SMART SECURITY AND PARKING SYSTEM

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ABSTRACT

A video camera will be interfaced with the processor (Raspberry Pi). As the vehicle approaches, the camera will take the image of person and transmit it to Pi for image processing. In the database, images of the persons are already stored for matching process. Face recognition will be used for verification. As soon as the Raspberry recognizes the image, it will signal the Reader to start its own processing. Active tags placed on the vehicles will send the Tag ID related to that particular vehicle to Reader for vehicle identification. There would be three parking areas. The vehicles belonging to a particular class would be directed to go to its particular parking area. Depending upon the ID received, main barrier and the barrier of specified parking will be lifted. For no match case in any of face recognition or RFID techniques, main barrier will not open.

For obvious reasons, machine based recognition can never surpass face recognition of a human eye. Thus there remains a room for improvement in terms of efficiency and results as well. Complexity in computation is a major dilemmas of recognition techniques and for large databases, this problem is further aggravated. In this project the algorithm used is Principal Component Analysis with the help of which face recognition process will be achieved in an easy and low computational manner.

It is hereby certified that the form of the report and the contents of the project “Smart Security and Parking System” being submitted by the syndicate of students

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Have been written well and found satisfactory as per the requirements of the B.E Degree in Electrical (Telecom) Engineering.

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DECLARATION

We hereby declare that none of the content of our work presented in this thesis has been submitted for some other award of qualification or degree either in this or anywhere else in another institution.

DEDICATED TO

Allah Almighty and Prophet Muhammad (S.A.W)

Project Supervisor Dr. Mir Yasir Umair

And our Parents and Family

ACKNOWLEDGEMENT

Being Muslim, we believe that nothing can happen without Allah Almighty’s will. So we thank Him for ushering his blessings and giving us knowledge as well as the strength to achieve the required goals successfully.

As a special mention, we thank our project supervisor, Asst. Prof. Dr. Mir Yasir Umair, for his support and encouragement was the inspiration without which it would never have been possible to achieve the goals.

We would also like to thank the faculty for being there for us whenever we needed help of any kind as well as the colleagues and other people willingly helping with their abilities us for their support and aid in the development of our project and achieving the goals.

Last mention but an important one, we would like to thank our parents who stood beside us in difficult times and hardships and were such a support. Without this support and encouragement, it would have been impossible to achieve the targets successfully.

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List of Abbreviations

Abbreviation	Word in Full
RFID	Radio Frequency Identification
ID	Identification
PCA	Principal Component Analysis
GHQ	General Headquarters
VIP	Very Important Person
EM	Electromagnetic
AT&T	American Telephone and Telegraph
LED	Light Emitting Diode
MP	Mega Pixels
EEPROM	Electrically Erasable Programmable ROM
ROM	Read Only Memory
I/O	Input / Output
USB	Universal Serial Bus
HDMI	High Definition Multimedia Interface
GPIO	General Purpose Input Output
LAN	Local Area Network
NOOBS	New Out of Box Software

1. Chapter 1

1.1 Introduction

1.1.1 Overview

RFID technology is now commonly being used in daily life. Bar codes are replaced by use of this technology. It also provides more security and privacy. However it is also being misused. To avoid such events, a face recognition is used with RFID. Driver is identified by use of facial recognition and vehicle is verified using RFID.

Face recognition is computationally complex and can pose problems like increase in complexity with improvement in image resolution. High computation involved is thus a major concern.

Many techniques can be used for reducing computational complexity. One of them is PCA which is used for reduction of computational complexity and is being incorporated at many places.

Therefore, there is a dire need to reduce the complexity before the process of feature extraction for facial recognition.

1.1.2 Problem

Parking and Security provision for the vehicles, is a major concern for any institution. A handsome number of human resources are utilized for this purposes which makes it more expensive system.

