BANK LOCKER SECURITY SYSTEM USING VOICE AND FACE AUTHENTICATION

A Project Report Submitted By

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Abstract

Cloud computing is a major computing paradigm that has drawn extensive attention in recent days. It is the on-demand availability of computer system resources,especially data storage and computing power, without direct active management by the user. Various objects surrounding humans tend to be on the network in one form or another in the cloud computing and IoT framework. Though both cloud computing and the Internet of Things together have profound applications, integrating them involves many challenges. Any cloud worker can access the information from the cloud hence, sustaining the security and interoperability of the information becomes difficult. In this paper, Secure Hybrid cloud-enabled architecture for the Internet of Things has been proposed. This involves a hybrid cloud- Private cloud and Public cloud. Hybrid clouds offer the opportunity to reduce the potential exposure of the data and it enables the user to keep sensitive or critical data off the public cloud while still taking the advantage of the cloud. The main purpose of this paper is to ensure intradomain data security and to address the issues of interoperability.

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Chapter 1
Introduction

1.1 General Introduction

Security is one of the major concerns we face in this modern society. Every day we face the risk of either losing our identity, money or any other valuable asset. Therefore, security and authentication is necessary in our daily lives especially in bank lockers, since most of accumulated assets are kept there. So, in this bank locker security system we will collect the biometric data of each individual trying to access the locker. This data will then be compared with the data present in the database. Only the authenticated individual can access the contents. All of this is achieved by using a Raspberry pi, a dc motor to indicate the opening and closing of the locker and in the case of an unsuccessful entry a buzzer is used to relay the message. In the past a key was provided by the bank for the locker's issuers, and having physical keys is a big hassle. The hassle being that, you might lose the key or you have to carry it every single time you need to access the locker and the biggest problem is someone can duplicate or steal the key. To eliminate this major problem biometrics can be utilized, since the keys used here will always remain with you at all times and can't be easily duplicated or stolen. A biometric system is a system that allows the recognition of a certain characteristic of an individual using mathematical algorithms and biometric data. Here the characteristic that is used is the physiological characteristic specifically the face and the voice. In this model the user information has to be first stored in the database. The use of this model will ensure a high level of security for bank lockers.

1.2 Aim

The aim of the project is to design and construct a Bank Locker Security System that overcomes the issues encountered in the old banking system. The system will recognize the identity of each individual using voice and face authentication.

1.3 Objective/s

The followings are the objectives of this project:
1. To develop a Smart Bank Locker System which is handy and self-powered.

2. To ensure the speed of the bank locker is faster recording process than the previous system.
3. To be able to recognize the face and voice of an individual accurately based on the database.

1.4 Problem Formulation

In the real world, people are more concerned about the safety of their valuable things like jewelry, money, important documents. The rise of fast growing technologies makes users to have high security systems with electronic identification options. These technologies include Bank Lockers, intelligent cards, user IDs and password based systems. But, unfortunately these are insecure due to hacker attacks, thefts, and forgotten passwords. In spite of all these problems and malfunctions these systems are prevailing. But however, the biometric authentication based identification is the most efficient and reliable solution for security.

1.5 Proposed Method/Technique

The proposed security system uses face recognition and voice authentication in order to recognize the identity of each individual whose data is stored in the database system. Users will provide the voice command through the microphone. The system is implemented using Raspberry pi 4.

1.6 Methodology

A security system is proposed using image capturing and voice authentication which is capable of recognizing the identity of each individual and eventually record down the data into database system. The system is implemented using Raspberry pi 4. A microphone takes voice input from the user. If both the biometrics match successfully, the authorized users can have access to the locker. If in case the face and voice are not present in the database, the permission to access the locker is denied.

1.7 Literature Survey

P. Pavani Prapurna, Y. Sai Sreeja, P. Naga Babu, P. Bhargav, V. Bharat proposed a system based speech and face recognition. In the olden days, only mechanical

locks were available which were not secured enough. As technology grows, modern electronic locks were introduced into the market to avoid any further theft and unauthorized access. Then comes the electronic lock systems that are based on RFID [1].
Priya Kumari, Pushpanaik, Raghavendra, Parameshwara, Divya M N presented a technique on live image and voice authentication. The functionality of RFID based system is depicted wherein the main components are RFID tag and reader. The RFID value acts as the authentication factor. Later, the bioscience lock system came into existence. Face recognition, fingerprint recognition, voice recognition, iris recognition and identification and work on the principle "what we are" . Here the non-public identification of every individual is employed because of the issue for verification [2].
B. Sudarshan, Akshaya R.K, Mohan Reddy B, Srinivasa, Ramya L.K proposed a system based on high protection voice and image authentication. An encryption based lock system was introduced where the original password was encrypted to generate the new password which is used to unlock the door. This technique is mainly introduced to prevent hacking.There are many more methods like IOT, Wi-Fi and Near Field Communication (NFC) based lock systems which work with the help of smart phones and networks [3].
P. Sugapriya, K. Amsavalli described a method based on pattern analyzer. Physiological characteristics include fingerprint, face and iris etc. These characteristics remain unchanged throughout the life of a person. Initially pattern flows are collected as datasets and maintained in a bank agent server. The machine has a camera to capture the pattern flow of the user and sent for processing features of the logic were compared and the user was recognized. Image processing is used and keypad password is needed for another level of security [4].
H. F. Alqahtani proposed automated smart locker for college. There are many fields which are using the Internet, including the educational, commercial, security, industrial, and communications fields, as it has an effective role in accomplishing many tasks, hence a new revolution began in technical science, known as the Internet of Things (IoT) technologies. It is a new revolution of the internet so that all things in our life have the ability to communicate through the internet sending and receiving data to perform specific functions over the network [5].

