Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF SMART DOOR UNLOCK SYSTEM BASED ON FACE RECOGNITION TECHNOLOGY

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SOO YING SAN

Bachelor of Electronics Engineering Technology with Honours

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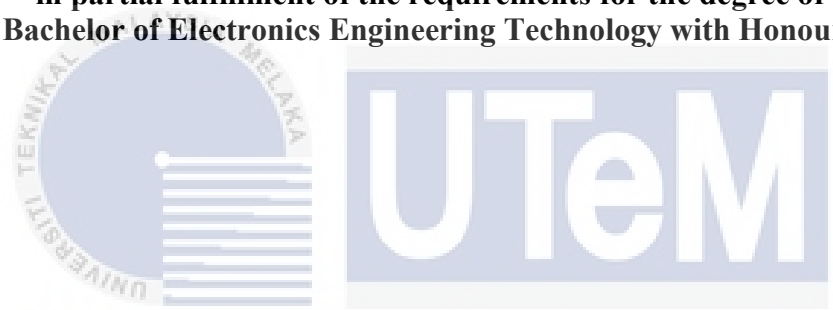
DEVELOPMENT OF SMART DOOR UNLOCK SYSTEM BASED ON FACE RECOGNITION TECHNOLOGY

SOO YING SAN

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



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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 with Honours.

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DEDICATION

To my beloved mother, Teoh Suan Lian, and father, Soo Nam Aik,

and

To my supervisor, Nurulhalim Bin Hassim

and

To my co-supervisor Ts. Khairul Azha Bin A Aziz.

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ABSTRACT

With the change of times, the progress of science and technologies have not only improved people's lives but also generated a lot of safety problems. With the rise of crime, people began to pay attention to privacy and home security. One of the important aspects of the door lock system is the security capability that can lock and unlock the door in simple and secure ways. Facial recognition has been widely used nowadays because of its convenience and reliability. There are numerous techniques and algorithms with various levels of accuracy and speed. In this paper, an unlocking system based on facial recognition is proposed. The system uses the Raspberry Pi to automate the door lock and unlock and enhance the door's security by facial recognition. A Raspberry Pi 4 Model B device with a camera module is used in this design. The Raspberry Pi features a 1.5 GHz 64-bit CPU and 4 GB RAM, and a 5-megapixel camera module. This system uses Haar Cascade in OpenCV to perform facial detection, and then uses LBPH to perform facial recognition, which can accurately identify faces. At the same time, Python was used as the programming language of this whole program, and Blynk apps was used as the user interface.

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ABSTRAK

Dengan perubahan zaman, kemajuan sains dan teknologi bukan sahaja meningkatkan taraf kehidupan manusia tetapi juga menimbulkan banyak masalah keselamatan. Dengan meningkatnya jenayah, keselamatan telah menjadi salah satu elemen yang penting. Salah satu aspek penting dari sistem kunci pintu adalah kemampuan keselamatan yang dapat mengunci dan membuka kunci pintu dengan cara yang mudah dan selamat. Teknologi pengenalan wajah telah banyak digunakan sekarang kerana kemudahan dan kebolehpercayaannya. Banyak teknik dan algoritma tersedia dengan tahap ketepatan dan kelajuan yang berbeza-beza. Tujuan penelitian ini adalah mencipta satu sistem membuka pintu berdasarkan teknik pengecaman wajah. Sistem ini menggunakan Raspberry Pi untuk mengautomasikan tutup dan membuka kunci serta meningkatkan keselamatan pintu dengan teknologi pengecaman wajah. Metode yang digunakan dalam penelitian ini adalah peranti Raspberry Pi 4 Model B yang dipasang dengan modul kamera. Raspberry Pi mempunyai CPU 64-bit 1.5 GHz bersama dengan RAM 4 GB dan modul kamera berresolusi 5 MP. Sistem ini menggunakan teknik Haar Cascade di OpenCV untuk melakukan pengesanan wajah, dan kemudian menggunakan teknik LBPH untuk melakukan pengecaman wajah. Akhir sekali, Python digunakan sebagai bahasa pengaturcaraan keseluruhan program ini dan program ini juga menggunakan applikasi Blnyk sebagai antara muka pengguna.

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LIST OF ABBREVIATIONS

AIDC	-	Automatic Identification and Data Capture
CPU	-	Central Processing Unit
CSI	-	Camera Serial Interface
DC	-	Direct Current
DNA	-	DeoxyriboNucleic Acid
DTMF	-	Dual-Tone Multi-Frequency
GHz	-	GigaHertz
GPRS	-	General Packet Radio Service
GSM	-	Global System for Mobile Communication
HOG	-	Histogram of Oriented Gradients
ID	-	Identification
IR	-	Infrarred Radiation
LBP	-	Local Binary Pattern
LBPH	-	Local Binary Patterns Histograms
MP	-	Mega Pixels
PCA	-	Principle Component Analysis
RAM	-	Random Access Memory
RFID	-	Radio Frequency Identification
SIM	-	Subscriber Identity Module
SMS	-	Short Message Service
V	-	Voltage

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CHAPTER 1

INTRODUCTION

1.1 Background

In these new age, technology has changed the world. As technology is increasing, facilities for human beings are increasing too. Technological has been used to resolve modern-day problems, and people's daily lives becomes very convenient with the incorporation of many technologies [1].In such advanced scenario, home security has also become one of the hottest points to concern.

