IOT IMPLEMENTATION OF MULTI-MODULE AUTOMATED LOCK SYSTEM USING FACIAL AND VOICE RECOGNITION

MUHAMMAD NUR IMAN BIN KHARIMAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IOT IMPLEMENTATION OF MULTI-MODULE AUTOMATED LOCK SYSTEM USING FACIAL AND VOICE RECOGNITION

MUHAMMAD NUR IMAN BIN KHARIMAN

This report is submitted in partial fulfilment of the requirements for the Bachelor of Computer Science (Computer Networking) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

DECLARATION

I hereby declare that this project report entitled

IOT IMPLEMENTATION OF MULTI-MODULE AUTOMATED LOCK SYSTEM USING FACIAL AND VOICE RECOGNITION

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT :MUHAMMAD NUR IMAN BIN KHARIMAN Date : 17/12/2019

I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of [Computer Science (Software Development)] with Honours.

SUPERVISOR :ASSOC. PROF. MOHD FAIZAL BIN ABDOLLAH Date : 17/12/2019

DEDICATION

This thesis is dedicated
to my beloved parent, family, teachers and friends,
that has been giving me a blessing for this project.
With all these individuals being in my life,
It has enabled me to reach this level of education with
success.

ACKNOWLEDGEMENTS

I would also like to thank you, God, beloved parents, family's member, and fellow friends who have been giving me support and motivation throughout my project.

I would also like to express my sincere thank you to Associate Professor Doctor Mohd Faizal Bin Abdollah for giving an opportunity to proceed with an IoT implementation project. Nonetheless, finite thanks for giving me assistant and guidance to complete this project successfully.

ABSTRACT

This project is about an IoT Implementation of multi-module automated lock system using facial and voice recognition-based totally on Raspberry pi. Lock security device has been launched for many years but most of them are simply a CCTV, IP camera or door sensor alert system. It may want to be more environment-friendly with makes use of face recognition. It will affirm the individual facial and voice that goes near to the recognition modules. Only the people who match the identification with the dataset and enter the correct password have the right to unlock. A cellular application telegram, photo processing technique Eigenfaces and voice method ASR primarily based have been involved in this system. An ultrasonic sensor is used to notify the individual presence between the door. Lock system will only begin to function when any individual goes close to the door. An alert message and image taken will send to owner mobile smartphone by telegram via the internet when the face recognition algorithms observe a stranger comes near the door and additionally a buzzer will be set off to act as an alarm system.

ABSTRAK

Projek ini adalah mengenai Pelaksanaan IoT sistem kunci automatik pelbagai modul menggunakan pengenalan wajah dan suara sepenuhnya pada pi Raspberry. Kunci peranti keselamatan telah dilancarkan selama bertahun-tahun tetapi kebanyakannya hanyalah kamera CCTV, kamera IP atau sistem peringatan pintu pintu. Ia mungkin mahu menjadi lebih mesra alam dengan menggunakan pengiktirafan muka. Ia akan menegaskan wajah dan suara individu yang berdekatan dengan modul pengiktirafan. Hanya orang yang sepadan dengan pengenalan dengan dataset dan memasukkan kata laluan yang betul mempunyai hak untuk membuka kunci. Aplikasi telegram selular, teknik pemprosesan foto Eigenfaces dan kaedah suara ASR yang berasaskan asasnya telah terlibat dalam sistem ini. Sensor ultrasonik digunakan untuk memberitahu kehadiran individu di antara pintu. Sistem kunci hanya akan berfungsi apabila mana-mana individu pergi ke pintu. Mesej amaran dan imej yang diambil akan dihantar kepada pemilik telefon pintar mudah alih melalui telegram melalui internet apabila algoritma pengenalan wajah mengamati orang asing datang berhampiran pintu dan tambahan buzzer akan dimatikan untuk bertindak sebagai sistem penggera.

TABLE OF CONTENTS

LIST OF TABLES

PAGE

LIST OF FIGURES

PAGE

LIST OF ABBREVIATIONS

IOT	**INTERNET OF THINGS**
PS	**PROBLEM STATEMENT**
PQ	**PROJECT QUESTION**
PO	**PROJECT OBJECTIVE**
PC	**PROJECT CONTRIBUTION**
GSM	**GLOBAL SYSTEM FOR MOBILE COMMUNICATION**
QR	**QUICK RESPONSE**
IAGS	**INTELLIGENT AUTOMATIC GATE SYSTEM**
RFID	**RADIO-FREQUENCY IDENTIFICATION**
LCD	**LIQUID-CRYSTAL DISPLAY**
WI-FI	**WIRELESS FIDELITY**
CCTV	**CLOSED-CIRCUIT TELEVISION**
DNA	**DEOXYRIBONUCLEIC ACID**
MRTD	**MACHINE-READABLE TRAVEL DOCUMENT**
AES	**ADVANCED ENCRYTION STANDARD**
ANN	**ARTIFICIAL NEURAL NETWORK**
HMM	**HIDDEN MARKOV MODEL**
VNC	**VIRTUAL NETWORK COMPUTING**
SDLC	**SYSTEM DEVELOPMENT LIFE CYCLE**
OS	**OPERATING SYSTEM**
LED	**LIGHT-EMITTING DIODE**
USB	**UNIVERSAL SERIAL BUS**

PCA	**PRINCIPAL COMPONENT ANALYSIS**
LDA	**LINEAR DISCRIMINANT ANALYSIS**
SPEECHPY	**SPECCH PYTHON**
ASR	**AUTOMATIC SPEECH RECOGNITION**
SR	**SPEECH RECOGNITION**
FYP	**FINAL YEAR PROJECT**
IDE	**INTEGRATED DEVELOPMENT ENVIRONMENT**
OPENCV	**OPEN SOURCE COMPUTER VISION**
RAM	**RANDOM ACCESS MEMORY**
GPU	**GRAPHIC PROCESSING UNIT**
CPU	**CENTRAL PROCESSING UNIT**
GPIO	**GENERAL-PURPOSE INPUT/OUTPUT**
VCC	**VOLTAGE COMMON COLLECTOR**
GND	**GRADUUATED NEUTRAL DENSITY**
SCL	**SERIAL CLOCK LINE**
SDA	**SERIAL DATA LINE**
DC	**DIRECT CURRENT**
HZ	**HERTZ**
TTL	**TIME TO LIVE**
TTLE	**TIME TO LIVE END**
TRIG	**TRIGONOMETRY**
OSI	**OPEN SYSTEM INTERCONNECTION**
MRTD	**MINIMUM RESOLVABLE TEMPERATURE DIFFERENCE**

LIST OF ATTACHMENTS

CHAPTER 1: INTRODUCTION

1.1 Project Introduction

Nowadays, home security with only door locker is not enough to protect your home and family. However, the smart home security system is still not popular on the market for household uses because of the higher price than a traditional lock. Moreover, the smart home security system nowadays still can be improved by adding a higher security level and build using low-cost material. Regarding this issue, an intelligent automated lock system using facial and voice recognition project have been started to solve this issue. It can help solve the issues by trigger an alarm and capture an image of theft and send to the owner when a stranger is detected. The theft will get alert, so they got no time to start to break into the household.

1.2 Project Background

This project is to provide a solution with a new design with improvement embedded system to protect the household with a higher security level and notification on real-time. The issues such as the face and voice recognition only will start to activate when someone walks in front of the door. If any robber tries to break in, the lock device notifies the owner via the internet.

1.3 Problem Statement (PS)

As commonly used, a today security system is still a simple key and padlock to lock the household door. For a household, it is important to have a multiple-layer of security because with multiple layers of security, when a thief tries to break into a household it will give the owner time to defend themselves and call the authority if

there any thief tries to break in. Nowadays, not many are exposed to a smart home security system.

Table 1.1: Summary of Problem Statement

PS	Problem Statement
PS 1	A household with a traditional lock is not enough to protect your home.
PS 2	Cannot capture robber identity and activity, when robbery happen.
PS 3	The owner does not notify when a robber enters the household

1.4 Project Question (PQ)

Project question is to differentiate the issues that occur in problem statement in table 1.1. The 1.2 table displays the project questions summary based on the problem statement 1.3.

Table 1.2: Summary of Project Questions

PS	PQ	Project Question
PS 1	PQ 1	What security system that can replace traditional security?
PS 2	PQ 2	How to develop a system to capture robber identity and activity?
PS 3	PQ 3	How to create communication, where it can notify the owner when robber tries to break in the household?

1.5 Project Objectives (PO)

Project objectives used to describe the things need to be completed. In order to accomplish the project objectives, targets are stated and need to be considered, that is from the problem statement and the project question. There are a few objectives that need be completed in this project and project objectives as shown below.

Table 1.3: Summary of Project Objectives

PS	PQ	PO	Project Objectives
PS 1	PQ 1	PO 1	To develop an IoT locking device with facial and voice recognition.
PS 2	PQ 2	PO 2	To design the lock device with a sensor and a camera.
PS 3	PQ 3	PO 3	To integrate the lock device with a microprocessor, sensor module, facial module, voice module and applications to communicate over the internet.

PO 1: To develop an IoT locking device with facial and voice recognition

Develop an IoT locking device with facial and voice recognition, is one of the alternatives that can improve the security level in a household. With this only authorised user can have access to enter the household a user without authority cannot access.

PO 2: To design the lock device with a sensor and a camera.

The sensor detects the presence or movement of any that close to it. Any will activate the camera module. The camera module act as a facial recognition module and also can capture the image of the individual that does not have the authority to enter the house

PO 3: To integrate the lock device with a microprocessor, sensor module, facial module, voice module and applications to communicate over the internet.

The IoT locking device uses Raspberry Pi as the microprocessor, an ultrasonic sensor to detect the presence, facial and voice be used as a recognition. These modules communicate over the internet use Blynk to turn on-off the device and transmit notification using Telegram.

1.6 Project Scope

The scope of this project is to develop an embedded system with the implement of face and voice recognition algorithm. This project involves a new design with low-cost material but higher security level. Plus, it was designed to eliminate the weakness of the current security system on the market. The boundary or coverage of this project was limited to household uses. The design architecture, the structure of the embedded system and the programming skill are included in this project.

1.7 Project Contribution (PC)

Project contribution is estimated result from the project and substantial contribution of this project. This project uses users facial and voice recognition as a security mechanism. For the hardware prototype, the system will use Raspberry PI as the microprocessor and store all the user data. As for the facial and recognition, the system will use a Raspberry PI camera and voice detection. Users need to use their facial and voices to unlock the door. Only facial and voice that inside the database can be granted to unlock the door. Users without access will be notified to the owner if try to access through the door. Notification sends via Telegram. Also, Raspberry can be remotely accessed over the internet. Here, can help the user to monitor anywhere in the world when absent from home.

Table 1.4: Summary of Project Contribution

PS	PQ	PO	PC	Project Contribution
PS 1	PQ 1	PO 1	PC 1	The household owner will have multiple security levels to enter the household.
PS 2	PQ 2	PO 2	PC 2	The owner can capture images of the robber and send to the authority for investigation.
PS 3	PQ 3	PO 3	PC 3	The owner receives notification in real-time via the internet when robber tries to enter the household.

1.8 Report Organisation

Chapter 1: Introduction.

Chapter 1 emphases on the introduction of a project which includes the introduction and the background of the project. It also explained the problem statement, project objective, scope of the project, the expected outcome and conclusion to make assured the project can be understood simply.

Chapter 2: Literature Review

Chapter 2 emphases on the clarification of the reading material and publish a thesis. Later, this chapter described uses and journal articles on sensor technology. Those publish thesis and articles is analysed specifically about the main tools used in this project. Such as Raspberry PI, facial and voice recognition.

Chapter 3: Project Methodology

Chapter 3 emphases on the project technique which explain each stage of the selected methodology such as System Development Life Cycle Methodology. The chapter also describes the breakthrough of this project.

Chapter 4: Analysis and Design

Chapter 4 emphases about the problem investigation, analysis requirement and the project design. For the problem analysis, most of all the problem statement that stated in chapter 1 discussed in here whereby the analysis requirement of the project focuses on two sides, which are hardware requirement and software requirement. For the design of the project, the logical design of the project and the flow of the project also attached in chapter 4.

Chapter 5: Implementation

In chapter 5 emphases on how the project is executed. This project used the Raspberry Pi, facial sensor and voice detection. The stage by stage of how to wire and configuration the Raspberry Pi with facial sensor and voice detection are identified in this chapter.

Chapter 6: Testing

Chapter 6 emphases on the project test plan, test design and test results and analysis of the project. The testing plan is done consist of the test organization, test environment and test schedule. Next, the test design is described in the testing data. The test result is analysed in order to determine in the testing phase.

Chapter 7: Conclusion

Chapter 7 emphases the summary of the project. The conclusion includes the reflection on weaknesses and strengths, suggestion for improvement which for future development, project contribution and the limitation of the project.

1.9 Conclusion

Summary of this chapter discussed facial and voice recognition, to reach the complete development of this IoT based security system. In this chapter, explained the background project, problem statement, objective, scope and project contribution. It is the foundation for the project

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This part will talk about innovative work has been completed by others. The writing analysis, for the very part, is to help to interpretations about the project. To enhance the current events related to this project. In this way, the discovery and analysis from the previous project may expand the viability for the progression of the task.