1.8 Organization of the Report

Chapter 1 briefs about introduction, aim, objectives, problem formulation and methodology of the project including literature survey.

Chapter 2 explains the insights of main architecture system and explanation of each blocks used.

Chapter 3 describes the hardware description of the components used in the project.

Chapter 4 describes the software description of the components used in the project.

Chapter 5 focuses on the design and implementation of the project.

Chapter 2
System Architecture

The voice input of the user is taken via the Microphone, the voice input here is a password. The password is already present in the database. Once the password has been verified the control moves on to the camera module. The camera module runs facial recognition over the user, it compares the dominant features of the user's face with the face data present in the database. Once all the checks are done, and the biometrics match successfully the locker will open up. The successful opening up of the locker indicated here using the dc motor. In the case that the input given doesn't match the data present in the database, the buzzer turns on which indicates an authentication failure. All of the processing is done by a Raspberry pi 4.

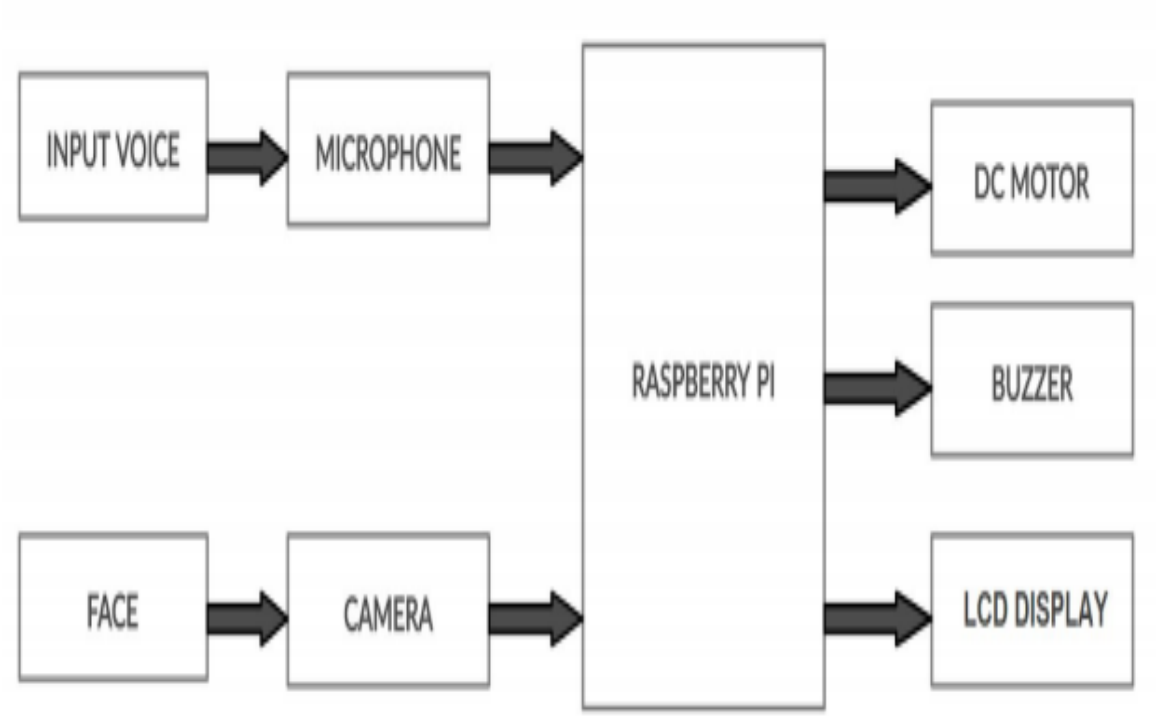

Figure 2.1: Block diagram of Bank Locker Security System

2.1 Block Diagram Description

2.1.1 Raspberry pi 4

The Raspberry Pi 4 Model is the latest product in the Raspberry Pi 4 range, boasting a 64-bit quad core processor running at 1.5GHz, dual band 2.4GHz and 5GHz wireless Local Area Network (LAN). The Raspberry Pi 4 maintains the familiar 40-pin GPIO [6]. The range of connectivity options such as WiFi (2.4GHz and 5GHz), Gigabit Ethernet, Bluetooth and USB enables to code with convenience anytime, anywhere.

2.1.2 Microphone

A microphone, colloquially called a mic or mike, is a device – a transducer that converts sound into an electrical signal. Here we are using a microphone with a USB input, Since the audio jack of a raspberry pie cannot be used to receive audio input.