In general, people use security camera to secure home but this type of approach is a passive way and there is possibility the camera may be damage [2]. Then the numerous security measures and recognition system have been implemented to enhance the security aspects. Several smart door unlock system have been proposed used RFID [3], mobile unlock [4] and password [5]. The other proposed smart door unlock system by employing biometric recognition, such as fingerprint recognition [6], voice recognition [7], and face recognition [8] to process the identification and verification.

Biometric has been used extensively over the past few decades. Human body characteristics such as voice, face, and fingerprint are preferred for biometric authentication because they satisfy biometric properties such as universality, distinctness, permanence, and collectability. Hence, these unique and difficult to replicate individual traits may provides superior security and convenience than recognition techniques based on passwords, PIN and identity cards [9].

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1.2 Problem Statement

Security holds an integral position in every field. In today's automation and smart devices era, there is a crucial need to upgrade the security system as privacy and security are major concerns nowadays. It isn't easy to trust the traditional and simple security system blindly. In a traditional system, many of the doors are secured with a mechanical lock, which is restricted by the number of duplicate keys [10]. Besides that, physical keys that are used to open doors are vulnerable to replication or can be lost [11]. Furthermore, it is exacerbated for people with physical disabilities. For example, for an individual in a wheelchair, it may be difficult to open a door system without the assistance or help of another person. Moreover, no action can be taken immediately for traditional door lock as soon as a security threat occurs. Traditional security system works well, but when we wish for a more secured environment and accountability of who have locked and unlocked the door, this is the major part missing in a traditional system. So, to solve the aforementioned problems with traditional locking systems, they must be modified and made smart and automated.

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1.3 Project Objective

The main aim of this project is to propose an effective methodology to build a smart door unlock system by using face recognition technology. Specifically, the objectives are as follows:

a) To allows the user to unlock the door by using face recognition.

b) To design a smart door unlock system with Raspberry Pi.

c) To allow the user receives notifications when security threat occurs.

1.4 Scope of Project

Before the project is built, this project's scope has been researched. The project scope is vital to make sure the program meets the requirements. Among the scope of this project is using Raspberry Pi as the brain to control all the components used in this project. Additionally, a Raspberry Pi Camera was used to capture the image so that the microcontroller could run the face recognition process. Raspberry Pi will compare the captured image with stored database images; if it matches the authorized user, the system will supply power to the relay to unlock the solenoid door lock. Otherwise, the buzzer will turn on thus alerting the occupants and neighbours about a possible intrusion. This project is also a combination system of a surveillance camera and a smart door lock. Any detection of an unknown user, the system will record the strange face until it leaves the camera. Besides the hardware system, a user interface will also be designed to allow users to monitor the system's status and do some essential control of the system.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The population's personal safety in public or private buildings has always been an issue in modern life. Building access control is a vital mechanism for safeguarding both building occupants and the structure itself. Door access control is one of the essential security systems in a property. Door access control is a kind of protection that ensures the security of a room or building by restricting access to specific people and keeping track of those accesses [12]. Basically, door access control is mostly accomplished by the use of locks on doors. Simply stated, doors are designed to keep people out, while key and locks enhance security [13].

Traditional methods were used to enforce the development of these security tools during the mediaeval period. People could easily breach the security perimeters established by this security equipment, so these tools and equipment became obsolete over time. As a result, people have been on the lookout for more effective security measures. People's interest in developing more sophisticated security systems to overcome the issues of protecting valuable assets grew as the world became more globalized and industrialized. The majority of homeowners will be at work or out doing errands during the day. This makes the house a convenient target for burglars and decreases the possibility of the suspect being arrested. Furthermore, a typical door lock employs a key, which an unauthorized individual or burglar can easily unlock whether they have the correct key or a duplicate. Burglars would be able to steal valuables from the homes. When homeowners lose the keys to the locks, they are unable to unlock the door and must wait for a technician to arrive. Another issue is that

if the key is lost or if it is left in the building, the owner would not be able to gain access to his property [14]. A lock system could provide access to personal belongings and documents both at home and at work, in addition to gaining access to a house. Confidential papers, money, expensive jewelry, and other valuables may be among these items. To overcome these problems, security systems such as smartcards, security codes, RFID, and biometrics have been developed to prevent unauthorized access.