The RFID technology has been given a lot of attention in the last few years as technologists and privacy advocates debate the ethics of its use at one end. Privacy advocates seem concerned about issues like many corporations considering to use RFID technology for inventory tracking purpose may have honorable intentions, but without the care due for it, the technology may and can be used to bring forward some undesirable outcomes to customers. The basic problem is that radio based technologies make use of invisible communication channels, so one never know when communication is going to occur.

1.1.3 Statement

To overcome the concerns regarding RFID, face recognition techniques would be utilized which includes face detection, feature extraction and other such techniques.

Many dimensionality reduction techniques exist in literature such as Principal Component Analysis, however even the best option available in literature is not sufficient for dimensionality reduction calculations for real time scenario. The optimal wavelet basis is yet to be explored in the literature.

1.1.4 Approach

In order to design and develop such a parking system with security parameters induced as well, an in depth study of face recognition theory as well as RFID is required. The approach and steps required to achieve such a system have been listed below.

RFID technology availability and its credibility, types of RFID, Algorithms for face recognition depending upon their feasibility and ease of interfacing with RFID being used, Strong processor able to handle complex computations and work load and Camera to be used along with its ease of interface with the processor.

The diagram below shows our approach to the system.

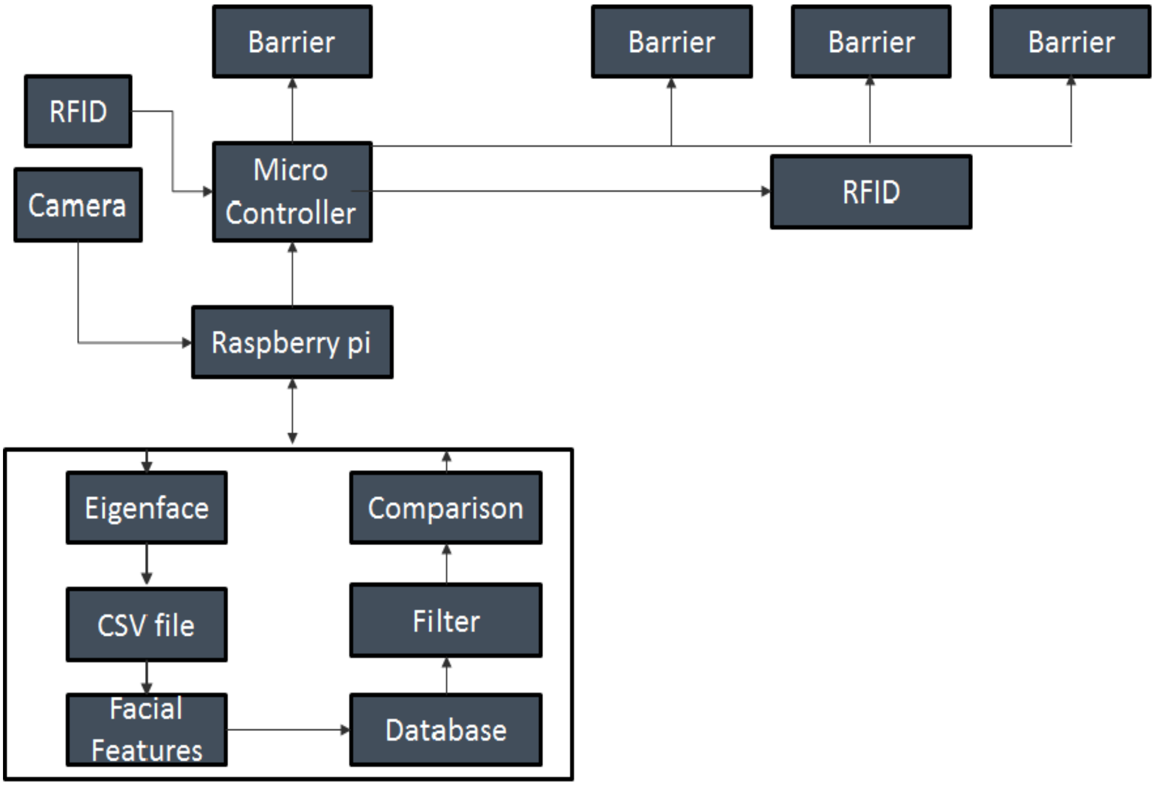


Figure 1: Project Design flow

1.2 Project Description

The project involves the combination of RFID technology and Image processing. A camera placed at the main entrance will capture the image of the person. In the database, images for each of the persons are already stored for matching process. Face recognition will be used for verification. As soon as the person/image is recognized by the processor, the system will read from the tag on the vehicle through RFID reader. When the vehicle approaches, the reader will read the tag ID of active tags being transmitted by them at every time.

Once the vehicle is verified through RFID and face recognition, it will be allowed to pass from entrance. An authorized person with a registered vehicle, will be able to enter from main entrance only if the vehicle is registered and is against his own name. The barrier would open once the vehicle and person both are verified. There would be three parking areas for faculty, administration and students each. The vehicle belonging to a particular class (faculty, administration and students) would be directed to go to its particular parking area. A student would not be allowed to park his vehicle in either faculty or administration parking area and vice versa.

It is quite evident that a face recognizing of face by a machine based mechanism can never eradicate the human eye facial recognition system because of understood reasons. Betterment and improvement has always a room in such cases.

1.3 Scope, Objectives & Deliverables

1.3.1 Scope

Basic scope in our project is to achieve the following;

1. Face recognition software using Python