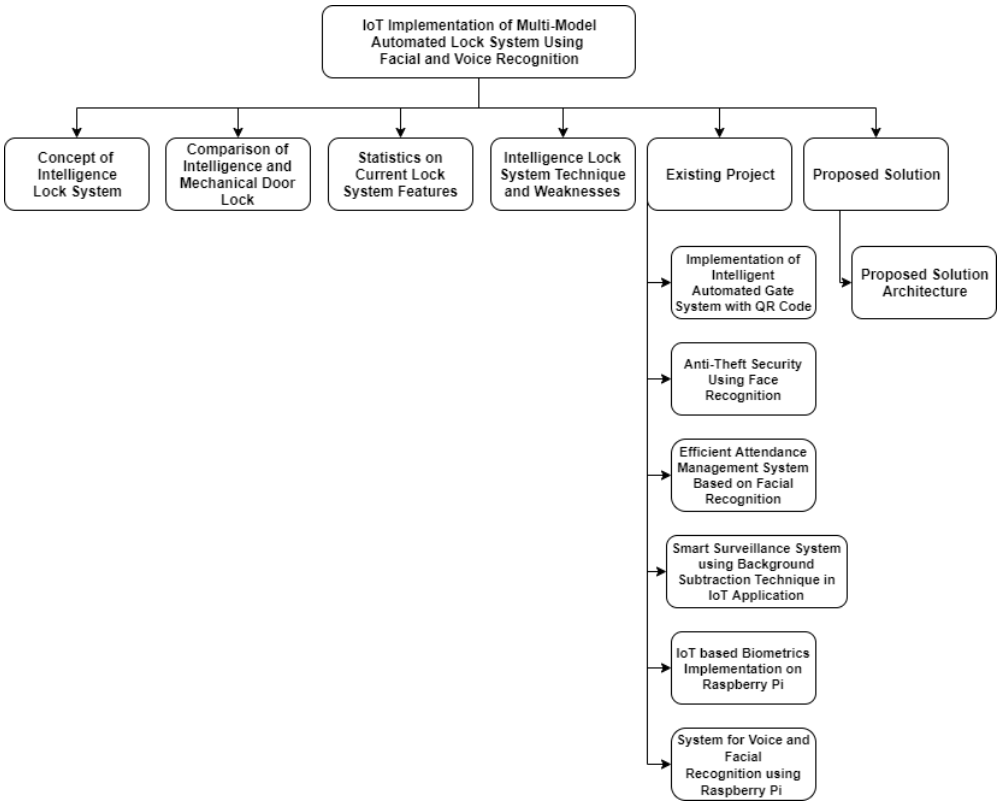

Figure 2.1: Overview of the Literature Review

2.2 Concept of Multi-Module Lock System

According to (Anaza, Jiya, & Haruna, 2017) One of the most critical aspects of a truly intelligent system is the ability to learn, that is, to improve its own functionality by interacting with the environment and exploring it. A standard intelligent lock system must have the following basic features: Provides environmental monitoring, access control and management system. Prevents unauthorized access. Allows doors to be opened using a proximity card, keypad or via a web interface. Accommodates sensors to monitor temperature, humidity, smoke, presence of water or liquids. automatically generates an audio alert. Records all the security information you need every time the door opened by who, where and when. The figure below shown basic component needed for intelligent lock system.

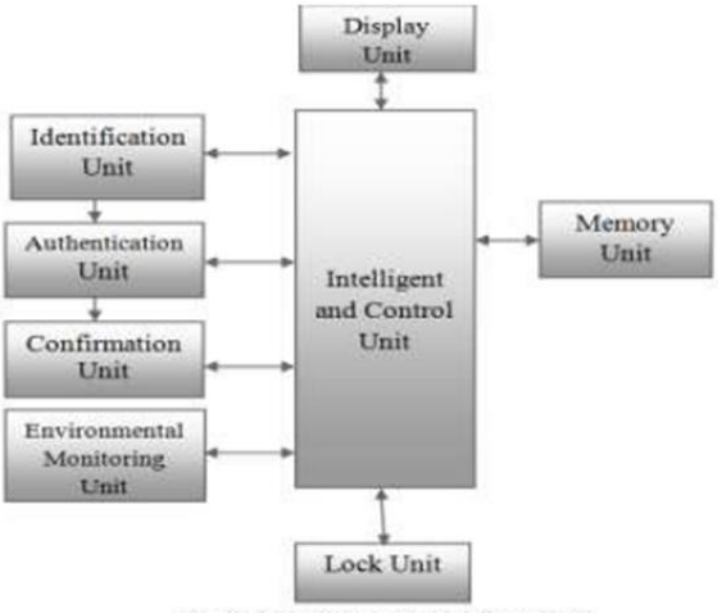

Figure 2.2: Concept of Multi-Module Lock System (Anaza et al., 2017)

2.3 Comparison of Multi-Module and Mechanical Door Lock

As had been review by (Bannister, 2016) Nowadays, as digital locks move beyond offices and into the home, what do people think about augmenting or replacing their mechanical locks with digital technologies from a security perspective. A similar majority to those who endorsed the other three access

mediums agree that smartphone access is more secure than traditional keys. Short-lived battery power a notorious disadvantage of the smartphone is not so convenient, although innovations are in the pipeline to alleviate the problem. Below shown a figure of a statistic of respondent think a digital door lock is more or less secure than a mechanical door lock.

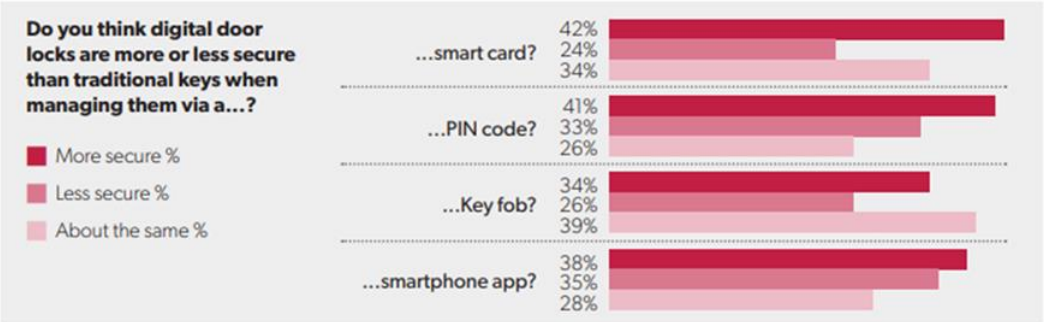

Figure 2.3: Statistics of Digital Door Lock is more or less secure than Mechanical Door Lock (Bannister, 2016)

2.4 Statistics on Current Lock System Features

According (Bannister, 2016) It is not exactly an earth-shattering revelation that security would be valued as the most important consumer concern. An emphatic 99% rated it at least ‘somewhat important’ and 90% as ‘very important’ in any purchase decision. This is, after all, a lock’s whole point. Beyond that, having the ability to override the digital lock to open a door mechanically for example, if software malfunctions or power is lost was ranked as ‘very important’ by about three-quarters of respondents. Just one in 25 thought it was not important at all.

Managing access rights at the door lock was the third-most important potential function, with only 10% of those polled saying it didn’t matter at all. Nonetheless, all consumers have experienced that nagging anxiety after leaving the house. It is understandable that this kind of functionality would provide peace of mind. Remote access also means parents can grant access to their children, if they’ve lost a smart card or run out of phone battery, from afar. In the nutshell, consumers are very demanding when it comes to what they want from an intelligence lock.

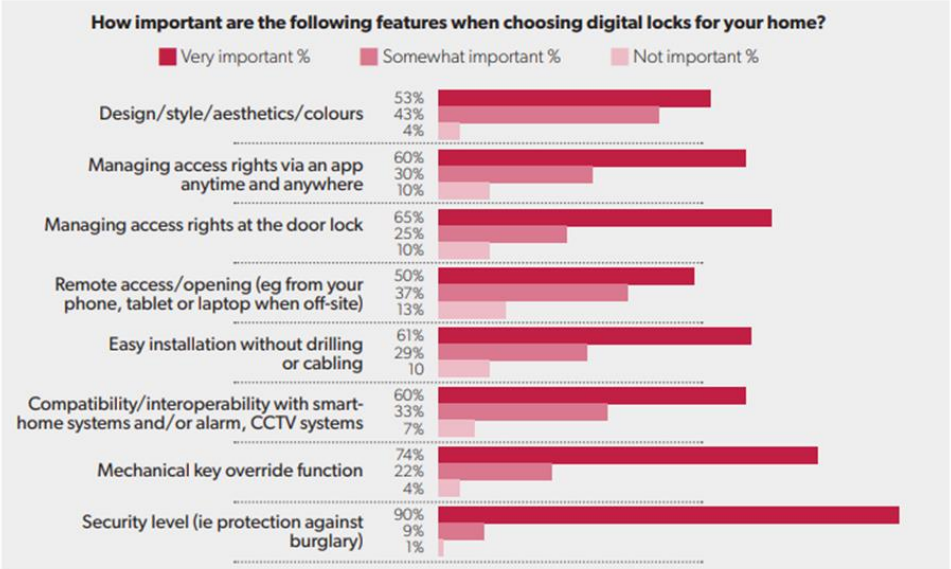

Figure 2.4: Important Features When Choosing Digital Locks For A Household (Bannister, 2016)

2.5 Multi-Module Lock System Techniques and Weaknesses

According to (R., P., R., & P., 2016) In today's technologically advanced world, autonomous systems are gaining rapid popularity so the advancement in the latest technology is continuously and rapidly made on different latest automatic door lock security systems. The need for an advanced door lock security systems using new technologies is increasing day by day as security becomes a very important or serious issue for everybody. As per the requirements, need to develop a system suitable for all types of applications. So, need is to develop a new technique for this project. Where the table 1 shows the technique uses and its weaknesses.

Table 2.1: Techniques and Weaknesses (R. et al., 2016)

Techniques	**Weaknesses**
Face Recognition	No reliability and robustness
Palmtop Recognition	Needed high-resolution scanner
Face Recognition with GSM and Email Technology	Connectivity problems when abnormal weather occur
Iris Scanner, Vein Detection	Needed large storage to store

	information
Digital Code Lock	During power failure system turn off
One Time Password	Few second timeout and multiple lockouts

2.6 Existing Project

2.6.1 Implementation of Intelligent Automated Gate System with QR Code

Basically, according to (Hamid et al., 2018) IAGS (Intelligent Automated Gate System with QR Code) is the phase of a protection system. It focuses safety challenge including ‘s consumer authorization, intrusion alarm and makes use of to protect the organisation from the unwanted access. The current implementation for structures such as IAGS is which includes biometric-based applications, RFID/passcode, car license identification and QR code. IAGS focuses on the implementation of the QR Code for the purposes of consumer authorization in order to make certain solely the right individual can enter the premises. The fundamental theoretical framework of Intelligent Automated Gate System with QR Code is illustrated as below.

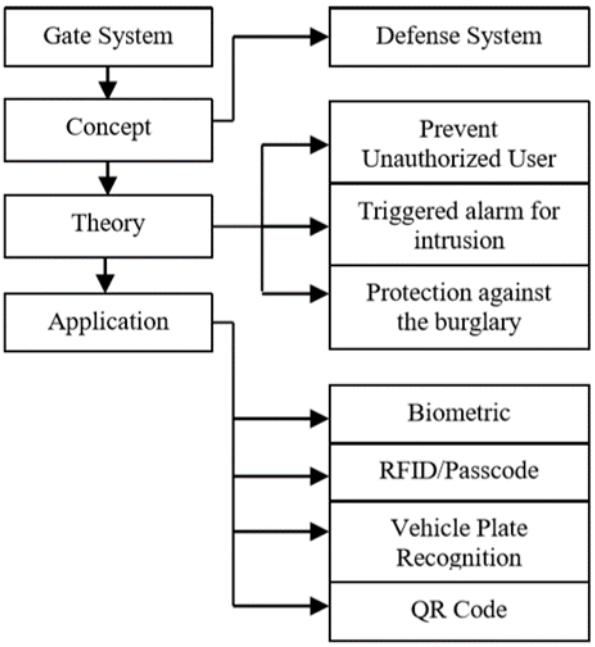

Figure 2.5: The Theoretical Framework (Hamid et al., 2018)

The figure below suggests the System Architecture of the Intelligent Automated Gate System. An interface has created with the use of VB.NET to manage the Arduino Uno Microcontroller. The Arduino Uno Microcontroller receives the command through a serial port and performs the rotation of the servo motor. If an approved scanning is detected, the servo motor will rotate ninety degrees as the gate opens, or else it will no longer rotate, and an e-mail will be despatched to the applicable branch concerning the unauthorized scanning detected. Besides that, there are two cameras that will be used as scanners to detect the QR code skip card and additionally operate as security cameras. All data of staffs will be saved into the SQL database along with the created QR code and take a look at in or out record.

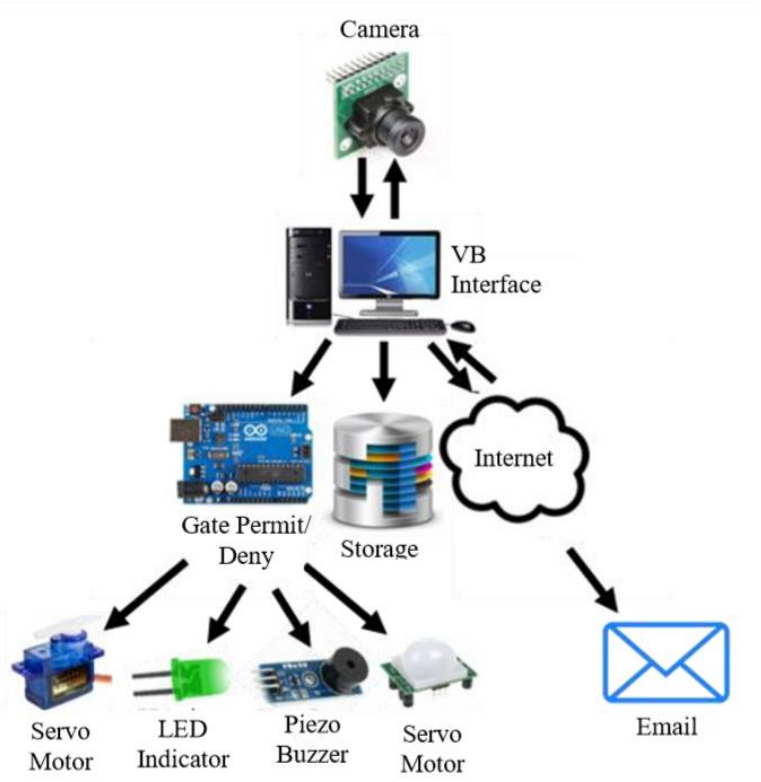

Figure 2.6: Architecture of IAGS System (Hamid et al., 2018)

2.6.2 Anti-theft Security System Using Face Recognition

Following (University Tunku Abdul Rahman, 2018) Anti-theft Security System made of software section and hardware section mix together to operate its functionality. Firstly, the software section will be used is Telegram and Blynk. Both of them are mobile applications. The system will begin surveillance characteristic and capture image send to the user to notify him using Telegram when stranger attempt to enter. User can manage the locker on and off wirelessly with the cellular application Blynk. OpenCV used in this project to code the photo processing algorithm. It is an open-source computer imaginative and prescient library compatible to run with Raspberry pi.