2.2 Existing System

Several works on lock system have been done using different methods to control access. Reviews of some of these systems are presented below.

2.2.1 Lock and Key System

The lock and key system was the first step toward security. “One key for a single lock” was the security protocol used in this system. Initially, this device was thought to have the highest level of protection. However, the fact that several keys can easily be made for a single lock soon disproved this assumption [15]. The traditional door lock has a keyhole about the doorknob, and the door can be opened when a user inserts a correct key and rotate it. Unfortunately, when there is a target above the doorknob, some people use a screwdriver or other tools to open the door violently [16]. As a result, this system is obsolete in terms of security.

2.2.2 Password Based System

Password is being used as an authentication method at the next stage of security. This is also one among the hundreds of attempts made for providing security. The programmable electronic code lock device is locked using predefined digits. It is also called

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an integrated combinational type lock. The programmable code lock is displayed as shown in Figure 2.1.

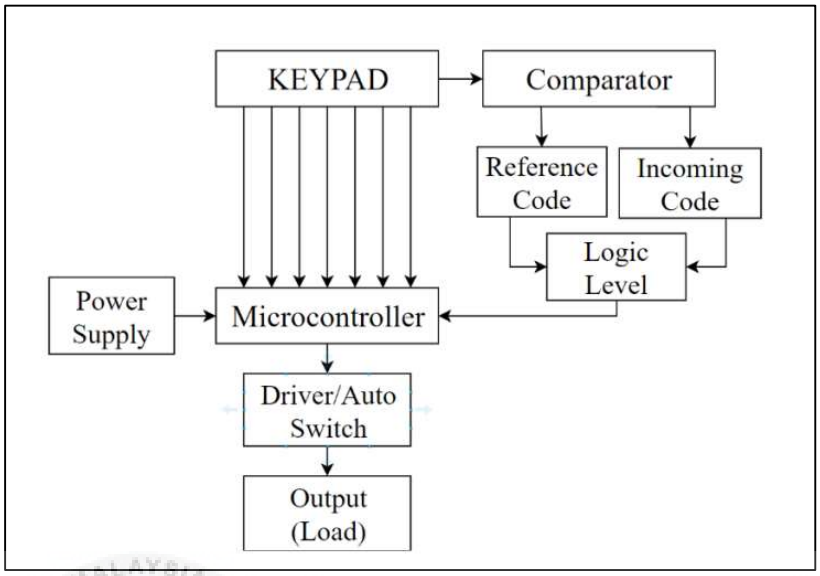

Figure 2.1 Programmable Electronic Code Lock. [17]

The passwords of authenticated users are stored in this system for validation purposes. Password authentication provides users with a high level of security because it serves as a key for approved users. However, this system also has the disadvantages in allowing an unauthorized user to obtain a password by repeatedly attempting all possible combinations. In 2013, a new design of a programmable electronic digital code lock device was designed to address this problem. It will be triggered by switching to alarm mode if any incorrect code is entered four times in a row, and it will only be turned off when the user enters the correct predefined digits in the correct sequence [17]. It is a cost-effective and straightforward protection system, but it lacks notification features and a mechanism for changing the passcode [18].

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2.2.3 GSM Based System

Presently, the Global System for Mobile Communication (GSM) technology is effectively deployed in automating our homes and home appliances. In many door lock security systems, GSM is used for communication purpose. In 2013, a security door lock system has been proposed [19]. In this system, a transmitter which is a GSM phone can remotely control the door motor by connecting to another GSM phone with dual-tone multi-frequency (DTMF) that acts as a receiver. When the receiver received the input or tone, it will pass the same to the DTMF decoder so that the controller can use it to run the analysis and comparing process. The DTMF decoder is acting as the interface of the microcontroller. This project aims to connect the microcontroller to the GSM modem to control the operation of the stepper motor by receiving a preset sentence. The software application and hardware implementation will assist the microcontroller in reading messages sent by the user from a mobile phone or sending messages to the mobile phone through the modem and changing the motor's output accordingly. The system was built entirely with GSM and embedded systems technology, and the software ran flawlessly before being burned onto the microcontroller.

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In 2017, an electronic door lock/unlock device using the Arduino have been designed. The security system has three modes for locking and unlocking the door: keypad, Bluetooth, and the Global System for Mobile (GSM). The password in this system is four digits long. The user can use the keypad, a Bluetooth application on a smartphone, or a four-digit message from a GSM phone to open or close the door. If any one of the modules received three times wrong password key in consecutive, the authorized user would receive a notification from the GSM mobile number, and the buzzer alarm also will be initiated by Arduino as a warning of unauthorized intrusion. [20]. According to [21], GSM based door lock system also can be designed using the Arduino. In this paper, the proposed system uses