2. RFID reader and Microcontroller based hardware module
3. An algorithm to match the outputs from above mentioned steps

1.3.2 Objectives

To understand the RFID technology which includes its principal, Near Field and Far Field RFIDs, Inductive coupling and Propagation Coupling. Various dimensionality reduction techniques that include Eigen faces and Eigen vectors, Principal Components Analysis and feature extraction algorithms.

The major purpose of this system is a secure and efficient, fully automated parking system which require less/negligible human power to operate it. Another objective is to provide separate parking lots to every class (student, faculty and administration) of MCS.

The designed system will not only reduce man power but also provide enough security with minimum resources being used.

1.3.3 Deliverables

1. Face recognition based on PCA and Eigen vectors
2. RFID Module
3. Raspberry Pi and its camera
4. Microcontroller (AT-Mega 328)
5. LCD and motor interfacing
6. Interfacing of all modules together

1.4 Specifications & Applications

1.4.1 Specifications

Hardware Specifications

Hardware specifications required for the project are;

1. RFID reader and active tags
2. AT-Mega 328 microcontroller
3. Raspberry pi v 3.0
4. Raspberry pi camera
5. Servo motors, LCD and LEDs

Software Specifications

Following software requirements are required as well;

1. Python for face recognition processing
2. C used for microcontroller programming

1.4.2 Applications

With an exponential increase in the number of vehicles being used around the globe, parking systems can be found almost everywhere today and require good security with less man power required for it especially at places where security clearance of people is regarded as a major issue. Some of the applications are as follows;

- ❖ General purpose utilization of system not only for educational institutions but also in offices and stadiums.
- ❖ Specific purpose utilization of system includes its use for VIP protocols at government level, for occasions/functions being held at GHQ, in the Presidency and Parliament House as well.
- ❖ Security condition of our country at present also envisages on development and application of such measures

2. Chapter 2

2.1 Background Study

2.1.1 Overview of Existing Literature

The project envisages how to build a smart and secure parking system using RFID and Face Recognition system with the use of a good algorithm. A good and suitable algorithm will be chosen based upon their computation time and efficient processing amongst the algorithms available for the image processing and recognition technique. A result will be obtained from recognition system showing whether the image is verified. The result is to be matched with the RFID results. Following steps will be performed to achieve our target;

1. Normalizing the face images in the data base using PCA
2. Acquire input image/ frame for recognition in real time through camera
3. New image normalization using PCA as well
4. Extract facial features from the image by calculating Eigen vectors
5. Calculation of Covariance matrix and employing these to get the input face image.
6. Using above calculations to get results of recognition
7. Reception of active tag ID and comparison with database
8. Decision to open a barrier or not and which one to open

Further explanation of these steps is included in the subsequent paragraphs.

