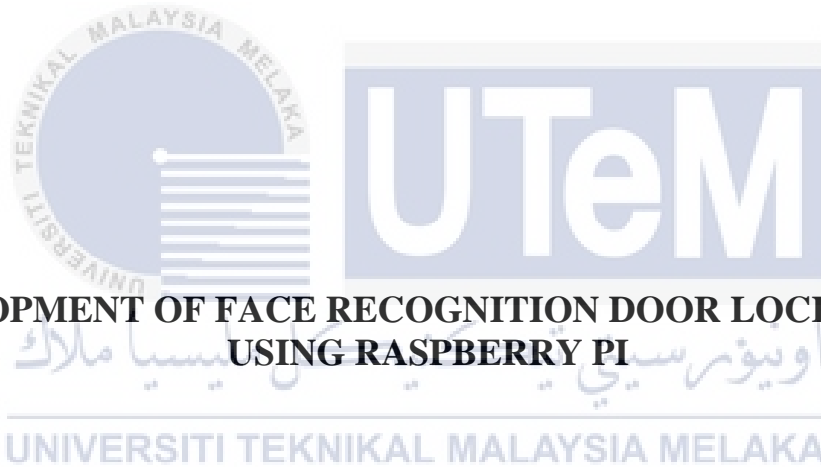**Faculty of Electrical and Electronic Engineering Technology**

DEVELOPMENT OF FACE RECOGNITION DOOR LOCK SYSTEM USING RASPBERRY PI

MUHAMMAD AFIQ BIN MASOR

Bachelor of Computer Engineering Technology (Computer Systems) with Honours

2021

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A project report submitted
in partial fulfillment of the requirements for the degree of
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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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I declare that this project report entitled "Development Of Face Recognition Door Lock System Using Raspberry Pi" 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.

Signature   :

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Date   :   11/1/2022

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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 Computer Engineering Technology (Computer Systems) with Honours.

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DEDICATION

I would like to dedicated and special thanks to
My beloved father and mother
To my beloved family and friends, and my respected lecturer
Thank for all the guidance and support

ABSTRACT

Security aspect in need for many areas of life today. Since technology plays an essential role in our everyday lives, different domains of interest are taking advantage of technology. Biometric security system. The trend went from fingerprint scanners to facial recognition. This project develops a face recognition door lock system prototype using Raspberry Pi. This project uses Raspberry Pi as the main component of the prototype. As for the door lock, the solenoid lock acts as the door lock because of its simplicity, and it uses less power. The webcam camera is suitable for this project because it has a USB connection to Raspberry Pi. To fulfil the project's requirement, the user's image is stored in the database for facial recognition. Next, the store images of the user undergo a process where the recognizer capture all the facial point in the user's face and compare it to the user that uses the door lock. How the project work is that every user that uses the door lock need to take a photo for facial recognition. Next, the images are processed to capture the facial points of the user for the recognizer to identify which user is using the door. If the user's face matches the database, the Raspberry Pi sends the signal to the solenoid lock to open the lock allowing the user to open the door. As a result, the project provides faster entry than standard locks and keys and offers more security because only registered users can open the door. This door lock system is able to provide security and reliability that play an important role in door security.

ABSTRAK

Aspek keselamatan yang diperlukan untuk banyak bidang kehidupan hari ini. Memandangkan teknologi memainkan peranan penting dalam kehidupan seharian kita, domain minat yang berbeza mengambil kesempatan daripada teknologi. Sistem keselamatan biometrik. Trend berubah daripada pengimbas cap jari kepada pengecaman muka. Projek ini membangunkan prototaip sistem kunci pintu pengecaman muka menggunakan Raspberry Pi. Projek ini menggunakan Raspberry Pi sebagai komponen utama prototaip. Bagi kunci pintu, kunci solenoid bertindak sebagai kunci pintu kerana kesederhanaannya, dan ia menggunakan kurang kuasa. Kamera kamera web sesuai untuk projek ini kerana ia mempunyai sambungan USB ke Raspberry Pi. Untuk memenuhi keperluan projek, imej pengguna disimpan dalam pangkalan data untuk pengecaman muka. Seterusnya, imej stor pengguna menjalani proses di mana pengecam menangkap semua titik muka di muka pengguna dan membandingkannya dengan pengguna yang menggunakan kunci pintu. Cara projek berfungsi ialah setiap pengguna yang menggunakan kunci pintu perlu mengambil gambar untuk pengecaman muka. Seterusnya, imej diproses untuk menangkap mata muka pengguna untuk pengecam mengenal pasti pengguna yang menggunakan pintu. Jika wajah pengguna sepadan dengan pangkalan data, Raspberry Pi menghantar isyarat kepada kunci solenoid untuk membuka kunci yang membolehkan pengguna membuka pintu. Hasilnya, projek ini menyediakan kemasukan yang lebih pantas daripada kunci dan kunci standard dan menawarkan lebih keselamatan kerana hanya pengguna berdaftar boleh membuka pintu. Sistem kunci pintu ini mampu memberikan keselamatan dan kebolehpercayaan yang memainkan peranan penting dalam keselamatan pintu.