For the hardware section, a Raspberry pi 3 model B, Solenoid electric-powered door locker, keypad, 1602 LCD display, ultrasonic sensor module, digital camera module and mini buzzer. Raspberry pi will take accountable to procedure all the workload. When the ultrasonic two sensors realize an individual comes close to the door it will set off the camera to begin capture the individual face and compare with the database if a stranger detected it will notify house proprietor with telegram via Wi-Fi and start giving alert with the buzzer. If the individual user to be matched with the database, then he or she will want to key in the password with a keypad to unlock the solenoid locker.

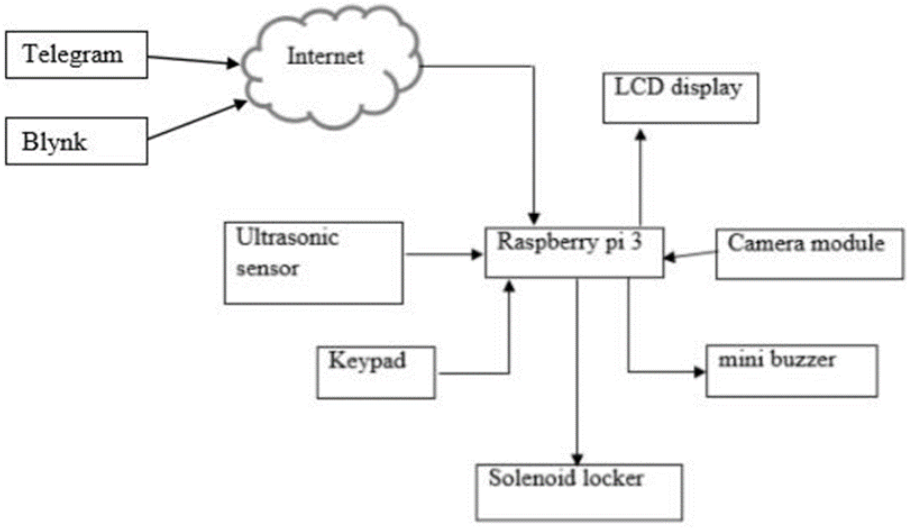

Figure 2.7: Anti-Theft Security System using Face Recognition Architecture (University Tunku Abdul Rahman, 2018)

2.6.3 Efficient Attendance Management System Based on Facial Recognition

Based on (Choudhary, Kakaji, Pranay, & Prabhu, 2018) proposed four-stage of the system architecture that is digital image acquisition, face recognition, face database generation and automated attendance upload. Initially, the code is to be set up with the facts of the students in the class and then the pictures are to be captured in accordance with the situation given in the code. These parts which are detected are mixed further and then form a single frame with the whole face detection and then, in addition, shows the identity of the person.

Images of students in the class are to be captured the use of a high definition web-camera which offer 1280x720 resolution. For a given subject up to twenty pictures are to be captured. The camera detects the three parts of the face in separate frames. After taking pictures the pictures are stored in the record. After the detection of the faces, the verification procedure is done, then the successful recognition of the faces is done. The captured photos are to save in the database. Below shows a figure of the system architecture.

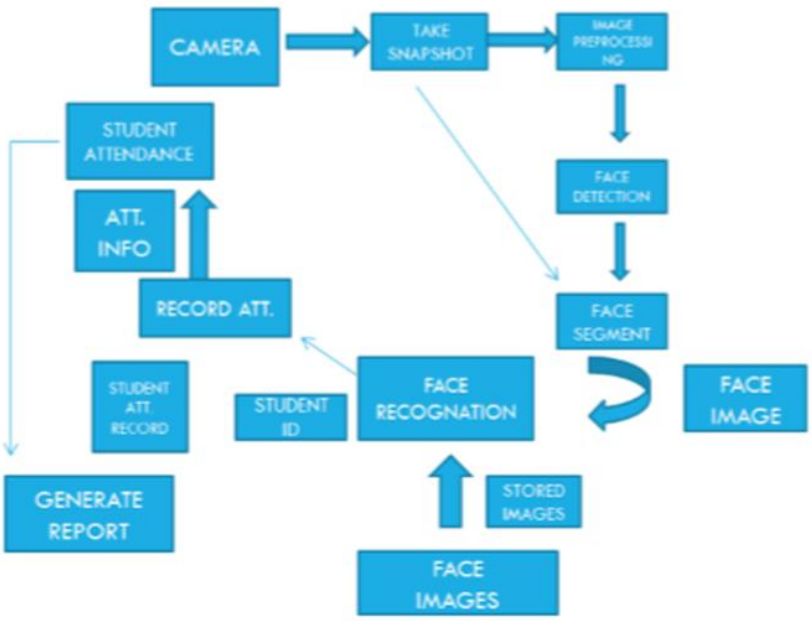

Figure 2.8: Attendance Management System based on Facial Recognition Architecture (Choudhary et al., 2018)

2.6.4 Smart Surveillance System using Background Subtraction Technique in IoT Application

According to (Harum, Faeq, Azma, & Anawar, 2018) a prototype of an IoT based security system using an energy-efficient microprocessor, known as Raspberry Pi, using the camera as a motion sensor and Telegram as an IoT application, used by a user to control the CCTV from anywhere has been developed. The developed CCTV system can detect intruders using a motion sensor, capture video of the intruders and send the video to the owner. In this paper, motion detection using image processing technique has been used where the camera in parallel performs video capturing and also motion detection.

After evaluation of detected object count, size, class and motion vector object of the properties are sent to the server node by RF transceiver. The developed CCTV can act as a silent alarm to notify the owner about the intruders. Image information acquired by Raspberry Pi HD camera module is analysed for moving objects

presence. This project however for traffic monitoring, which is not suitable for offices and home CCTV system.

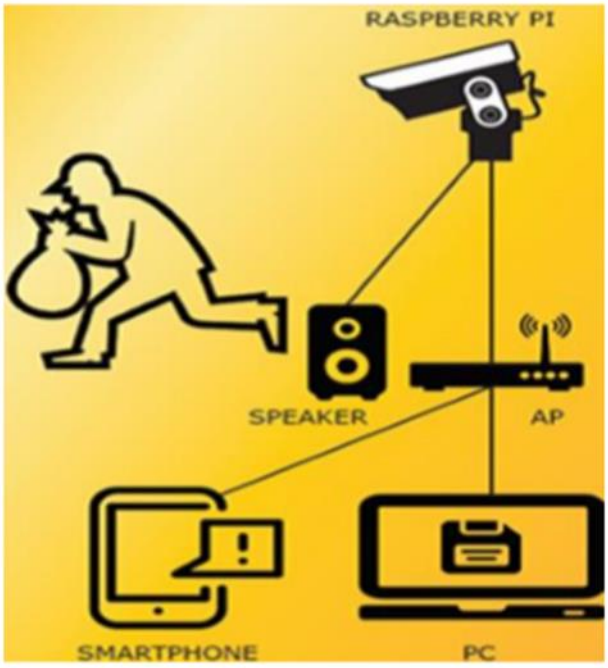

Figure 2.9: Concept Architecture of Developed Ubiquitous Security Camera (Harum et al., 2018)

2.6.5 IoT based Biometrics Implementation on Raspberry Pi

Following (Shah & Haradi, 2016) In among the biometrics of face, finger, hand, voice, eye, DNA and signature, the face biometric ranks first in the compatibility evaluation of a machine-readable travel document (MRTD) system on the basis of six criteria: enrolment, renewal, machine-assisted identity verification requirements, redundancy, public perception, and storage requirements and performance.

Peter Peer and Jernej Bule have proposed a face recognition system on the cloud, This paper tries to elaborate on the issues such as the most common challenges and obstacles encountered when moving the technology to a cloud platform, standards and recommendations pertaining to both cloud-based services as well as biometrics, and existing solutions. Griaule Biometrics introduces a biometric

information management system in the cloud, which leverages cloud storage to store biometric data on the cloud.

One of the main aims of this research is to empower biometrics as an authentication method for security purposes like authenticating for cloud services, unlocking a door, accessing a particular service. Godson D'silva has proposed an architecture for implementing an online signature recognition system on a public cloud-like Windows Azure. Griaule's biometric information management system protects biometric data using AES encryption while stored and Secure Socket Layer while in the transfer. But the first question to be addressed is: why enable biometrics for authentication? The security and usability problems of password-based authentication, which is the most commonly used authentication method for secure access, have been reviewed.

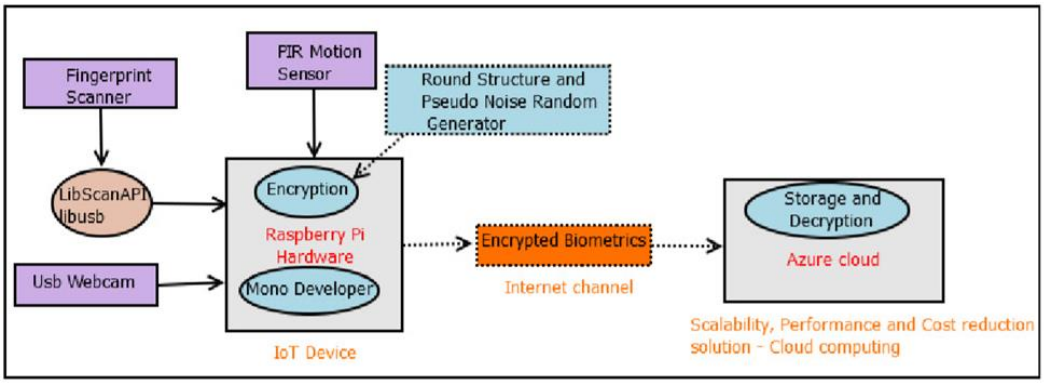

Figure 2.10: IoT Based Biometric System Architecture (Shah & Haradi, 2016)

2.6.6 System for Voice and Facial Recognition using Raspberry Pi

According to (Hajari & Andurkar, 2015) review paper, there various approaches for facial and voice recognition. First, for facial recognition that needs to be approached are Neural network, one of the first artificial neural network (ANN) techniques used for face recognition is a single layer adaptive network, which contains a separate network for each stored individual. Next, Hidden Markov Models (HMMs), The stochastic modelling of non-stationary vector time series based on HMMs has been very successful. The way in constructing the neural network

structure is crucial for successful recognition. Faces were intuitively divided into regions such as the eyes, nose, and mouth. Eigenfaces, The Eigenface is one of the most thoroughly investigated approaches to face recognition. It is also known as Karhunen-Loeve expansion, eigen picture, eigenvector, and a principal component.

For voice recognition approaches. Initially, Acoustic Phonetic Approach, in this speech recognition approach, the system tries to decode the speech signal in a sequential manner based on the observed acoustic features of the speech waveform and the known relations between acoustic features and phonetic symbols. Then, Pattern Recognition Approach, in a pattern recognition approach, the speech patterns are used directly without explicit feature determination and segmentation. Moreover, Artificial Intelligence Recognition Approach, the approach is a hybrid of the acoustic-phonetic approach and the pattern recognition approach. Finally, the decision rule decides which reference pattern best matches the unknown test pattern, based on similarity scores from the pattern classification phase.

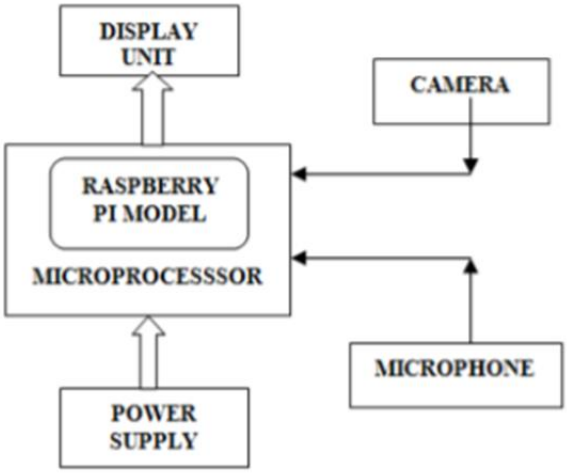

Figure 2.11: Overview of Facial and Voice Recognition using Raspberry Pi (Hajari & Andurkar, 2015)

The system is basically designed for the home security purpose where the constructional details are shown in above Figure The camera and microphone are on the input side which will provide an image of the face of a person along with his or her voice to the microprocessor as inputs. The output results will be displayed on display unit where we can recognize whether the person outside the door is a family face or not and the words spoken by that person will also be displayed on display

unit in textual form. Raspberry Pi model is having its memory card for all data and instructions storage.