2.1.3 Camera module

A 5MP camera module with high resolution is used. A camera module with lower pixel quantity is chosen for mainly two reasons, to reduce the processing speed and to reduce the overall cost of the project.

2.1.4 LCD display

An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16x2 translates a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix.

2.1.5 DC motor

An electrical machine that is used to convert the energy from electrical to mechanical. This motor helps in opening and closing of the locker box. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Chapter 3
Hardware Description

The system consists of the hardware components like Raspberry pi 4, Microphone, 16x2 LCD display, DC motor. Their descriptions are as follows.

3.0.1 Raspberry pi 4

Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers. It offers great processor speed, multimedia performance, memory, and connectivity. For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems. This product's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 8GB of RAM,dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0,and PoE capability [7].

Figure 3.1: Raspberry pi 4

3.0.1.1 Technical Specification

The technical specifications of Raspberry pi 4 is shown in Table 3.1.

Table 3.1: Technical specifications of Raspberry pi 4

Function	Description
System on chip	Broadcom BCM2711, 64-bit quad-core,1.5GHz
GPU	Broadcom VideoCore VI
RAM	1 GB,2 GB,or4 GB LPDDR4 SDRAM
Bluetooth	Bluetooth 5.0, BLE
Display & audio port	2 × micro-HDMI 2.0, 3.5mm audio-video jack
USB	2x USB 3.0 + 2x USB 2.0
Ethernet	Native Gigabit Ethernet
Power Supply	5V via USB up to 3A and GPIO header up to 3A
Expansion	40-pin GPIO header
Wifi	2.4GHz and 5GHz wireless LAN
Storage	microSD card

3.0.1.2 Processor / System on chip(SoC)

BCM2711 is the Broadcom chip used in the Raspberry Pi 4. The architecture of the BCM2711 is a considerable upgrade on that used by the SoCs in earlier Pi models. It continues the quad-core CPU design of the BCM2837, but uses the more powerful ARM A72 core. The ARM cores are capable of running at up to 1.5 GHz, making the Pi 4 about 50 % faster than the Raspberry Pi 3B+. The new VideoCore VI 3D unit now runs at up to 500 MHz. The ARM cores are 64-bit, and while the VideoCore is 32-bit, there is a new Memory Management Unit, which means it can access more memory than previous versions. The BCM2711 chip continues to use the heat spreading technology started with the BCM2837B0, which provides better thermal management.

3.0.1.3 Power Specifications

The Raspberry Pi 4 requires a good quality USB-C power supply capable of delivering 5V at 3A. The power requirements of the Raspberry Pi increases as various interfaces on the Raspberry Pi are used. The GPIO pins can draw 50mA safely, distributed across all the pins; an individual GPIO pin can only safely draw 16mA. The HDMI port uses 50mA, the camera module requires 250mA, and keyboards and mice can take as little as 100mA or over 1000mA.

3.0.1.4 General Purpose Input Output(GPIO)

General-purpose input/output (GPIO) is a generic pin on an integrated circuit whose behavior, including whether it is an input or output pin, can be controlled by the user at run time. GPIO pins have no special purpose defined, and go unused by default. The raspberry pi 4 consists of 40-pin GPIO. A standard interface for connecting a single-board computer or microprocessor to other devices is through General-Purpose Input/Output (GPIO) pins.The raspberry pi 4 model B board consists of two 5V pins, two 3V3 pins, and 7 ground pins (0V). A GPIO pin set as input allows the signal transmitted by any external device (connected to this pin) to be received by the Raspberry Pi. Input voltage between 1.8V and 3.3V is read as HIGH by the Raspberry pi. And when the input voltage is lower than 1.8V, it is read as LOW. A GPIO pin set as output can output HIGH/3.3V or LOW/0V.

