output of the door lock and the LED. The door lock was also mounted on a door and tested with a battery to determine whether it was functioning. When there is no electricity flowing through the door, a simple circuit on the lock is all that is required. When the electromagnetic in the door lock system supplies 12 volts DC to a plate in the lock, the door may be pulled open easily. When the RFID card is read, a programming cycle starts in which the servo motor turns 90 degrees, after which the gear mechanism in the lock shuts and opens. The open condition will match when the correct card is scanned, in which the servo motor will spin 90 degrees, the green light will be on, the buzzer will sound for 500 microseconds, and the

door lock will be open. When an unregistered card is scanned and the condition of the erroneous card matches, it will be resulted in a beep twice for 500 microseconds and a 1-second red light. The LCD will also show the erroneous card.

2.4 Door Lock Security System Using Raspberry Pi & QR Code [3]

The authors Dr. Badugu Suresh, Angela Sai Kalyan, Balibineni Bharat Teja Raju, and Mudraboina Venkatesh develop this system in 2021. This system is thought to be the best method, as it is much less expensive than RFID and simple to use. Aside from that, additional security measures such as the monitoring device are critical. Without a monitoring system in that place, the user will be unaware of what is going on in there when this system has been installed. This project core component is run by a Raspberry Pi 3B+ with a 64bit ARMv7 Quad Core Processor powered Single Board Computer running at 1.2GHz. Another main component also consisting of a Raspberry Pi camera that is used to capture the user's face when it unlocks to ensure that the QR code user is not someone else.

A tilt sensor will be used for measuring the tilt in multiple axes of a reference plane as it is easy to detect orientation or inclination. Moreover, green and red LEDs have also been used for this project to emit light for authorized and unauthorized access after scanning the QR code. In terms of software, this project was using the Raspbian OS to generate Raspberry Pi-optimized "hard float" code. Applications that use a lot of floating-point arithmetic will notice a significant performance boost. The use of advanced instructions in the Raspberry Pi's ARMv6 CPU will also improve the performance of all other applications. This project was also coded in Python programming since it has efficient high-level data structures and an object-oriented programming approach that is simple but

effective. Python's elegant syntax and dynamic typing, as well as its interpreted nature, make it an excellent language for scripting and rapid application development across a wide range of platforms. As the software library, this project uses OpenCV to create a common infrastructure for computer vision applications and to speed up the incorporation of machine perception into commercial products. Lastly, an Android application QR code scanner for users' authorized QR codes to be scanned and read. This project will once unlock the door and emit a green light when the authorized QR code has been scanned [6].

2.5 Fingerprint Module based Door Unlocking System Using Raspberry Pi [4]

This project proposed the idea of unlocking a door with a fingerprint sensor by the author Dr. Mohd. Abdul Muqeet in 2019. Because of its widespread use in the development of new systems with ease of implementation and low cost, this system is based on Internet of Things (IoT) technology. The main goal of this system is to provide home security by granting access to only the home's owner or to whom authentication is provided by using a fingerprint module to consider his fingerprint. The core component that runs this project is the Raspberry Pi 3 board that contains the BCM2837 controller which supports the ARM11 processing unit. Another main component is an optical fingerprint scanner which comprises a charge-coupled device (CCD) and outputs an image of the scanned finger. The author used the TTL UART interface fingerprint sensor module. The fingerprint data can be stored in the module and verified in 1:1 or 1: N mode to identify the person. The fingerprint module can be connected to a 3.3V or 5V microcontroller directly with a relay that can operate the switch with 5V and 20mA maximum current. Quantum QHM495LM 25MP Webcam (Black) which has an inbuilt sensitive microphone been used to stream and

capture the real-time image. For the buzzer, the author used a small PCB mountable 5V passive buzzer that operates on a 5V supply and uses a coil element to generate an audible tone. Moreover, a solenoid lock has been used for this project as well instead of the normal door lock. Only while the solenoid is powered on can unlock the door. In the event of a power outage or a wire break, this type of door is locked and not opened, ensuring maximum safety [7]. Lastly, as for the software term, Raspbian OS has been used. Raspbian OS is more than just an operating system; it includes over 35,000 packages, which are pre-compiled software packages packaged in a convenient format for Raspberry Pi installation.

2.6 Fingerprint Door Lock System with Temperature Sensor [5]

The author of this project Arkajyoti Poddar, Somrup Roy, Subhasish Raha, Kusal Thakur, Tamojit Dasgupta, and Dr. Saikat Maity has implemented this project in 2020. The author's main objective of this project is to implement a fingerprint door lock system based on the temperature sensor. As the author implemented this project, the Arduino UNO board will be used to act as the heart of the system. Another main component was the R305 Fingerprint sensor. Fingerprint Sensor (R305) -TTL UART is a TTL UART interface fingerprint sensor module. The author can save the fingerprint data in the module and use it to identify the person in 1:1 or 1: N mode. Moreover, the fingerprint module can be connected to a 3v3 or 5v microcontroller directly. As for the temperature sensor, the author chooses the LM35 Body Temperature Sensor because of its output voltage of these high-precision integrated-circuit temperature sensors were proportional to the temperature in degrees Celsius. The LM35 device has the benefit of not needing the user to lose a huge