2.1.2 RFID

Radio frequency identification (RFID) technology has advanced from anonymity into majority applications that helps speeding up the treatment of things. RFID or radio frequency identification allows to identify from a remoteness, but not like barcode technology, it does so minus to have any need of a line of sight. RFID tags do provide a greater chunk of distinctive IDs as compare to the bar codes and it can also include supplementary data such as producer, good category, and can do measurement of other features like temperature. RFID systems can distinguish a number of tags in the same area not having any aid from human.

RFID has many other features like

- A upkeep tool to automate processes
- Condenses labor, eradicates human errors
- Stuff like wood, plastic, cardboard, stuff other than metal can also be used to read through the tag that are embedded and hidden without the need of any line of sight.
- Applicable in severe environments, like outdoors, near to chemicals, moisture and huge temperatures.

Types

Usually RFID devices are classified into two major types, Active and Passive.

Active tags need a power source. Either they have connection to a powered infrastructure or consume energy stored in an integrated battery. A tag's lifespan is imperfect by the stored energy, balanced in contrast to the number of read operations the device must endure. Transponder connected to an aircraft which is responsible for the identification of its national origin can be one specimen of a tag that is active by type.

Passive tags are of attention because the tags don't need batteries or maintenance. The tags also have an unlimited operational life and are sufficiently small to fit into a practical adhesive sticker. A passive tag contains three parts: an antenna, a semi- conductor chip attached to the antenna, and some form of encapsulation. The tag reader is accountable for powering and communicating with a tag. The tag antenna captures energy and transfers the tag's ID. The encapsulation keeps the tag's integrity and protects the antenna and chip from different conditions or elements of the environment.

Principle of RFID

Two primarily dissimilar RFID scheme methods happen for transfer of the power through the receiver to the tag: magnetic induction and electromagnetic (EM) wave capture. They utilize the properties of EM linked with a Radio Frequency antenna—the near field and the far field. Enough power can be allotted to a far placed tag to carry on its activities—normally it is from 10 micro W and 1mili W.

Privacy Issues

Huge focus has been gained by RFID in past years along with the privacy concerns associated with this technology. Concern of privacy by different advocates although a large number of the companies consider RFID use with ethical concern but without any proper attention, this technology can be used to breach the privacy of at both individual and at whole level. The major issue is of such technologies is that they have a channel for their communication which is invisible problem, hence therefore occurrence of the communication is not known.

2.1.3 Image Acquisition

This point onwards, the process of recognizing the face begins. The person is required to give a face image to the system performing the face recognition. And Raspberry pi camera will be used to get the image of the user.

2.1.4 Database

Here onwards the real task of programming and face recognition begins. We have a number of images captured and stored in a database. In the training set, the format of the database used is of AT&T's database available. In here, we have images from different angles with different illuminance and other errors that may occur during the recognition process as every algorithm have some limitations.

2.1.5 Image Normalization

After the images have been stored in a database, next step is to apply the algorithm. The first step in our algorithm is to normalize the images. It is done by taking all the images and converting them into a matrix. If an image is of dimension MxN, then we convert it to a column of MNx1 size and after this process has been implemented onto all images the matrix is obtained. Now all these columns have some common features as do the images have. So we calculate the mean from these. Next step is to subtract each column from the mean and the columns obtained after taking the difference are used in production of another matrix. This matrix is called the normalized matrix and the step is reckoned as image normalization.