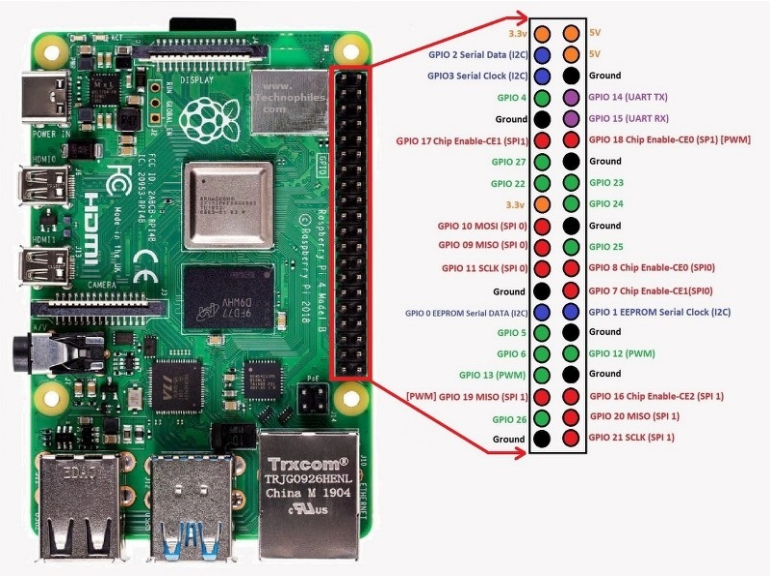

Figure 3.2: Raspberry pi 4 GPIO pins

3.0.1.5 Camera and Display Interfaces

The Raspberry pi 4 has 1x Raspberry Pi 2-lane MIPI CSI Camera and 1x Raspberry Pi 2-lane MIPI DSI Display connector. These connectors are backwards compatible with legacy Raspberry Pi boards, and support all of the available Raspberry Pi camera and display peripherals. The camera module associates with the Raspberry Pi board through the Camera Serial Interface (CSI) connector to interface with camera. The Camera Module can be used to take high-definition video, as well as stills photographs. Raspberry pi camera module is shown in the Figure 3.3.

3.0.1.6 Universal Serial Bus(USB)

The Raspberry pi 4 has 2x USB2 and 2x USB3 type-A sockets. Downstream USB current is limited to approximately 1.1A in aggregate over the four sockets.

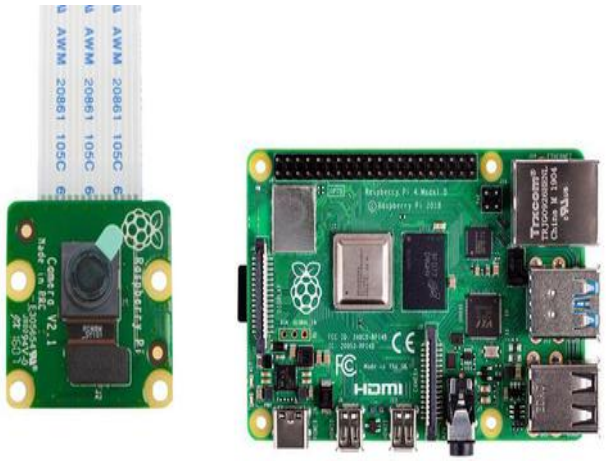

Figure 3.3: Raspberry pi Camera module

3.0.1.7 High-Definition Multimedia Interface(HDMI)

The Raspberry pi 4 has 2x micro-HDMI ports, both of which support HDMI 2.0 with resolutions up to 4Kp60.

3.0.1.8 Ethernet

The The Raspberry pi 4 has Gigabit Ethernet. The Ethernet port, relocated to the top-right of the board, offers full-speed network connectivity. Two USB 3.0 ports, centre, offer high-speed connectivity for external devices including storage and accelerator hardware.

3.0.1.9 Wifi and Bluetooth

Aside from the unobstructed Gigabit Ethernet, Raspberry Pi 4 B also has wireless networking and Bluetooth onboard. The board supports 802.11ac Wireless LAN (throughput of around 100 Mbps) that can run on 2.4GHz or 5GHz and Bluetooth 5.0.

3.0.1.10 Storage

Raspberry pi 4 has a microSD card slot to load the operating system and user data. The operating system is loaded on a SD card which is inserted on the SD card

slot on the Raspberry Pi. It can be loaded on the card using a card reader on any computer.

3.0.1.11 Temperature Range and Thermals

The recommended ambient operating temperature range is 0 to 50 degrees Celcius. To reduce thermal output when idling or under light load, the Raspberry pi 4 reduces the CPU clock speed and voltage. During heavier load the speed and voltage (and hence thermal output) are increased. The internal governor will throttle back both the CPU speed and voltage to make sure the CPU temperaturenever exceeds 85 degrees C. The Raspberry pi 4 will operate perfectly well without any extra cooling and is designed for sprint performance expecting a light use case on average and ramping up the CPU speed when needed (e.g. when loading a webpage). If a user wishes to load the system continually or operate it at a high termperature at full performance, further cooling may be needed.

3.0.2 Microphone

Raspberry Pi does not have a sound card and therefore it won't support microphones on audio jack, so a USB microphone is used.

3.0.3 16×2 LCD

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. 16×2 LCD is named so because it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen [8].

3.0.3.1 Features

- Operating Voltage is 4.7V to 5.3V.
- Current consumption is 1mA without backlight.
- Alphanumeric LCD display module which means they can display alphabets and

numbers.
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box.
- Can work on both 8-bit and 4-bit mode.
- It can also display any custom generated characters.

3.0.3.2 Pin Configuration

The Pin Configuration of 16x2 LCD is as shown in the Figure 3.4.