Table 2.2: Journal Comparison

Author	Technology Category	Distributed Reader and Microprocessor	Microprocessor/ Microcontroller	Description
Hamid et al., 2018	QR Reader, RFID Reader, Web-Based, Network	YES	Arduino	IAGS is a framework that utilizations substantial staffs' QR code pass card to actuate the entryway. It is created to associate with the web and give a constant email warning if any unapproved exercises identified
University Tunku Abdul Rahman, 2018	Ultrasonic Sensor, Camera, Internet,	YES	Raspberry Pi	An anti-theft security system that uses facial recognition and can be monitor remotely. A user receives notification if any unwanted access at their household.
Choudhary, Kakaji, Pranay, & Prabhu, 2018	Web-Based, Network, Python	NO	Windows	A Face recognition framework is the use of PC vision which is equipped for performing two significant undertakings distinguishing and checking an individual from the given information base.
Harum, Faeq, Azma, & Anawar, 2018	OpenCV, Camera, Speaker, Network, Python	YES	Raspberry Pi,	A security framework is dependent on (IoT) innovation, where an IoT gadget, Raspberry Pi has been utilized. A camera fills in as a sensor to distinguish movement, and catch the video of where the movement is recognized
Shah & Haradi, 2016	Biometrics, Azure Cloud, Motion Sensor, camera	YES	Raspberry Pi	Biometric system that manages a wireless node and Biometric service hosted on the cloud will verify it. The captured biometric traits are relayed through the end-to-end encryption process to the Biometric (SaaS). Raspberry Pi's peripherals were validated retrieve fingerprints and face images:
Hajari & Andurkar, 2015	Camera, Microphone,	YES	Raspberry Pi	The system provides a voice-actuated security camera system. Recognition of facial and voice is used. The system aims to implement a face recognition software code and to successfully implement this code for real-time recognition on the Raspberry Pi platform.
Proposed Project- IoT Implementation of Multi-Module automated lock system	Ultrasonic Sensor, Python programming, Camera,	YES	Raspberry Pi, Ultrasonic Sensor, Pi Camera Module, Microphone Module	Intelligent automated lock system using facial and voice recognition integrated together with Raspberry Pi, ultrasonic sensor that merges with a camera module and microphone module for

2.7 Discussion

According to a past existing project, it indicates various IoT project not familiar with an ultrasonic sensor for the security-related project. The common technology used is QR code, RFID Reader and Biometric Reader. Yet, vastly use are Raspberry Pi as the microprocessor or microcontroller and integrate it with Arduino or use the Raspberry Pi board itself to intergrade with the sensor, tags or readers. Many use Raspberry Pi because it is one the cheapest microprocessor and can adapt in various situation. Nonetheless, as an intelligent automated lock system, many developers have created these security features but the price range for research and development is expensive. For this reason, this thesis is to develop a low-price home security device but with a higher security level and be monitored remotely from anywhere. As an addition, to inform the developer that there is other idea or solution on how home security can de develop and implemented.

2.8 Proposed Solution

Regarding the previous discussion, a project has been proposed that is to develop a low-price home security device because the current smart home security is much more expensive, and the traditional lock is not enough to keep your home safe and secure. For this project, where the security recognition use facial and voice has been proposed to solve the issue. From past development, many use Raspberry Pi as a microprocessor that acts as to configure and installation for the system because it is a small build with low-price range and adapt ant situation for this development. As a solution, Python programming will be used for system configuration and Raspberry Pi acts as a database to store all user information. Ultrasonic sensor, camera and microphone module will be integrated with raspberry pi using a breadboard. The sensor detects if there any user that comes close to trigger the facial and voice recognition module. Initially, for this security devices to work. User needs to store the facial image and voice recording in Raspberry Pi. Telegram will be used to transmit a message to the user if there any unwanted access at their home. This device can be remotely monitored using VNC viewer for personal computer and

applications such as Blynk to monitor using a mobile phone. A prototype will be developed to demonstrate the working communication of the project.

2.8.1 Proposed Solution Architecture

As already proposed as a solution, the figure below shown proposed solution architecture. Where it shows the flow of the lock system such as what module involves in the project. Also, how to use the lock system as the details already explained above.

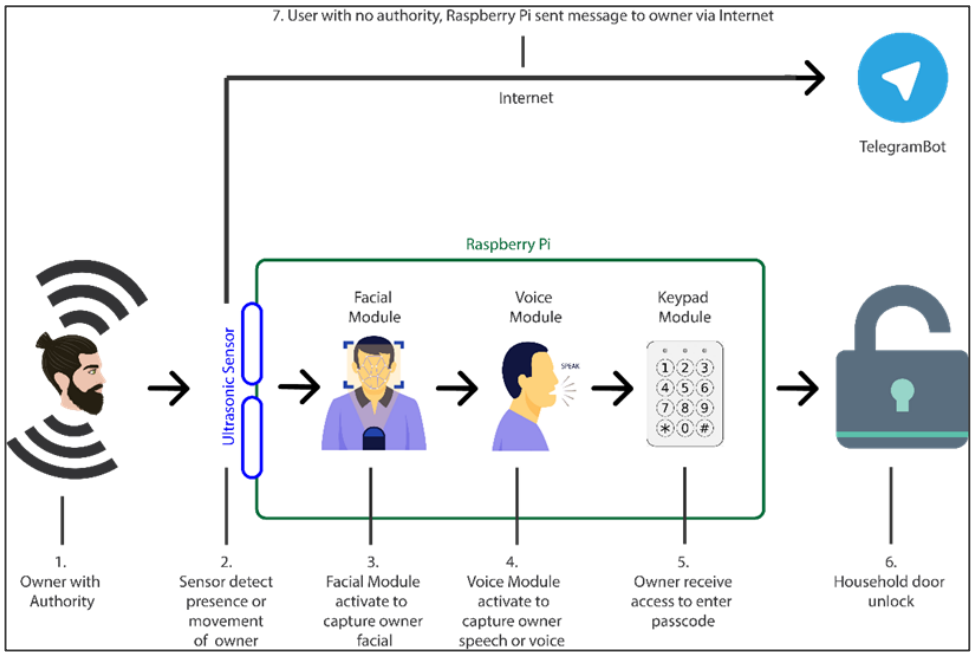

Figure 2.12: Proposed Solution Architecture

2.9 Conclusion

As a conclusion, this chapter, in brief, enlighten on technology in IoT and previous project that use the same tools to develop this security device. To achieve the objective of this project, Raspberry Pi, ultrasonic sensor, camera and microphone module are needed. There a few challenges are found during the review the journal of a past project, mostly on how to integrate sensor with camera and microphone for facial and voice recognition

CHAPTER 3: METHODOLOGY

3.1 Introduction

In this chapter will mention the methodology used in the project. Discussed will be divided by using two primary components which consist the venture methodology and task milestones. The assignment methodology is a model, which engage the design, planning implementation and procurement of the project. The milestones aspect consists of a timetable period with the necessary procurement of the project. All activities in the project are recorded in the milestones and a Gantt chart is developed to exposition the planning of the task within an allotted time.

3.2 Project Development

Before proceeding to the improvement process, the initial approach is to gather the information from assets journal, article, e-book and internet. In this evaluation, the aim is to enhance home safety carrier by using Implementation of Intelligent computerized lock system the use of facial and voice recognition which use IoT platform such as Raspberry Pi. The information series will be analyses the inapplicable way to make objective can be performed successfully. two

The task will carry in for one semester, for the half the closing year task of this semester, it is the part of an initial segment for the researcher will make some research to get from the sources to recognize notion for the project. The purpose is to prepare the thesis that included all the facts needed and can be beneficial for the development of the real project.

The hardware and system are run in the demonstration section and being placed and set up to feature in accordance to the objective and it will be performing statement on the diagram equipment and efficacy task that will be used.

3.3 Project Methodology

The strategy selected in this project is the System development life cycle (SDLC) describe the levels of the improvement project. The life cycle defines a methodology for enhancing the exceptional of the standard development process. By the use of SDLC model, the project can be implemented successfully and smoothly. Various SDLC model has been developed to assist the methods of creating a system, for example, waterfall model, spiral model, prototyping model and so on. In this project, the Prototyping model is used.

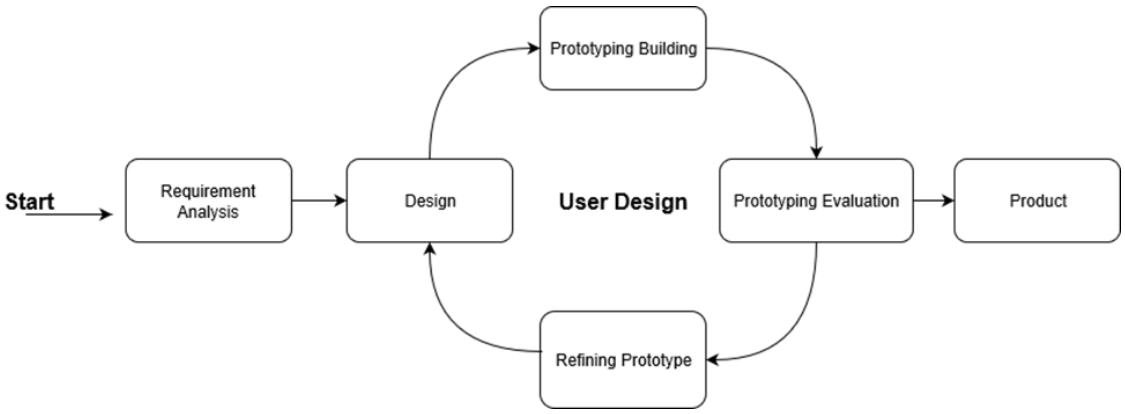

Figure 3.1: Prototyping Model

3.3.1 Phase I: Requirement Analysis

In this segment of the prototype model, the primary requirement identification carried out with the aid of the product analysis. It entails to understanding the consumer functional requirement with the aid of requirement analysis. After totally grasp the consumer demand prepared product requirement equipment documents. But in the extra problematic small print of the internal design and exterior components like performance can be overlooked at this stage.

3.3.1.1 Software and Application Requirement

The software used in this project are:

Table 3.1: Software Requirement

Software and Application	Description
Raspbian OS	An operating system that permits a user to communicate, program and upload information into Raspberry PI board
Python IDE	A programming editor to develop a python program.
Blynk	Blynk is a mobile application which allows the user to use it to monitor and control their self-develop IoT product. It can control Raspberry Pi over the internet
Telegram	Telegram is an online instant messaging application which can use a computer and mobile phone

3.3.1.2 Hardware Requirement

The hardware used in this project are:

Table 3.2: Hardware Requirement

Hardware	Description
Raspberry pi 4	Act as the prototype microprocessor
Raspberry pi camera module	Capture image
Microphone USB	Capture voice
I2c lcd1602 display	Display password input
Buzzer	Indicate status
Solenoid locker	Lock and unlock the door
Hc-sr04 ultrasonic sensor	Detect the presence of people in the front door
LED light bulb	Indicate status
4x4 matrix keypad	Password input

5V relay module	Control Solenoid current
Resistor	Protect the component with lower down voltage
Breadboard	A construction base for developing a circuit
18650 battery	Provide sufficient current to control solenoid

3.3.2 Phase II: User Design

3.3.2.1 Design

The project needs the use of the software phase and hardware phase to combine collectively to operate its functionality.

Firstly, the software phase will be used is Telegram and Blynk. Both are mobile applications. The system will start the surveillance function and capture image send to the user to notify him or her with Telegram when stranger attempt to enter. User can control the locker on and off wirelessly with the mobile application Blynk. OpenCV will be used in this project to code the photo processing algorithm. It is an open-source computer vision library well suited to run in Raspberry pi.

For the hardware phase, a Raspberry pi, Solenoid electric-powered door locker, keypad, 1602 LCD display, ultrasonic sensor module, camera module and mini buzzer. Raspberry pi will take accountable to manner all the workload. When the ultrasonic sensor discovers the individual comes close to the door it will set off the camera to start to seize the individual face and compare with the database if a stranger detected it will notify the user with telegram by using Wi-Fi and begin giving alert with the buzzer. If the individual was matched with the database, then the individual has access to the key in the password with a keypad to liberate the solenoid locker.

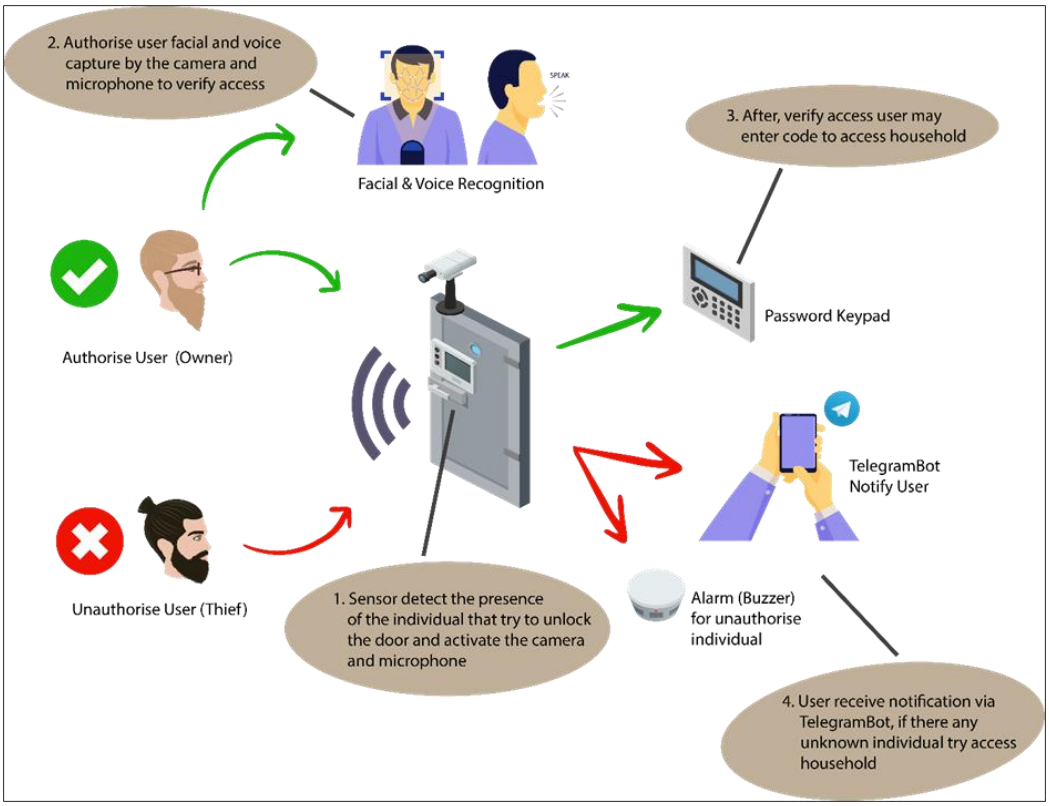

Figure 3.2: User Design

(a) Facial Algorithm Design

For this project facial recognition using OpenCV. According to (Balogh, Magdin, & Molnár, 2019) OpenCV has a range of modules through which it is possible to solve several troubles in computer vision. The most beneficial part of OpenCV might also well be its structure and reminiscence management. It provides a framework inside which it is viable to work with photos and videos in any range of ways. The algorithms to apprehend faces are available in OpenCV library and are the following:

- FaceRecognizer.Eigenfaces: Eigenfaces, additionally described as PCA, first used through Turk and Pentland in 1991

- FaceRecognizer.Fisherfaces: Fisherfaces, additionally described as LDA, invented with the aid of Belhumeur, Hespanha and Kriegman in 1997

- FaceRecognizer.LBPH: Local Binary Pattern Histograms, invented with the aid of Ahonen, Hadid and Pietikäinen in 2004

For this project, the Eigenfaces algorithm will be used, according to (Gunawan, Hasan Gani, Abdul Rahman, & Kartiwi, 2017) The face detection algorithm will observe and segment the face from the standard image. Then, it does the fundamental aligning and in addition cropping and conversion from shade to grayscale. The eigenfaces feature vector will be extracted from this process. After that, the classification algorithm will use principal component analysis (PCA) to evaluate the input characteristic vector with the database, in which it will figure out whether the enter face image is compared with the registered face image. The input facial image captures p x q dimensional vector space. For example, an image with 128 x 128 pixels has 16384-dimensional picture space. The PCA selects a set of perchance correlated characteristic vectors into a smaller set of uncorrelated variables. In different words, the PCA algorithm tries to reduce the dimensionality of the characteristic vectors whilst retaining its unique characteristics. Algorithm use formula below:

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i$$

$$S = \frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)(x_i - \mu)^T$$

$$Sv_i = \lambda_i v_i, i = 1,2,\cdots,N$$

Figure 3.3: Eigenfaces Algorithm Formula 1 (Gunawan et al., 2017)

After that, we order the eigenvectors descending by means of their eigenvalue. The k fundamental aspects are the eigenvectors corresponding to the k biggest eigenvalues. The primary factors of the observed vector x are given:

$$y = W^T(x - \mu)$$

Figure 3.4: Eigenfaces Algorithm Formula 2 (Gunawan et al., 2017)

The reconstruction from the PCA base is then analyzed as:

$$x = Wy + \mu$$

Figure 3.5: Eigenfaces Algorithm Formula 3 (Gunawan et al., 2017)

The Eigenfaces technique then performs face recognition via projecting all training samples into the PCA subspace, projecting the query picture into the PCA subspace, and discovering the nearest neighbour between the projected training pictures and the projected query picture.

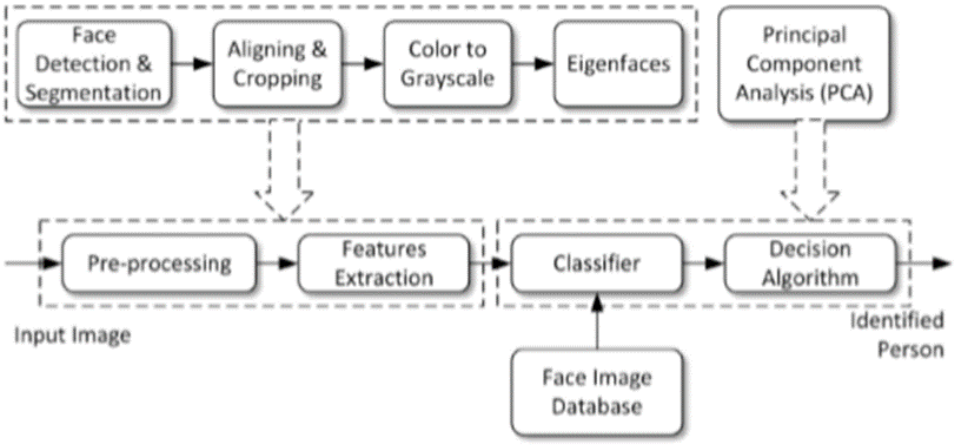

Figure 3.6: Flow for Facial Recognition Algorithm (Gunawan et al., 2017)

(b) Voice Algorithm Design

For voice recognition will be use python speech recognition (SpeechPy). Where it use Automatic Speech Recognition (ASR). According to,(Torfi, 2018) ASR requires three main factors in the analysis that is Preprocessing, feature extraction, and post-processing. Feature extraction, in an abstract meaning, is extracting

descriptive elements from a raw sign for speech classification purposes. Due to the high dimensionality, the raw signal can be much less informative compared to extracted higher stage features. Feature extraction comes to our rescue for turning the high dimensional sign to a decrease dimensional and but an extra informative model of that for sound awareness and classification. Feature extraction should be accomplished considering the unique software at hand. For example, in ASR applications, the linguistic characteristics of the uncooked sign are of high-quality significance and the other characteristics should be disregarded (D. Yu and Deng 2016; Rabiner and Juang 1993). Therefore, the feature extraction intention is to extract the relevant function from the raw signal and map it to a lower-dimensional feature space. The speech points can be categorised into two usual kinds of acoustic and linguistic features. The former one is broadly speaking associated with non-verbal sounds and the latter one is related to the ASR system.

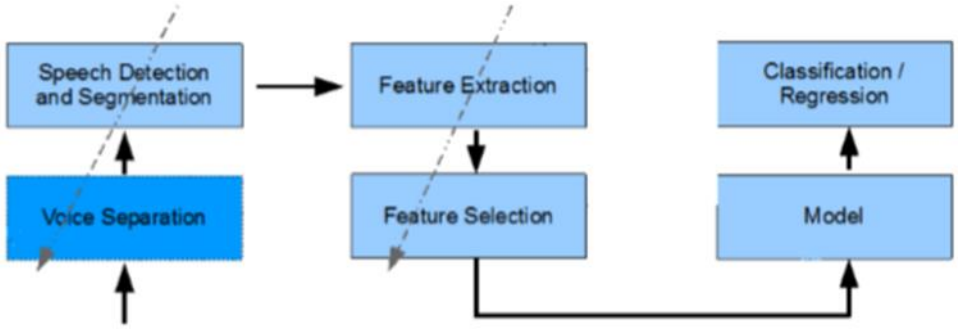

Figure 3.7: Speech Recognition Scheme (Torfi, 2018)

As SpeechPy has been chosen because it consists of the most important preprocessing and post-processing operations and a determination of frequently used speech features. The package is free and released as open-source software. Continuous integration the use of for instant error test and validity of adjustments has been deployed for SpeechPy.

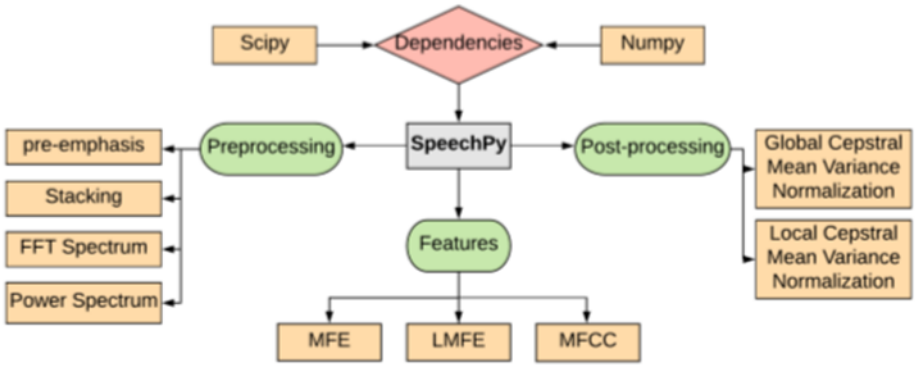

Figure 3.8: SpeechPy general view of the package (Torfi, 2018)

3.3.2.2 Prototyping Building

The most important in prototyping building is to the targeted layout of the proposed product. The sketch of the proposed product is at the beginning described in the user diagram and should be entire in this building. Based on this project, the building is divided into four-phase which is firstly to set up all the software and hardware, gather user facial and voice data, and programmed the Raspberry pi board to verify the communication between software and hardware, user facial and voice data, and programmed, which follow the design to ensure it works. Next, to determine the sensor working and can detect the user presence. Also, the camera and microphone can recognize user facial and voice. Lastly, User will be notified if there any unwanted entry through the door lock

3.3.2.3 Prototyping Evaluation

For prototyping evaluation or testing, integration testing is used for functional testing. This where individual device modules are combined and examined as a group. Integration testing is carried out to evaluate the compliance of the device components. Next, as for non-functional testing use compatibility testing where it is a type of Software testing to test whether or not your software is successful of running on specific hardware, operating systems, applications, network environments and mobile devices

For this project, the integration testing of lock system tested with two individuals where (A) have already store his or her data in the lock system and (B) the other individual does not have any data in the lock system. To ensure whether the sensor detects the individual (A) and (B) presence or not. Next, to ensure the camera and microphone capture individual (A) facial and voice, verify it and give access to unlock the door. To ensure telegram notified the user if the individual (B) try access lock system.

Furthermore, for compatibility testing is to test all hardware, operating system, application and network works smoothly and follow the project flows.

3.3.2.4 Refining Prototyping

For refining prototyping, if there any unwanted error or improvement needed in prototyping evaluation, this phase will do refining toward the prototype and go back to the design phase, building phase and evaluation.

3.3.3 Phase III: Product Development

For product development phase, the device will have a structure where it is easy to be placed as a door lock easy for the user to use it and low-cost to be made. The structure will be distinct and store all the hardware for the lock system.

3.4 Project Flow

To make sure the project development running smoothly and complete in the scheduled period, the project is divided into three phases which started with requirement analysis where software or application and hardware requirement occur. For user design, there are four phases occurs that is design, prototyping building, evaluation and refining. Lastly, product development. The project flow is shown below.

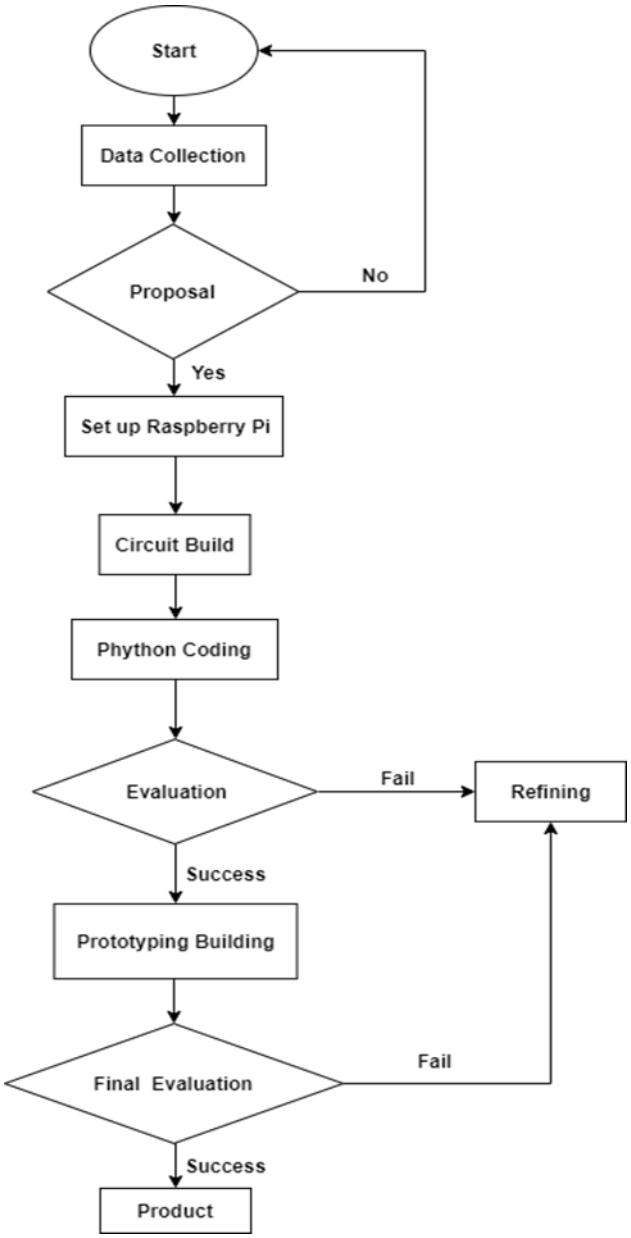

Figure 3.9: Project Flow Chart

3.5 Project Milestone

Table 3.3: FYP 1 Gantt Chart

No.	Activity / Task	Weeks															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Proosal Submission																
2	Chapter 1 (Deliverable)																
3	Chapter 2 (Deliverable)																
4	Chapter 3 (Deliverable)																
5	Chapter 4 (Deliverable)																
6	System Development																
7	Full Report & Product Demo																
8	PSM 1 Presentation																

Table 3.4: FYP 2 Gantt Chart

No.	Activity / Task	Weeks															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Chapter 5 (Deliverable)																
2	Chapter 6 (Deliverable)																
3	Chapter 7 (Deliverable)																
4	PSM 2 Presentation																
5	Final Thesis Report (Deliverable)																

CHAPTER 4: DESIGN

4.1 Introduction

In this chapter analysis and layout define an element requirement and design about the Intelligent automated lock system. This chapter will focally point on the plan of this project. All the requirement consisting of hardware and software used on this project will be defined to ensure the performance of the undertaking and the system structure which consist of the circuit diagram, flowchart, and flow diagram of the system due to the fact it is a vital method that needs to be subject while commencing the project.

4.2 Problem Analysis

Nowadays, home security with only door locker is not enough to protect your home and family. However, the smart home security system is still not popular on the market for household uses because of the higher price than a traditional lock. Moreover, the smart home security system nowadays still can be improved by adding a higher security level and build using low-cost material to fulfil the need of users. Regarding this issue, an intelligent automated lock system using facial and voice recognition project have been started to solve this issue. It can help solve the issues by trigger an alarm and capture an image of theft and send to the owner when a stranger is detected. The theft will get alert, so he got no time to start breaking the door and destroy the security system.