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V   Voltage
mAh   Milliamp's hour

LIST OF ABBREVIATIONS

ID	Identification
RFID	Radio Frequency Identification
IoT	Internet of Things
OTP	One Time Password
SD	Secure Digital
USB	Universal Serial Bus
RF	Radio Frequency
TFT	Thin Film Transistor
PCA	Principal Component Analysis
LDA	Linear Discriminant Analysis
AT&T	American Telefon and Telegraph company
SMS	Short Message Service
ARM	Advanced RISC Machines
MATLAB	Matrix Laboratory
GUI	Graphical User Interface
LCD	Liquid Crystal Display
IDE	Integrated Development Environment
RAM	Random Access Memory
CPU	Central Processing Unit
GPU	Graphics Processing Unit
GPIO	General Purpose Input Output
I/O	Input Output

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CHAPTER 1

INTRODUCTION

1.1 Background

The critical component of any home security system is identifying individuals entering and exiting the premises. Traditionally, individuals used the conventional manner to secure their homes. The traditional security system requires external items such as a key, password, or identification card to get access. However, biometrics are used to deliver such an exciting security solution due to certain constraints. Biometrics are a unique and quantifiable parameter for identifying an individual. Biometric systems require specific hardware such as fingerprint scanners, palm print scanners, and DNA analyzers(Syafeeza *et al.*, 2020).

Biometric technology is regarded as one of the most secure authentication systems available, as it provides a higher level of security than conventional methods. Apart from fingerprint features, face recognition is the most well-known method in biometric technology. This is because the face has a greater degree of stability due to the presence of more features.(Senthilkumar G, Gopalakrishnan K and Satish Kumar, 2014).

Based on previous works uses Arduino as their main component for their prototype but this project uses Raspberry Pi as the main component for the prototype due to it has capability to process images at a faster rate. As for the door lock solenoid lock more suitable because of the it uses low power and also provide the same security aspect as a standard door lock. For the camera webcam is sufficient because it has USB connection. For the recognizer it uses the OpenCV as the main algorithm it can process all the facial point that

the user has and it can able to determine registered and unregistered user with enough dataset.

The main purpose of this project is to provide faster entry to a door and also provide more security than a standard locks and keys method. For this prototype the door lock system able to identity resisted user and unknown user. The registered user able to open the door while unregistered user unable to open the door. This system provides some security and also faster entry to the premise or room and play vital role in home or office security.

1.2   Problem Statement

This facial recognition door system project is to provide some security and also faster entry to a premise or room. Without facial recognition anyone can enter a room just because their have a key or maybe just break in the room. This cause problem for the home or premise owner that want to allow a certain people to their premises or home. With facial recognition technology only, the registered user can enter the home or premises and this prototype uses facial recognition as the main features of the protype it is more secure that standard locks and keys because face is biometric and each person is different for each other and also there is no need for keys to open the door because every person bring their face every where their go which means faster entry to the premise or home. The target of this project is that able to create a facial recognition door lock using Raspberry Pi.