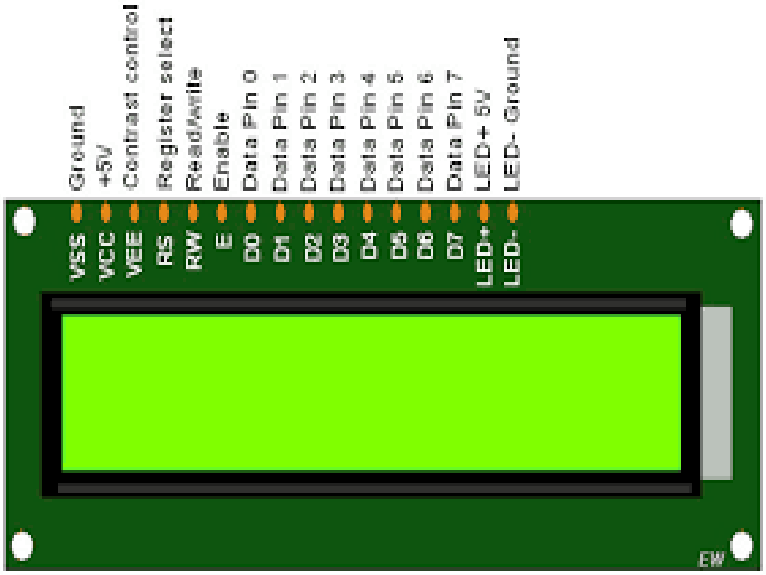

Figure 3.4: Pin Configuration of 16×2 LCD module

3.0.4 DC Motor

An electrical machine that is used to convert the energy from electrical to mechanical. This motor helps in opening and closing of the locker box. When a magnetic field and an electric field interact, a mechanical force is produced. The DC motor or direct current motor works on that principle. This is known as motoring action. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field winding.

3.0.4.1 Armature or Rotor

The armature of a DC motor is a cylinder of magnetic lamination that are insulated from one another. It is perpendicular to the axis of the cylinder. The armature is a rotating part that rotates on its axis and is separated from the field coil by an air gap.

3.0.4.2 Commutator and Brushes

The commutator of a DC motor is a cylindrical structure that is made of copper segments stacked together but insulated from each other using mica. The primary function of a commutator is to supply electrical current to the armature winding. The brushes of a DC motor are made with graphite and carbon structure. These brushes conduct electric current from the external circuit to the rotating commutator. Hence, we come to understand that the commutator and the brush unit are concerned with transmitting the power from the static electrical circuit to the mechanically rotating region or the rotor.

3.0.4.3 Working of the motor

The rotor is normally located on the inside of the motor, while the stator is located on the outside. The rotor contains coil windings that are powered by the DC current and the stator contains either permanent magnets or electromagnetic windings. When the motor is powered by DC current, a magnetic field is created within the stator, attracting and repelling the magnets on the rotor. This causes the rotor to start rotating. To keep the rotor rotating, the motor has a commutator. When the rotor aligns with the magnetic field, it would stop spinning, but in this case the commutator would reverse the current through the stator and this way reverse the magnetic field. This way the rotor can keep spinning.

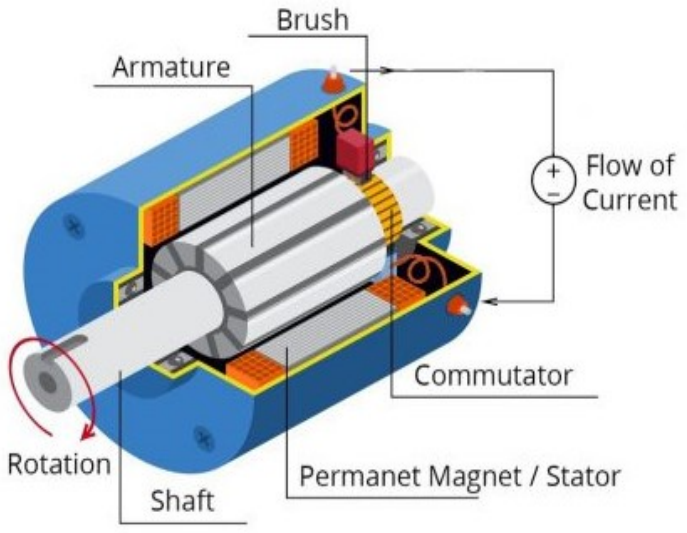

Figure 3.5: DC Motor

Chapter 4
Software Description

4.0.1 Raspberry pi operating system

Unlike a traditional computer where there is a BIOS, a drive that supports removable media and a hard drive inside the computer, the Raspberry pi simply has an SD card reader. The traditional computer-setup route of inserting a boot disk and installing the operating system to an internal storage device is not followed here. Instead, the operating system is loaded on a SD card which is inserted on the SD card slot on the Raspberry pi for further unpacking/tweaking. The install manager for Raspberry Pi is NOOBS. It's an operating system manager that makes it easy to download, install, and set up Raspberry pi.

The OSs included with NOOBS are:
- Arch Linux ARM
- Open ELEC
- Pidora (Fedora Remix)
- Raspbmc and the XBMC open-source digital media center
- RISC OS -The operating system of the first ARM-based computer
- Raspbian - Raspbian is a free operating system based on Debian optimized for the Raspberry pi hardware. An operating system is the set of basic programs and utilities that make Raspberry pi run. Of all the operating systems such as Arch, Risc OS, Plan 9 or Raspbian that are available for raspberry pi, Raspbian comes out on top as being the most user-friendly, best-looking, which has the best range of default software's and optimized for the Raspberry pi hardware.