4.2.1 Current situation at household

Figure 4.1: Current situation at Household

4.3 Requirement Analysis

For requirement, analysis is a vital phase due to the fact it is a system to decide the need for the project. In the subtopic it will be mentioned about the data requirement, functional requirement, non-functional requirement and other requirement consist of software requirement and hardware requirement of the project.

4.3.1 Data Requirement

For this project, the program input is from python programming tools that already pre-installed inside the raspberry pi. Next, in order for facial and voice recognition to work. Firstly, need to gather users facial and voice data where it can

be stored in the OpenCV library. Whereas after that the user presence detected by the sensor, the camera and microphone activated to capture the user facial and voice and matched it with data collection to see whether the user have the authority or not, if a user has the authority he/she can enter the passcode and enter the household. For user who does not have authority, a telegram bot had been created where it can notify and control via the internet.

4.3.2 Functional Requirement

For the functional requirement of this project, is divided into four parts. Initially, a sensor needed to detect the presence of an individual to the active camera and microphone module. Next, the modules capture the individual facial and voice and analysis it with data collection of authorizing user's data. After that, the user verifies to enter the passcode. Lastly, for unauthorize individual the lock system transmits a message and a captured image of the individual to the owner via telegram and remote turn it on and off via the internet.

4.3.3 Non- Functional Requirement

Information records need to be reliable. Appropriate error output to show the user unable to process request such an unauthorized user try to access the alarm start. Duration the device will load the message and notify the owner. unless if there an error takes place on the network. Furthermore, data storage of users must be stored safely and securely. Lastly, authentication of who has access to configure or maintain the lock system.

4.3.4 Other Requirement

The other requirement is about the software program chosen requirement and hardware chosen requirement. The software program requirement and hardware requirement discussed all the software program and hardware used in this project to develop the device.

4.3.4.1 Software Requirement

(a) Raspbian OS

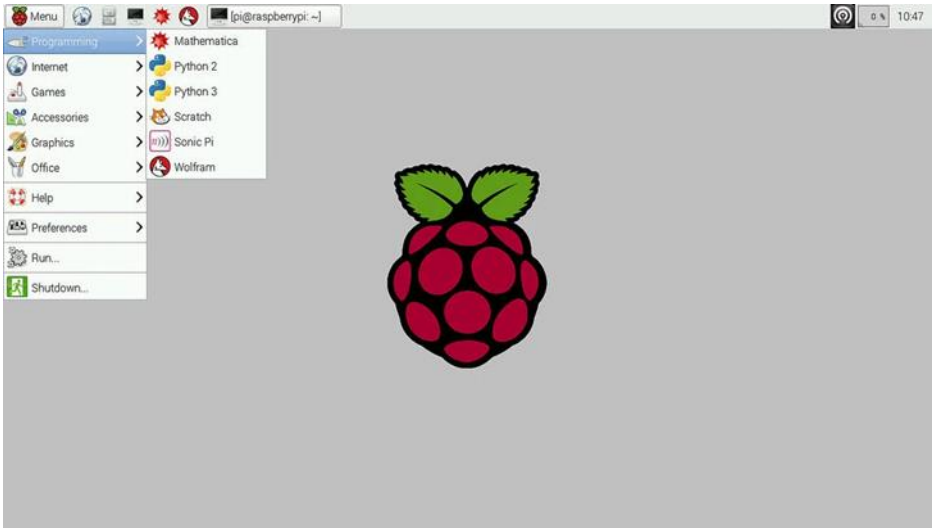

Figure 4.2: Raspbian Operating System

Raspbian is the free and foundation's legitimate supported running device based on Debian optimized for the raspberry pi hardware. Raspbian grant extra than pure OS if compare to the other running system. It comes with over 35000 packages, precompiled software program bundled in an excellent structure for easy set up on raspberry pi. Software like python IDE, Scratch and more are covered in this.

(b) Python IDE

Figure 4.3: Python Programming

Python IDE is a free and open-source programming software program. Additionally, an IDE stands for built-in development surroundings for Python. In Raspbian OS, python IDE is a constructed-in software and established with python2 and pyhton3. In this undertaking python IDE will be used to code most of the program which includes the face and voice recognition. face and voice detection use of OpenCV library.

(c) OpenCV

Figure 4.4: OpenCV

An open CV (Open-source Computer Vision, opencv.org) has a range of modules through which it is possible to solve a number of troubles in computer vision. The most beneficial part of OpenCV might also well be its structure and reminiscence management. It provides a framework inside which it is viable to work with photos and videos in any range of ways.

(d) Telegram

Figure 4.5: Telegram

Telegram is an online instant messaging application which can use at laptop and cell phone. However, for this task, I would like to use its greater feature which is creating a bot. Telegram permit third party developer to construct their own bot. With the bot, it can provide reply hence to one-of-a-kind command programmed via the developer. In this project, it will use to send.

(e) Blynk

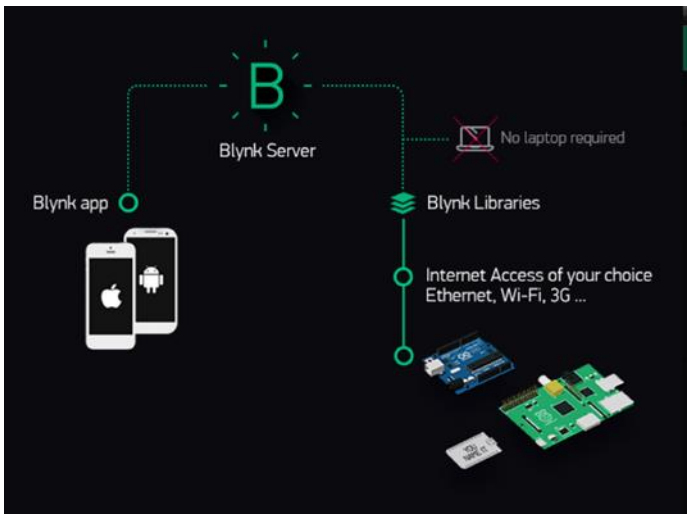

Figure 4.6: Blynk

Blynk is a mobile application which enables the consumer to use it to screen and control their self-develop IoT product. It can manage Raspberry Pi over the internet. Graphical consumer interface can be without problems construct with simply certainly drag and drop widgets and with some easy programming on your device. In this project, Blynk will use to sketch an on-off button to remote access manage the lock.

4.3.4.2 Hardware Requirement

(a) Raspberry Pi 4 Model B

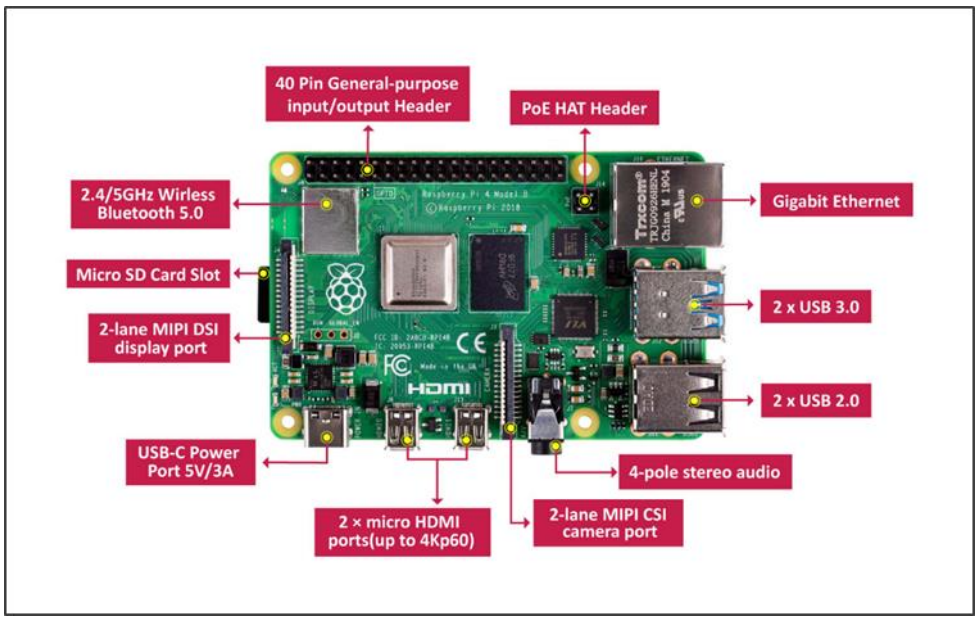

Figure 4.7: Raspberry Pi 4 Model B

The Raspberry Pi 4 Model B was designed with open source Linux-based and non-Linux based totally running system. This improvement board is the fourth generation of small single-board computer systems developed through the Raspberry Pi Foundation. The fourth era has been chosen for this mission is because the older generation of Raspberry pi needs to set up a Wi-Fi adapter for internet connection. Raspberry pi 4 model B already have constructed-in Wi-Fi chipset, more RAM and faster processor compare to the older generation. Above is the specification details of the Raspberry pi 4 model B.

(b) Raspberry Pi Camera Module

Figure 4.8: Raspberry Pi Camera Module

Raspberry pi digital camera module V1.3 has been chosen for this task is because it is less expensive examine with a newer version of pi camera module and additionally it is more effectivity and use lesser energy examine with a USB webcam. The decision of this pi camera is accurate ample to fulfil the requirement of this venture so more modern model with greater price tag is now not necessary. Pi digicam modules can be related at once to Raspberry pi's GPU so it can encode video at 1080p 30 frames per second. There is also use lesser CPU sources due to the fact it attached to GPU. In contrast, USB webcam requires more energy input and devour greater CPU resources. The specification details of Raspberry pi camera module V1.3 as below.

Table 4.1: Raspberry Pi Camera Module Specification

Specification	**Raspberry Pi Camera Module**
Still resolution	5 Megapixels
Video modes	1080p30, 720p60, 640 × 480p60/90
Sensor	OmniVision
Photo resolution	2592 × 1944 pixels
Pixel size	1.4 µm × 1.4 µm
Fixed focus	1 m to infinity

(c) Microphone Module

Figure 4.9: Raspberry Pi Microphone Module

Raspberry pi microphone module has been chosen for this project development. This module connected to one of the raspberry pi ports. This module functional is when consumer transmits voice to it. To unlock the door using voice.

(d) I2C LCD1602 Display

Figure 4.10: LCD Display

The LCD 16x2 show is used to display data for consumer and provide a user with an interface to enter the entry passcode. The chosen display comes with an I2C LCD controller it makes the connection easier because it requires lesser raspberry pi GPIO pins for it to work. It whole has four input pins which are VCC, GND, SDA, and SCL. The records for show only used 2 pins and it will connect to raspberry pi GPIO pins and another pin VCC will connect to 5V power source, GND will join to ground pin.

Table 4.2: LCD Display Pin Connection

LCD Input Pin	Raspberry Pi GPIO Pinout (Pin Number)
VCC	5V (04)
GND	GPIO 17 (11)
SDA	GPIO 2 (03)
SCL	GPIO 3 (05)

(e) Buzzer

Figure 4.11: Mini Buzzer

The buzzer is used to notify person for every single press on the keypad it will produce a “beep” sound. It also indicates the fame of lock and release of the door. After unlocking the door or lock the door it will notify the user. When a consumer fails on third strive correct password input it will produce a lengthy “beep” sound to alert the user.

(f) Solenoid Locker

Figure 4.12: Solenoid Locker

This solenoid locker requires a large current to power it up. It requires a minimum of 400mA and 7.5V. A 9V battery solely has 200mA so it is now not enough to set off it. For supply enough electricity and reduce the standard of changing the battery. For ideal ride two pcs of 18650 rechargeable battery had been used to power this solenoid. The solenoid locker is used to push and pull the locker to release and lock the door.

(g) HC-SR04 Ultrasonic Sensor

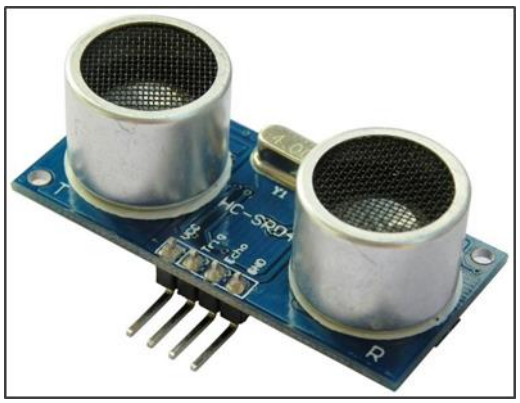

Figure 4.13: Ultrasonic Sensor

HC-SR04 Ultrasonic sensor has been chosen for this project is due to the fact it is less costly and can fulfil the need for the project. It is used to become aware of

the current person. It is the primary aspect to make this project power-saving and consume lesser power. The system will solely be activated when detected individual at a certain distance. Sensor specification as below.

Table 4.3: Ultrasonic Sensor Specification

Specification	**Ultrasonic Sensor**
Working Voltage	DC 5 V
Working Current	15 mA.
Max Range	4 meter
Min Range	2 centimeter
Measuring Angle	15 Degree
Trigger Input Signal	10 TTL Pulse
Echo Output Signal	Input TTLE lever signal and the range in proportion
Working Frequency	40 Hz
Dimension	45*20*15 milimeter

Table 4.4: Ultrasonic Sensor Pin Connection to Raspberry Pi GPIO

Ultrasonic Sensor Input Pin	**Raspberry Pi GPIO pinout (Pin Number)**
VCC	5V (+)
TRIG	GPIO 8 (24)
ECHO	GPIO 7 (26)
GND	5V(-)

4.4 The Main Design

The main design of the device for the task consists of the project architecture, OSI layer architecture representation, circuit design, and flow chart that give an explanation for the procedure of the project.