1.3   Project Objective

The objectives of this project are as follows:

a) To develop the face recognition door lock system using Raspberry Pi

b) To store the images of the users for database for the facial recognition

c) To train the recognizer to identify registered or unknown users from the database using OpenCV

1.4   Scope of Project

This project develops a face recognize door lock using Raspberry Pi and Python. This prototype use Web Camera which can be configure with Raspberry Pi that are already connected with the door. It is used to capture the image and send it to the Raspberry Pi. For the door lock we used solenoid lock that are mounted directly on the door. The Raspberry Pi check the image in the database in Python if the image matches the person in front of the camera the solenoid lock unlocks.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

The term "biometrics" is derived from the Greek words "bio" (life) and "metrics" (measurement) (to measure) (ASHOK *et al.*, 2010). Because of significant advances in the field of computer processing, automated biometric systems have only become available in the last few decades. Many of these new automated techniques, on the other hand, are based on concepts that were first conceived hundreds, if not thousands, of years ago.

The face is one of the oldest and most basic examples of a human-recognition characteristic. Faces have been used by humans since the dawn of civilization to distinguish between known (familiar) and unknown (unfamiliar) individuals. This simple task became increasingly difficult as populations grew and more convenient modes of transportation brought many new people into the country. Human-to-human recognition can also be found

in behavioral-predominant biometrics such as speaker and gait recognition. On a daily basis, people use these characteristics, albeit unconsciously, to recognize known individuals.

2.2   Overview of Biometric

Passwords, keys, ID cards, pins and other security mechanisms are used to authenticate users in computer system.(Dharavath, Talukdar and Laskar, 2013) However, as technology advances, the misuse and theft of these security mechanism is becoming more common. This resulted in the development of biometric security systems, in which an individual's authentication is based on a feature vector derived from physiological and/or

behavioral characteristics of a human being. Using biometrics technology, an individual can be authenticated based on "who he is" rather than "what he does."

2.3 Biometric Fingerprint lock

(Ali *et al.*, 2016) Uniqueness and permanence are the pillars of biometric recognition. The term "uniqueness" refers to the absence of feature similarity between two different biometrics data sets. For example, even if they are twins, no two humans have the same fingerprint feature. Any biometrics system has two phases. The first is the enrollment phase, and the second is the recognition phase. The recognition phase is divided into two parts: verification and identification.

The person's fingerprint is verified from the database using matching algorithms during the verification process. It is also known as (1:1) Matching. It is the comparison of a claimant fingerprint to an enroll fingerprint; initially, the person enrolls his/her fingerprint into the verification system, and the result shows whether the fingerprint taken from the user matches the fingerprint stored as a template in the database or not the verification system, and the result shows whether the fingerprint taken from the user matches the fingerprint stored as a template in the database or not.
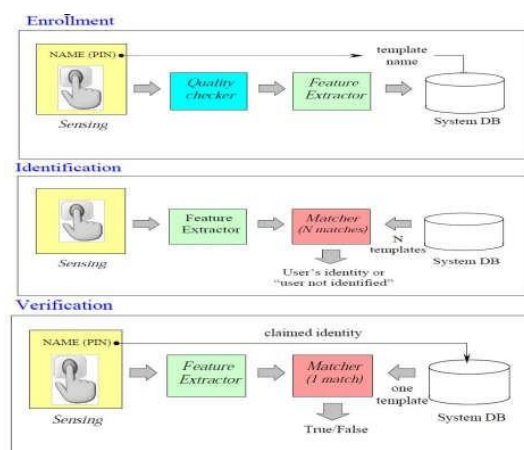

Figure 2.1: Process of Enrollment, identification and verification (L Karthik Narayan, Sonu. G and Soukhya S. M, 2020)

The fingertip surface is made up of numerous ridges and valleys. Figure 2.2 depicts the ridges as black lines and the valleys as white lines in the case of the ridges. The minutiae points are where the ridge structure changes, such as a bifurcation or an end point.
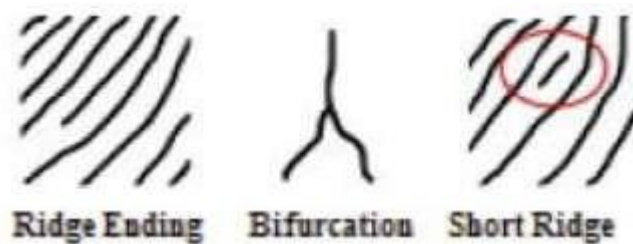