4.0.2 Raspberry pi Imager

Raspberry pi Imager is used to install Raspberry Pi operating system to a microSD card. Raspberry pi Imager downloads a .JSON file from a list of all current download options, that ensurs installing the most up-to-date version.
Once an operating system is selected from the available options, the utility reads the relevant file directly from the website and writes it straight to the SD card. This speeds up the process quite considerably compared to the standard process of reading it from the website, writing it to a file on hard drive, and then, as a separate step, reading it back from the hard drive and writing it to the SD card.

During this process, raspberry pi imager also caches the downloaded operating system image – that is to say, it saves a local copy on the computer, that enables to program additional SD cards without having to download the file again.

4.0.3 Raspbian OS

Raspberry pi OS, initially titled Raspbian, it is an operating system made specifically for the raspberry pi. The operating system was rooted in Debian, which is a kind of Linux operating system. Like any other operating system, the raspberry pi has some unique features that set it apart from others. The user interface of the raspberry pi operating system has a menu bar at the top of the screen, containing an app menu with set shortcuts to the Terminal, Chromium, and the OS's File Manager. The right side has Bluetooth, WiFi, and volume menus, alongside a digital clock. The default recommended software app for installing packages is Advanced Package Tool(APT). A Graphical User Interface(GUI) wrapper can be used for APT(the Add/Remove Software tool) to add new packages or remove existing ones.

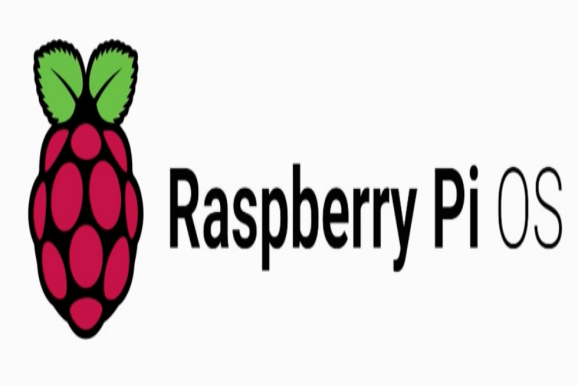

Figure 4.1: Raspbian OS

4.0.4 OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. It is developed by Intel research center and subsequently supported by Willow Garage and now maintained by itseez. It is written in C++ and its primary interface is also in C++. Its binding is in Python, Java, and Matlab. OpenCV runs on a variety of platform like Windows, Linux, and MacOS, openBSD in desktop and Android and IOS. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as Numpy, python is capable of

processing the OpenCV array structure for analysis. To identify image pattern and its various features we use vector space and perform mathematical operations on these features. It is a combination of OpenCV C++ Application Programming Interface(API) and Python language. In our project OpenCV is used to gesture control to open a camera and capture the image.

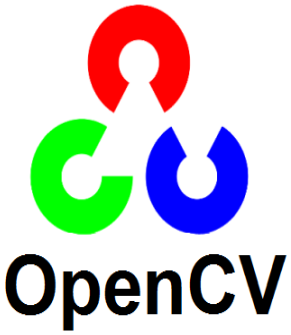

Figure 4.2: OpenCV

Chapter 5
Implementation

5.0.1 Visual Studio Code

Visual Studio Code is a source-code editor made by Microsoft for Windows, Linux and macOS. Features include support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git. Users can change the theme, keyboard shortcuts, preferences, and install extensions that add additional functionality. Visual Studio Code is a lightweight but powerful source code editor which runs on your desktop. It comes with built-in support for JavaScript, TypeScript and Node.js and has a rich ecosystem of extensions for other languages (such as C++, C#, Java, Python, PHP, Go) and runtimes (such as .NET and Unity). It aims to provide just the tools a developer needs for a quick code-build-debug cycle and leaves more complex workflows to fuller featured IDEs, such as Visual Studio IDE.

5.0.2 Open CV-Python

OpenCV is a library of programming functions mainly aimed at real-time computer vision. It has a modular structure, which means that the package includes several shared or static libraries. We are using image processing module that includes linear and non-linear image filtering, geometrical image transformations, color space conversion, histograms, and so on. The project includes libraries such as Haar classifier, Lower Binary Pattern histogram(LBPH) face recognizer, Histogram of oriented gradients(HOG).
Python is a general purpose programming language started by Guido van Rossum, which became very popular in short time mainly because of its simplicity and code readability. It enables the programmer to express his ideas in fewer lines of code without reducing any readability.
Compared to other languages like C/C++, Python is slower. But another important feature of Python is that it can be easily extended with C/C++. This feature helps to write computationally intensive codes in C/C++ and create a Python wrapper for it so that we can use these wrappers as Python modules. This gives two advantages: first, the code is as fast as original C/C++ code and second, it is very easy to code in Python. This is how OpenCV-Python works, it is a Python wrapper around original C++ implementation. And the support of Numpy makes the task more easier. Numpy is a highly optimized library for numerical operations. All

the OpenCV array structures are converted to-and-from Numpy arrays. OpenCV-Python is an appropriate tool for fast prototyping of computer vision problems.