4.4.1 System Architecture

In this project, the system architecture is a conceptual diagram which provides an explanation for the structure of the project, behaviour, and to exhibit the notion of the system. It helps the consumer to acknowledge the glide of the system and how the device works. In the architecture below showing the flow of the lock system. Firstly, a Raspberry pi, Solenoid electric-powered door locker, keypad, 1602 LCD display, ultrasonic sensor module, camera module and mini buzzer. Raspberry pi will take accountable to manner all the workload. When the ultrasonic sensor discovers the individual comes close to the door it will set off the camera to start to seize the individual face and compare with the database if a stranger detected it will notify the user with telegram by using Wi-Fi and begin giving alert with the buzzer. If the individual was matched with the database, then the individual has access to the key in the password with a keypad to liberate the solenoid locker. Next, the system will start the surveillance function and capture image send to the user to notify him or her with Telegram when stranger attempt to enter.

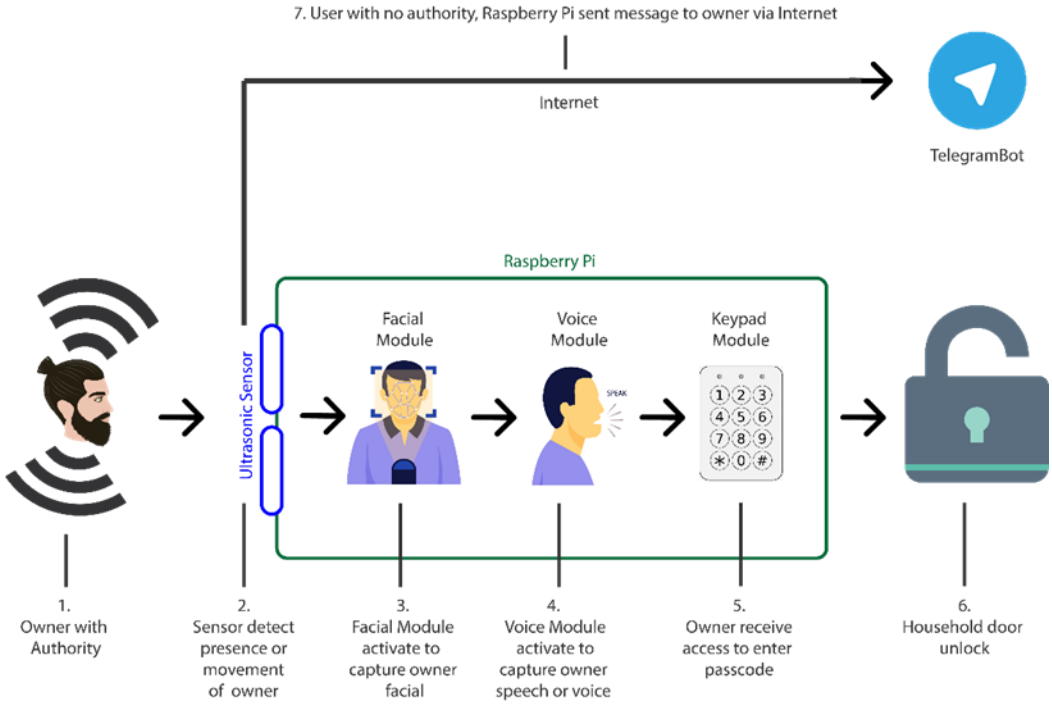

Figure 4.14: System Architecture

4.4.2 OSI Layer Architecture Representation

OSI model is a network communication layer. It suggests the motion of conversation between two endpoints, that is the lock device and user mobile smartphone. For this project network, it can be divided by way of 7 layers. Figures under show the OSI layer architecture representation for automated lock system using facial and voice recognition.

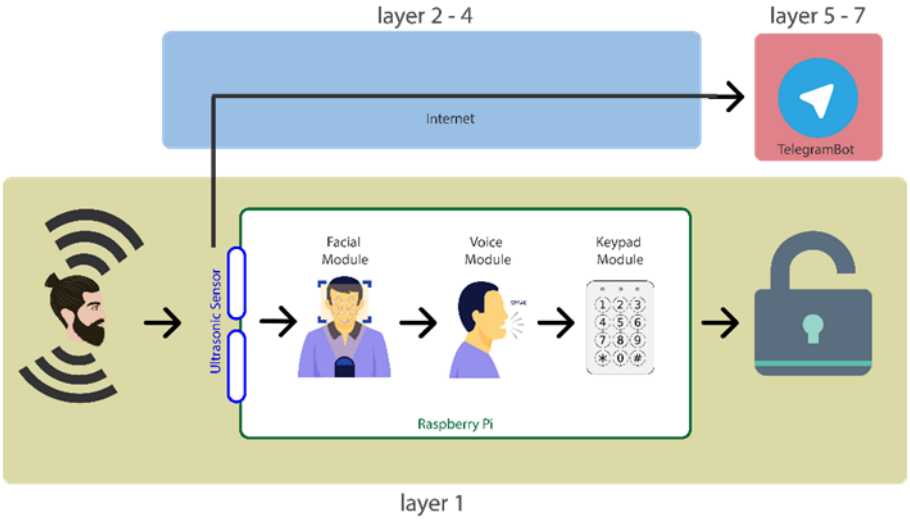

Figure 4.15: OSI Layer Representation

4.4.3 System Circuit design

For this project development, circuit design has been designed. It uses to integrate all modules in this project. To make sure all modules can run smoothly and work properly as design. A breadboard is used to connect all the hardware such as matrix keypad, LCD display, buzzer, 5V relay, battery and solenoid. Next, T-Cobbler pi GPIO Extension is used to connect Raspberry pi with the breadboard. Hardware that connects with Raspberry pi is the pi camera and USB microphone. All jumper connects to pi GPIO so it can be managed through the Raspberry pi.

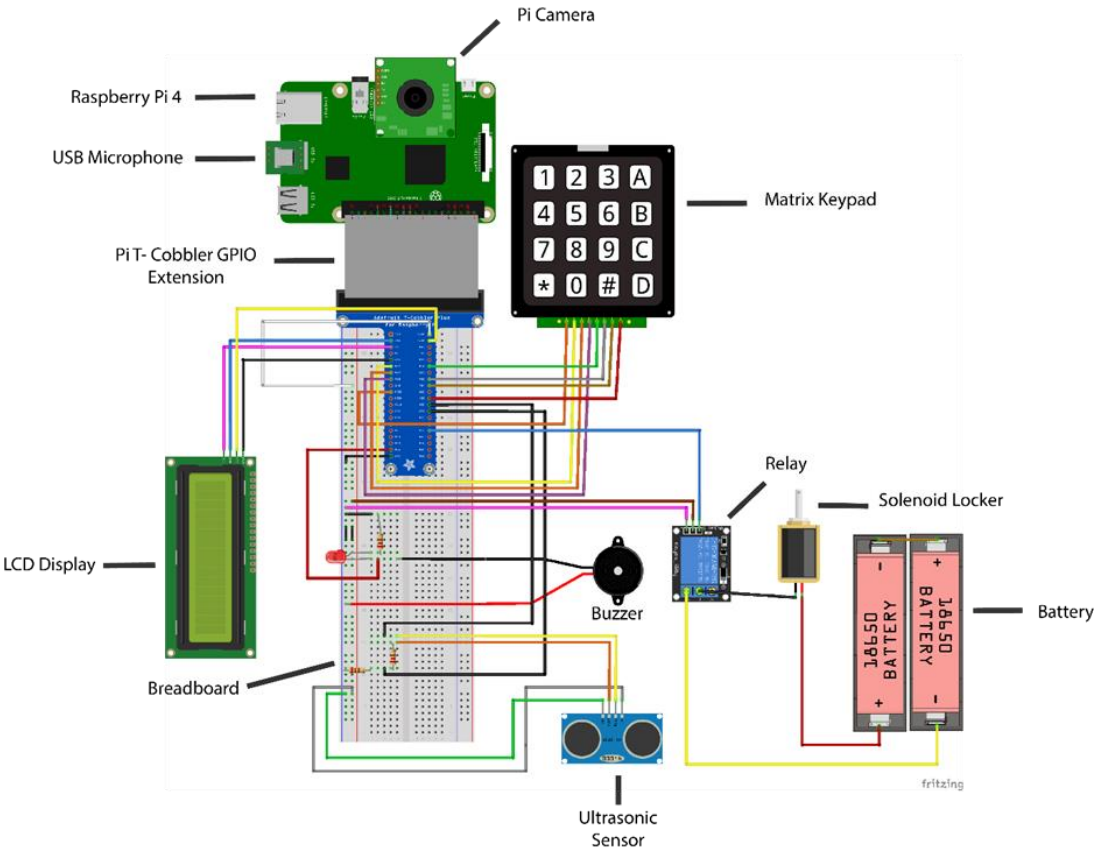

Figure 4.16: System Circuit Design

4.4.4 Flow Chart

For this project, several flow charts had been created to help the development of this project. Flow for this project follows all the charts to assist with project implementation and testing.

4.4.4.1 Sensor Flow Chart

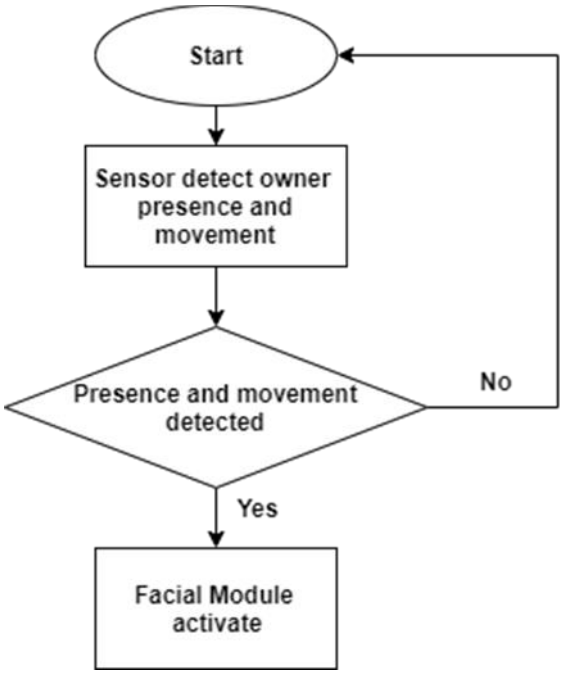

Figure 4.17: Sensor Flow Chart

As above shown, it is a flow chart for the ultrasonic sensor. Where the sensor detects the presence or movement of the owner or individual that stand in front of it.

4.4.4.2 Facial Recognition Flow Chart

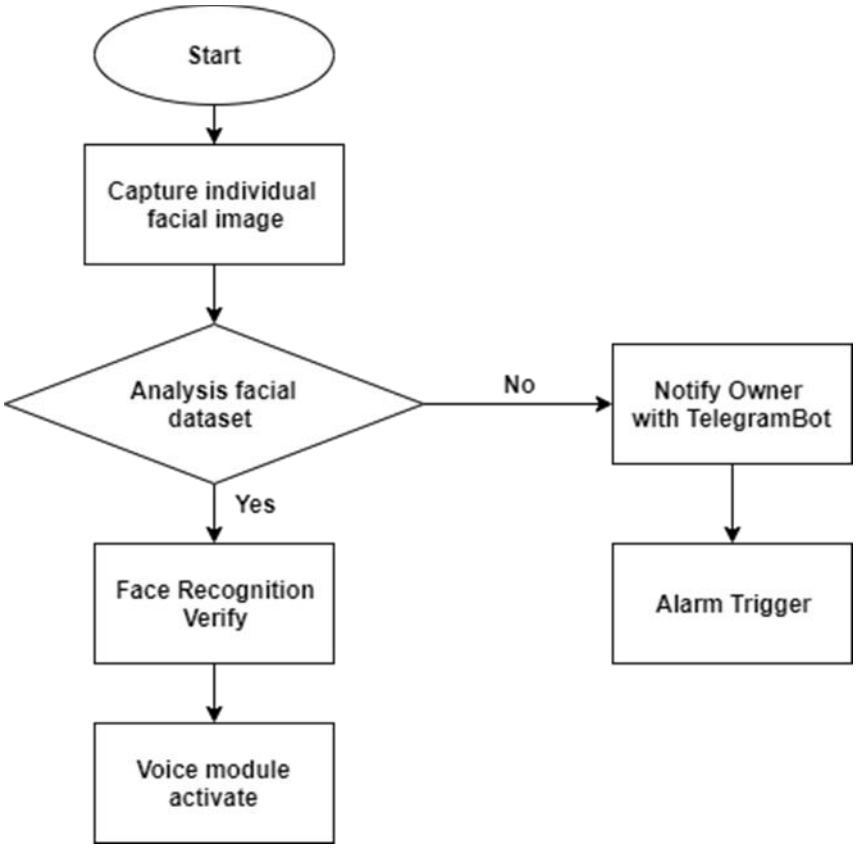

Figure 4.18: Facial Recognition Flow Chart

Figure above shown facial recognition flow chart, where it starts by capturing the individual facial image. Next, analyse it with the dataset to see whether is their match or not, if yes face recognition verifies and voice module activate. If no, it will notify the owner, through created TelegramBot and trigger the alarm.