Principal Component Analysis

A major issue in analyzing such multidimensional data is the complicated dimensionality. PCA is a technique for reduction of these high dimensions based on extraction of principal components from such high-dimensional data. As defined in a number of papers, it is a technique for visualizing high dimensional data. By maintaining the variance high as possible, PCA lessens the dimensionality of data set. It is also used to obtain Eigen faces as well as the Eigen vectors and Eigen values.

Many issues are there to be taken into account while choosing a recognition method. The key ones are given below;

- Its availability function
- Its function of being accurate
- Its function related to time limitations
- Its function process speed

Face recognition using PCA has been classified as comprising of 3 steps;

a) Preparing the data base b) Train the database c) Testing

The objective of using PCA for Eigen faces is to perform the extraction of related information from a face image, encoding it as efficiently as possible and their comparison with each face in the database. Mathematically, the need is to seek the principal components of face distribution, or the eigenvectors of covariance matrix of the image set of faces. According to the theory, a collection of face images can be approximately reconstructed using the storage of small collection of weights for every face stored and a little set of standard pictures.

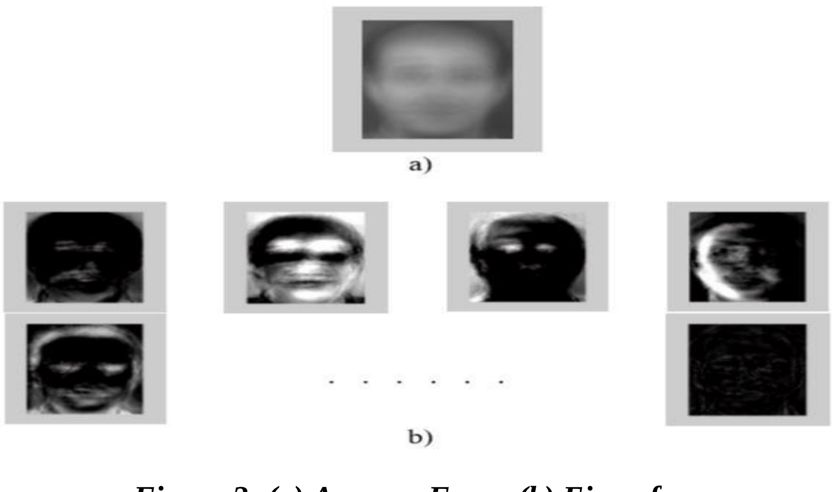


Figure 2: (a) Average Face (b) Eigen faces

2.1.6 Feature Extraction

The Eigen faces computation and feature extraction is done through the procedure described below;

Suppose the train set of face images be $\Gamma_1, \Gamma_2, \Gamma_3, \ldots, \Gamma_M$. The average face of this set will be given as

$$\Psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n$$

Every face varies from the mean face (average) by a vector

$$\phi_n = \Gamma_n - \Psi$$

Principal component analysis is then applied to this set of very big vectors, which finds a set of M no. of orthonormal vectors μ_n and their corresponding Eigen values λ_k which explains the distribution of the data effectively. These are the eigenvectors and Eigen values respectively obtained from covariance matrix

$$C = \frac{1}{M}\sum_{n=1}^{M}\phi_n\phi_n^T = AA^T$$

where the matrix $A = [\phi_1\phi_2 \ldots \phi_M]$, A^T is a transposed one. The matrix C is N^2 by N^2, and to calculate the N^2 eigenvectors and Eigen values is a huge task for usual image sizes. We need a method for this task which is feasible with computations. For this, we will calculate the eigenvectors by solving a very small M by M matrix problem firstly, and then taking a linear combinations of the obtained vectors.

Consider the eigenvectors v_n of A^TA such that $A^TAv_n = \lambda_n v_n$.