5.0.2.1 OpenCV-Python working

-Read an image
The function cv2.imread() is used to read an image. The image should be in the working directory or a full path of image should be given. This method loads an image from the specified file. Second argument is a flag which specifies the way image should be read.
cv2.imread_color loads a color image. Any transparency of image will be neglected. It is the default flag.
cv2.imread_grayscale loads image in grayscale mode.
cv2.imread_unchanged loads image as such including alpha channel.
-Display an image
The function cv2.imshow() is used to display an image in a window. The window automatically fits to the image size. First argument is a window name which is a string. The second argument is the image. One can create as many windows, but with different window cv2.waitKey() is a keyboard binding function. Its argument is the time in milliseconds. The function waits for specified milliseconds for any keyboard event. If any key is pressed in that time, the program continues. If 0 is passed, it waits indefinitely for a key stroke. It can also be set to detect specific key strokes like, if key a is pressed etc.
cv2.destroyAllWindows() simply destroys all the windows that are created. In order to destroy any specific window, the function cv2.destroyWindow() is used, where the exact window name is passed as the argument.

5.0.3 Image Processing Module

Image processing is a method to perform some operations on an image, in order to get an enhanced image and or to extract some useful information from it. Image processing is the analysis and manipulation of a digitized image, especially in order to improve its quality.
An image may be defined as a two-dimensional function f(x, y), where x and y are spatial(plane) coordinates, and the amplitude of any pair of coordinates (x, y) is called the intensity or grey level of the image at that point. An image is nothing more than a two-dimensional matrix (3-D in case of coloured images) which is defined by the mathematical function f(x, y) at any point is giving the pixel value at that point of an image, the pixel value describes how bright that pixel is, and what colour it should be. Image processing is basically signal processing in which

input is an image and output is image or characteristics according to requirement associated with that image.
The purpose of image processing are:
- Visualization- Observe the objects that are not visible.
- Image sharpening and restoration- To create a better image.
- Image retrieval- Seek for the image of interest.
- Measurement of pattern– Measures various objects in an image.
- Image Recognition– Distinguish the objects in an image.
OpenCV is a Library which is used to carry out image processing using programming languages like python.

5.0.3.1 Haar Classifier

This object detection framework is to provide competitive object detection rates in real-time like detection of faces in an image. A human can do this easily, but a computer needs precise instructions and constraints. To make the task more manageable, Viola–Jones requires full view frontal upright faces. Thus in order to be detected, the entire face must point towards the camera and should not be tilted to either side. While it seems these constraints could diminish the algorithm's utility somewhat, because the detection step is most often followed by a recognition step, in practice these limits on pose are quite acceptable the characteristics of Viola–Jones algorithm which make it a good detection algorithm are:

- Robust: Very high detection rate & very low false-positive rate always.
- Real time applications: For practical applications at least 2 frames per second must be processed.
- Face detection: The goal is to distinguish faces from non-faces (detection is the first step in the recognition process).

This algorithm includes Haar feature selection process. All human faces share some similar properties. These regularities may be matched using Haar Features. A few properties common to human faces:

- The eye region is darker than the upper-cheeks.
- The nose bridge region is brighter than the eyes.

Composition of properties forming matchable facial features:

- Location and size: eyes, mouth, bridge of nose.
- Value: oriented gradients of pixel intensities.

5.0.3.2 Numpy

NumPy is the fundamental package for scientific computing with Python. NumPy is an acronym for"Numeric Python" or "Numerical Python". It is an open source extension module for Python, which provides fast precompiled functions for mathematical and numerical routines. Furthermore, NumPy enriches the programming language Python with powerful data structures for efficient computation of multi-dimensional arrays and matrices. The implementation is even aiming at huge matrices and arrays. Besides that the module supplies a large library of high-level mathematical functions to operate on these matrices and arrays. NumPy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined. This allows NumPy to seamlessly and speedily integrate with a wide variety of databases.

5.0.3.3 Local Binary Pattern Histogram(LBPH) Face Recognizer

The Local Binary Pattern Histogram(LBPH) algorithm is a simple solution on face recognition problem, which can recognize both front face and side face. It is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number. It has further been determined that when LBP is combined with Histograms of Oriented Gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. However, the recognition rate of LBPH algorithm under the conditions of illumination diversification, expression variation and attitude deflection is decreased. To solve this problem, a modified LBPH algorithm based on pixel neighborhood gray median(MLBPH) is proposed. The gray value of the pixel is replaced by the median value of its neighborhood sampling value, and then the feature value is extracted by the sub blocks and the statistical histogram is established to form the MLBPH feature dictionary, which is used to recognize the human face identity compared with test image.
LBPH uses 4 parameters :

- Radius: It is used to build the circular local binary pattern and represents the radius around the central pixel.
- Neighbors: The number of sample points required to build the circular local binary pattern.
- Grid X : The number of cells in the horizontal direction.
- Grid Y : The number of cells in the vertical direction.

The model built is trained with the faces with tag given to them, and later on, the machine is given a test data and machine decides the correct label for it.