4.4.4.3 Voice Recognition Flow Chart

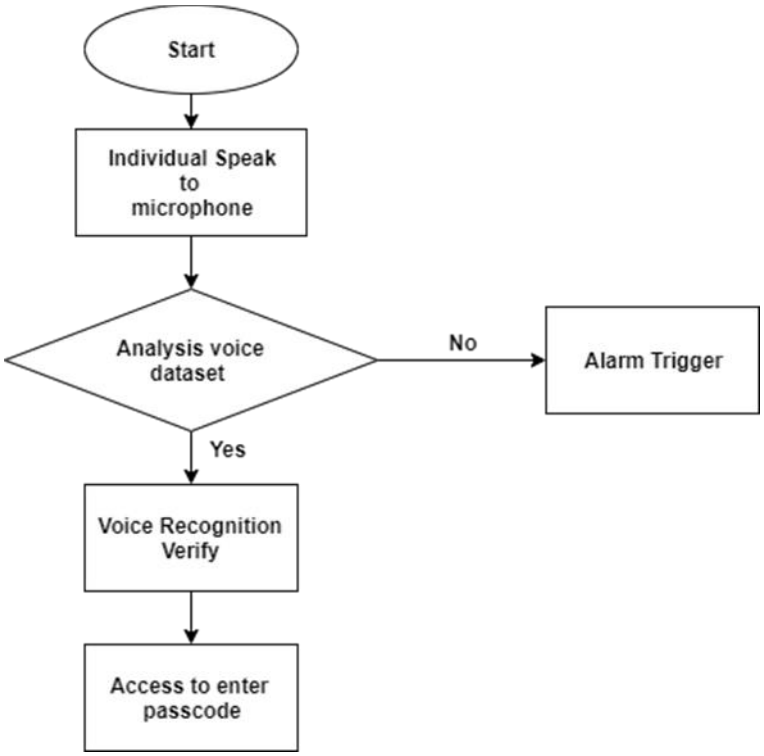

Figure 4.19: Voice Recognition Flow Chart

Figure shown voice recognition flow chart, individual need to speak to the microphone. In order for the voice to be analyses with the dataset. Here, also there will be an alarm trigger if does not have match dataset. If dataset match, it will verify and can enter the passcode.

4.4.4.4 Overall System Flow Chart

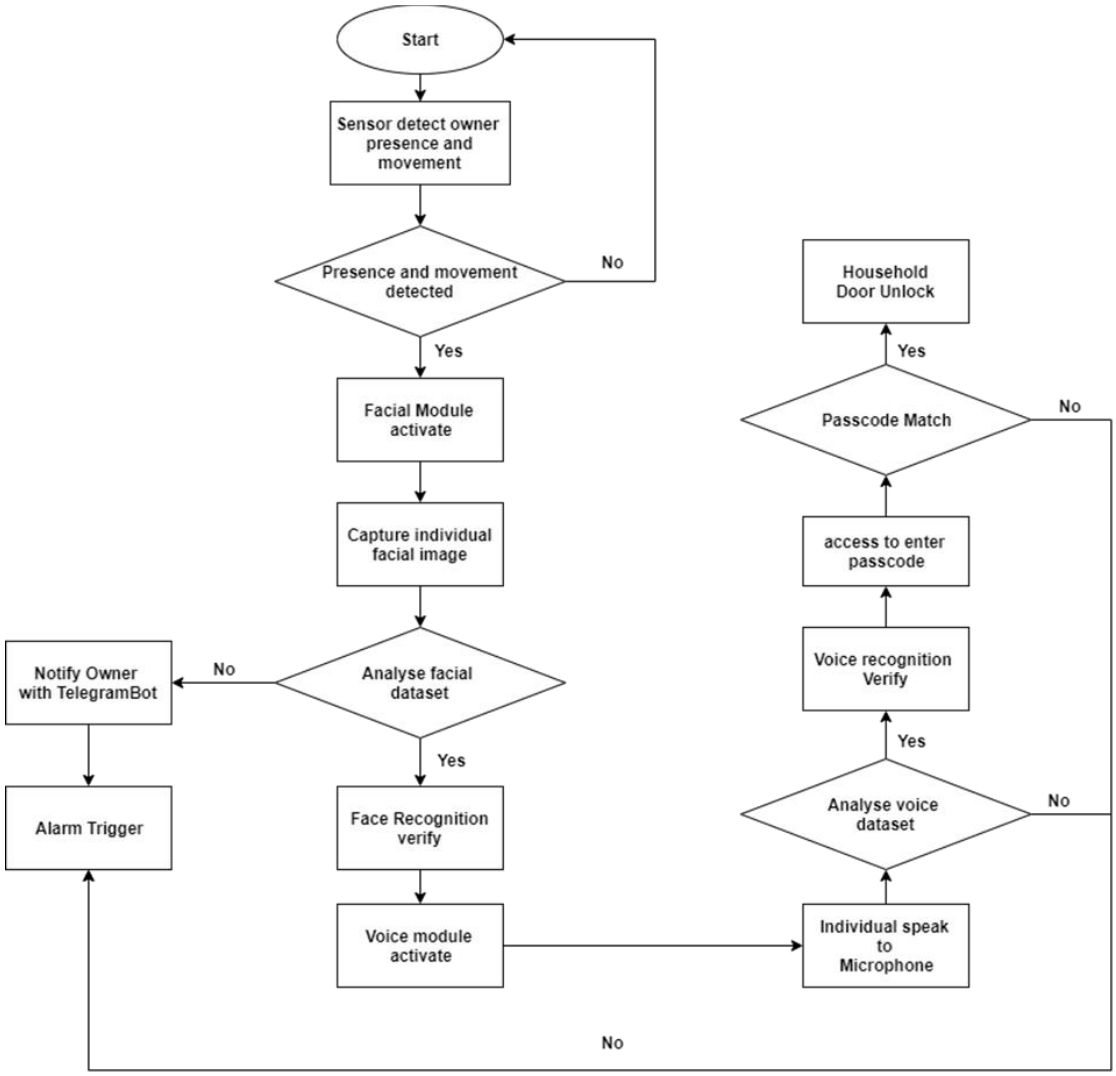

Figure 4.20: Overall System Flow Chart

Above shown the overall of the system flow chart, where the flow has begun form sensor, facial module, voice module, and keypad passcode. Have to complete these four modules, in order to unlock the household door.

4.5 Conclusion

As a conclusion, this chapter is one of essential phase before going to the next chapter which is implementation. It is due to the fact in this chapter accumulate all the requirement such as the hardware and software requirement. Besides that, it additionally indicates the flow of the circuit diagram and the flow chart of the system. The diagram layout is very essential that information us to do improvement in the subsequent segment and the flow chart assist to better understand the go with the flow of the system. The subsequent chapter explains about the implementation of the system.

REFERENCES

Anaza, S. O., Jiya, J. D., & Haruna, Y. S. (2017). *Open Access A Review of Intelligent Lock System American Journal of Engineering Research (AJER)*. (6), 9–15.

Balogh, Z., Magdin, M., & Molnár, G. (2019). Motion Detection and Face Recognition using Raspberry Pi, as a Part of, the Internet of Things. *Acta Polytechnica Hungarica*, *16*(3), 167–185. https://doi.org/10.12700/APH.16.3.2019.3.9

Bannister, A. (2016). *Smart-Home Security The Growing Market for Smart-Door Locks Smart-Home Security Report 2016: The Growing Market for Smart-Door Locks*. Retrieved from www.ifsecglobal.com

Choudhary, S., Kakaji, A., Pranay, K., & Prabhu, P. (2018). Efficient Attendance Management System Based on Facial Recognition. *International Journal of Engineering & Technology*, *7*(3.12), 565. https://doi.org/10.14419/ijet.v7i3.12.16180

Gunawan, T. S., Hasan Gani, M. H., Abdul Rahman, F. D., & Kartiwi, M. (2017). Development of Face Recognition on Raspberry Pi for Security Enhancement of Smart Home System. *Indonesian Journal of Electrical Engineering and Informatics (IJEEI)*, *5*(4), 317–325. https://doi.org/10.11591/ijeei.v5i4.361

Hajari, P. V, & Andurkar, A. G. (2015). Review Paper on System for Voice and Facial Recognition using Raspberry Pi. *International Journal of Advanced Research in Computer and Communication Engineering*, *4*(4), 232–234. https://doi.org/10.17148/IJARCCE.2015.4452

Hamid, E., Chong, L., Bahaman, N., Anawar, S., Ayob, Z., & Abdul, A. (2018). Implementation of Intelligent Automated Gate System with QR Code. *International Journal of Advanced Computer Science and Applications*, *9*(10), 359–363. https://doi.org/10.14569/IJACSA.2018.091043

Harum, N. binti, Faeq, M., Azma, N., & Anawar, S. (2018). Smart Surveillance System using Background Subtraction Technique in IoT Application.

International Journal of Advanced Computer Science and Applications, *9*(12), 122–128. https://doi.org/10.14569/IJACSA.2018.091218

R., P., P., J., R., S., & P., K. (2016). Literature Survey on Door Lock Security Systems. *International Journal of Computer Applications*, *153*(2), 13–18. https://doi.org/10.5120/ijca2016911971

Shah, D., & Haradi, V. (2016). IoT Based Biometrics Implementation on Raspberry Pi. *Procedia Computer Science*, *79*, 328–336. https://doi.org/10.1016/j.procs.2016.03.043

Torfi, A. (2018). SpeechPy - A Library for Speech Processing and Recognition. *Journal of Open Source Software*, *3*(27), 749. https://doi.org/10.21105/joss.00749

University Tunku Abdul Rahman (2018). *Anti-theft Security System Using Face Recognition.* Perak Campus, pp.11-20.

APPENDIX A

Python Source Code

face_datasets.py

```
# Import OpenCV2 for image processing
import cv2

# Start capturing video
vid_cam = cv2.VideoCapture(0)

# Detect object in video stream using Haarcascade Frontal Face
face_detector = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')

# For each person, one face id
face_id = 5

# Initialize sample face image
count = 0

# Start looping
while(True):

    # Capture video frame
    _, image_frame = vid_cam.read()

    # Convert frame to grayscale
    gray = cv2.cvtColor(image_frame, cv2.COLOR_BGR2GRAY)

    # Detect frames of different sizes, list of faces rectangles
    faces = face_detector.detectMultiScale(gray, 1.3, 5)

    # Loops for each faces
    for (x,y,w,h) in faces:

        # Crop the image frame into rectangle
        cv2.rectangle(image_frame, (x,y), (x+w,y+h), (255,0,0), 2)



        # Increment sample face image
        count += 1

        # Save the captured image into the datasets folder
        cv2.imwrite("dataset/User." + str(face_id) + '.' + str(count) + ".jpg", gray[y:y+h,x:x+w])

        # Display the video frame, with bounded rectangle on the person's face
        cv2.imshow('frame', image_frame)

    # To stop taking video, press 'q' for at least 100ms
    if cv2.waitKey(100) & 0xFF == ord('q'):
        break

    # If image taken reach 100, stop taking video
    elif count>100:
        break

# Stop video
vid_cam.release()

# Close all started windows
cv2.destroyAllWindows()
```

face_recognition.py

```
# Import OpenCV2 for image processing
import cv2

# Import numpy for matrices calculations
import numpy as np

# Create Local Binary Patterns Histograms for face recognization
recognizer = cv2.face.createLBPHFaceRecognizer()

# Load the trained mode
recognizer.load('trainer/trainer.yml')

# Load prebuilt model for Frontal Face
cascadePath = "haarcascade_frontalface_default.xml"

# Create classifier from prebuilt model
faceCascade = cv2.CascadeClassifier(cascadePath);

# Set the font style
font = cv2.FONT_HERSHEY_SIMPLEX

# Initialize and start the video frame capture
cam = cv2.VideoCapture(0)

# Loop
while True:
    # Read the video frame
    ret, im =cam.read()

    # Convert the captured frame into grayscale
    gray = cv2.cvtColor(im,cv2.COLOR_BGR2GRAY)

    # Get all face from the video frame
    faces = faceCascade.detectMultiScale(gray, 1.2,5)

    # For each face in faces
    for(x,y,w,h) in faces:

        # Create rectangle around the face
        cv2.rectangle(im, (x-20,y-20), (x+w+20,y+h+20), (0,255,0), 4)

        # Recognize the face belongs to which ID
        Id = recognizer.predict(gray[y:y+h,x:x+w])
```

```
        # Check the ID if exist
        if(Id == 1):
            Id = "Jacky"
        #If not exist, then it is Unknown
        elif(Id == 2):
            Id = "Jenifer"
        else:
            print(Id)
            Id = "Unknow"

        # Put text describe who is in the picture
        cv2.rectangle(im, (x-22,y-90), (x+w+22, y-22), (0,255,0), -1)
        cv2.putText(im, str(Id), (x,y-40), font, 2, (255,255,255), 3)

    # Display the video frame with the bounded rectangle
    cv2.imshow('im',im)

    # If 'q' is pressed, close program
    if cv2.waitKey(10) & 0xFF == ord('q'):
        break

# Stop the camera
cam.release()

# Close all windows
cv2.destroyAllWindows()
```

training.py

```
# Import OpenCV2 for image processing
# Import os for file path
import cv2, os

# Import numpy for matrix calculation
import numpy as np

# Import Python Image Library (PIL)
from PIL import Image

# Create Local Binary Patterns Histograms for face recognization
recognizer = cv2.face.createLBPHFaceRecognizer()

# Using prebuilt frontal face training model, for face detection
detector = cv2.CascadeClassifier("haarcascade_frontalface_default.xml");

# Create method to get the images and label data
def getImagesAndLabels(path):

    # Get all file path
    imagePaths = [os.path.join(path,f) for f in os.listdir(path)]
```

```
    # Initialize empty face sample
    faceSamples=[]

    # Initialize empty id
    ids = []

    # Loop all the file path
    for imagePath in imagePaths:

        # Get the image and convert it to grayscale
        PIL_img = Image.open(imagePath).convert('L')

        # PIL image to numpy array
        img_numpy = np.array(PIL_img,'uint8')

        # Get the image id
        id = int(os.path.split(imagePath)[-1].split(".")[1])
        print(id)

        # Get the face from the training images
        faces = detector.detectMultiScale(img_numpy)

        # Loop for each face, append to their respective ID
        for (x,y,w,h) in faces:

            # Add the image to face samples
            faceSamples.append(img_numpy[y:y+h,x:x+w])

            # Add the ID to IDs
            ids.append(id)

    # Pass the face array and IDs array
    return faceSamples,ids

# Get the faces and IDs
faces,ids = getImagesAndLabels('dataset')

# Train the model using the faces and IDs
recognizer.train(faces, np.array(ids))

# Save the model into trainer.yml
recognizer.save('trainer/trainer.yml')
```