Ridge Ending   Bifurcation   Short Ridge

Figure 2.2:Graphical of ridge and valley ridge ending, bifurcation and short ridge (Zhang *et al.*, 2003)

The identification of fingerprints is based on two fundamental assumptions. Singularity and Invariance. The term "invariance" refers to the fact that the fingerprint characteristics do not change over time. Singularity means that the fingerprint is unique and that no two people have the same fingerprint pattern.
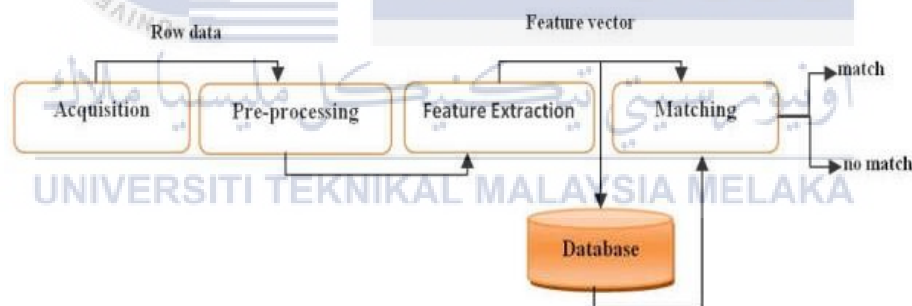

Figure 2.3:Fundamental steps of fingerprint recognition system (Ali *et al.*, 2016)

2.3.1   Arduino Based Smart Fingerprint Authentication System

Nowadays, high-level security is required for homes, offices, shops, and banks for safety reasons. A smart lock system is introduced to provide security for these fields. Many innovative smart door locks have been developed to lock and unlock the system. These have a fingerprint scanner, RFID card, pin, password, or IoT by unlocking the system with a

mobile phone (Meenakshi *et al.*, 2019). These systems lack a security level chain, which would improve security. To increase security, the user should unlock the system by at least two levels. A guest unlocking option should be available in the home lock system. Sometimes a thief will overlook the option and enter the house.

There are three levels of security in the fingerprint lock system, and the user can unlock the system by using any two of the three levels of security. When an unauthorized person tries to unlock, an alert message is sent to the administrator on the first attempt. The system performs fingerprint authentication, OTP (one-time password), and image password.
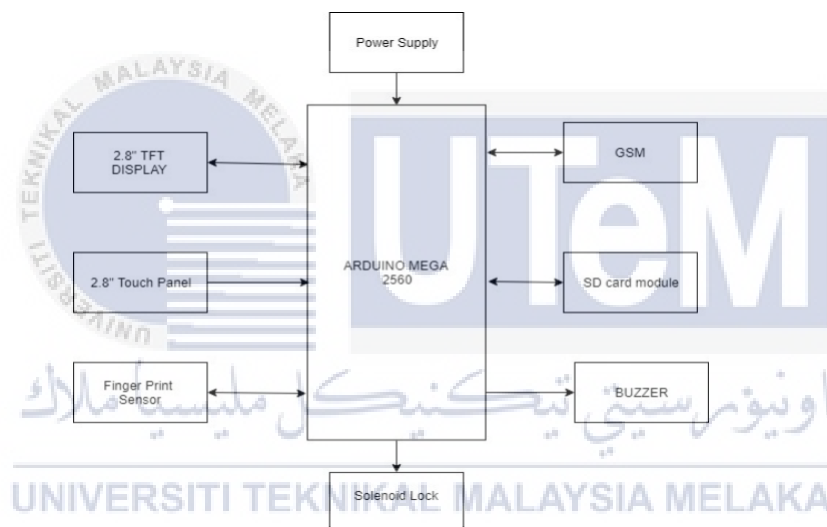

Figure 2.4: Block Diagram (Meenakshi *et al.*, 2019)

The proposed system's connection is depicted in the block diagram Figure 2.4. The Arduino mega 2560 serves as the system's main microcontroller. The system is unlocked using a fingerprint sensor, a keypad on a TFT display, and an image password. The output will be the system being unlocked. The Arduino board is powered via USB or an external power supply. An SD card is connected to the Arduino to store data suchas images, and fingerprints are stored in the fingerprint sensor module as a fingerprint imageor fingerprint template. The TFT displays the instruction for the input as well as whether the input is