5.0.4 Face Detection and Recognition

The face recognition is a technique to identify or verify the face from the digital images or video frame. A human can quickly identify the faces without much effort. It is an effortless task for us, but it is a difficult task for a computer. There are various complexities, such as low resolution, occlusion, illumination variations, etc. These factors highly affect the accuracy of the computer to recognize the face more effectively.
Face Detection: The face detection is generally considered as finding the faces in an image and probably extract them to be used by the face detection algorithm.
Face Recognition: The face recognition algorithm is used in finding features that are uniquely described in the image. The facial image is already extracted, cropped, resized, and converted in the grayscale.
In order for the system to function, it's necessary to implement three steps. First, it must detect a face and the face data must be stored. Then, it must recognize that face nearly instantaneously. Finally, it must take whatever further action is required, such as allowing access for an approved user. The most basic task on Face Recognition is Face Detecting.The face must be captured in order to recognize it, when compared with a new face captured on future. There are various algorithms of face detection and face recognition. Here Haar cascade algorithm for face detection is used.
In Data Gathering, a dataset is created, where we will store for each id a group of photos in gray with the portion that was used for face detecting. The next step is to train the recognizer, where face data and respective id's of each face is fed to the OpenCV recognizer so that it can learn. A Local Binary Pattern Histogram(LBPH) Face Recognizer, included on OpenCV package is used.
During the Face Recognition process, a fresh face is captured on the camera and if this person had his face captured and trained before, the recognizer will make a prediction returning its id and an index, shown how confident the recognizer is with this match. The process of Face Recognition is depicted in the Figure.5.1.

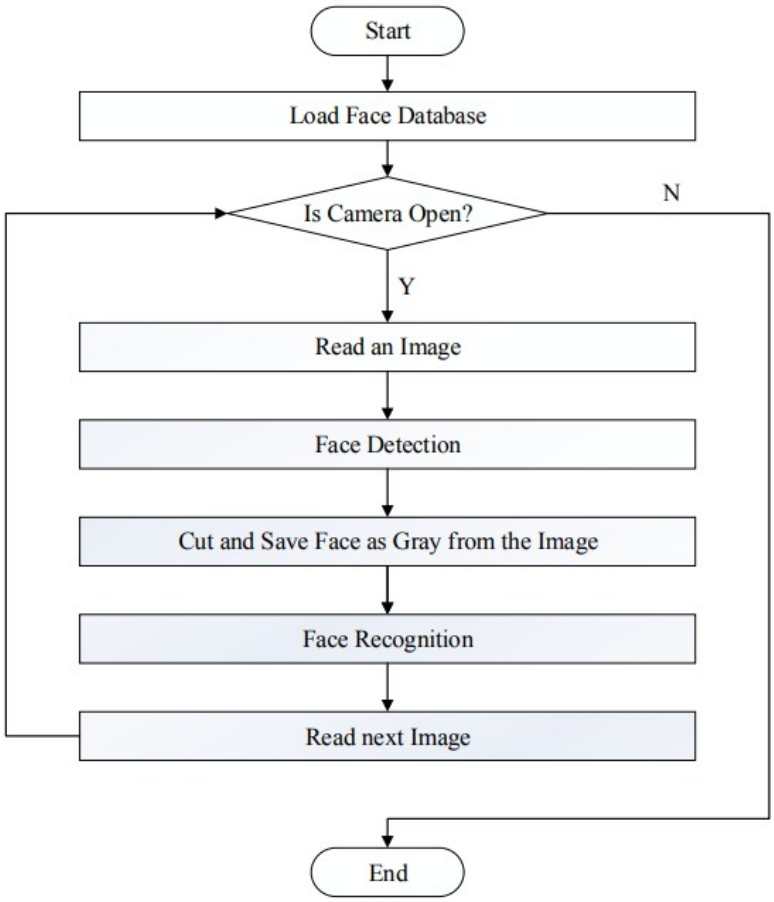

Figure 5.1: Face Recognition

5.0.5 Voice Authentication

Voice authentication is implemented in Raspberry Pi in order to add an extra layer of security. Raspberry Pi does not have a sound card and therefore it won't support microphones on audio jack, so we should use a USB microphone. Recognizing speech requires audio input, which a user provides through microphone.
Speech recognition, also known as Automatic Speech Recognition (ASR), computer speech recognition, or speech-to-text, is a capability which enables a program to process human speech into a written format.Speech recognition is the ability for a machine or program to identify words spoken aloud and convert them into readable text. Speech recognition works using algorithms through acoustic and language modeling. Acoustic modeling represents the relationship between linguistic units of speech and audio signals. Language modeling matches sounds with word sequences to help distinguish between words that sound similar. Recognizing speech requires audio input, and SpeechRecognition library makes retrieving this input. The SpeechRecognition library acts as a wrapper for several popular

speech APIs and is thus extremely flexible. One of these is the Google Web Speech API which supports a default API key that is hard-coded into the SpeechRecognition library.

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Appendix A
ATMega 8

Include relevant data if required.

Appendix B
Latex