Premultiplying both sides by A, we have $AA^TAv_n = \lambda_n Av_n$

from where we see that $\mathbf{A}v_{\mathbf{n}}$ are eigenvectors of matrix $\mathbf{C}$. Using this analysis, we build a M by M matrix $\mathbf{L} = \mathbf{A}^T\mathbf{A}$, where $L_{m,n} = \phi_m^T \phi_n$ and find the M number of eigenvectors v_n of this matrix $\mathbf{L}$. These vectors help to calculate linear combinations of the M training set of face to get Eigen faces u_n. Using this process, calculations are reduced to a lesser number from the order of pixels of images (N^2) to the order of images quantity in training set i.e. M. Practically, training set of faces will be smaller ($M<<N^2$), and calculations can now be managed. The associated eigenvalues help us sort the eigenvectors depending upon their usefulness in characterizing the difference among images. Once the Eigen faces have been found, the image is then projected onto "face space".

This whole process has been explained by following diagram;

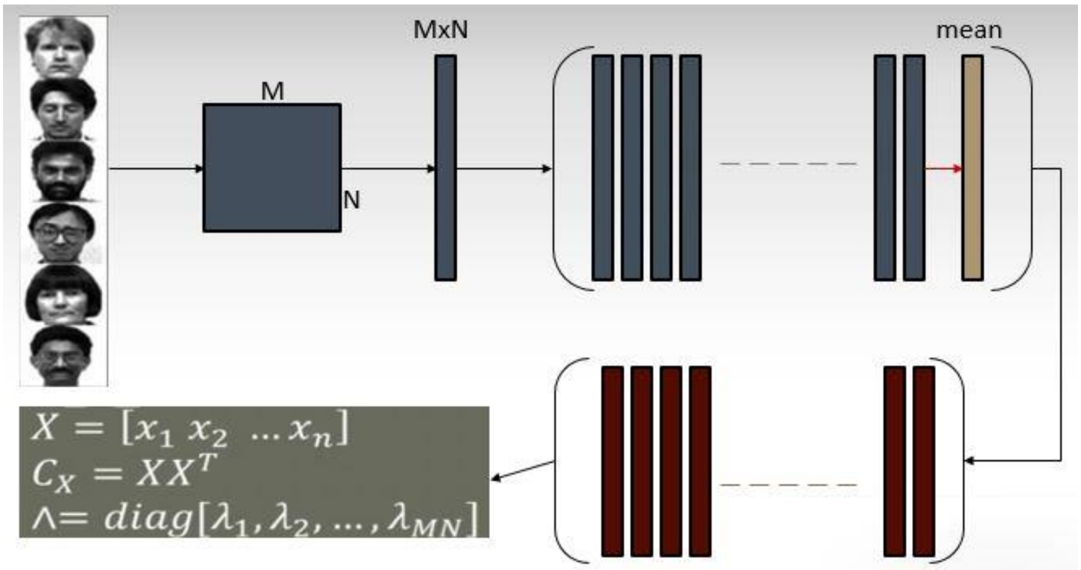


Figure 3: Calculation of Eigen vectors & Eigen values

2.1.7 Image Recognition

The module for recognition is the last one of proposed model for facial recognition where we use a test image as an input. This image is firstly processed as per the procedure mentioned above and afterwards we calculate the Euclidian distance of test case. Next the distance is calculated from database images also and difference is taken. On the basis of the threshold decided, we conclude whether the image is verified or not.

3. Chapter 3

3.1 Design and Development

3.1.1 Design Requirements

Major requirements of designing the system have been listed and explained in this section. These have been listed below:

- Raspberry pi as the main module for image processing
- A camera (Raspberry pi camera) for image acquisition
- Tolerance to facial expression / appearance (including open and closed eyes, facial hair)
- Inability to variate to light conditions (different brightness conditions)
- Face occlusion which involves presence of sunglasses, hat etc.
- RFID tags for vehicle identification
- RFID receiver for verification
- Motors to operate the barriers
- Microcontroller for final decision making and operating motors
- LEDs and Display for decision output

3.1.2 Hardware Design

The hardware design have been shown in the figure below.

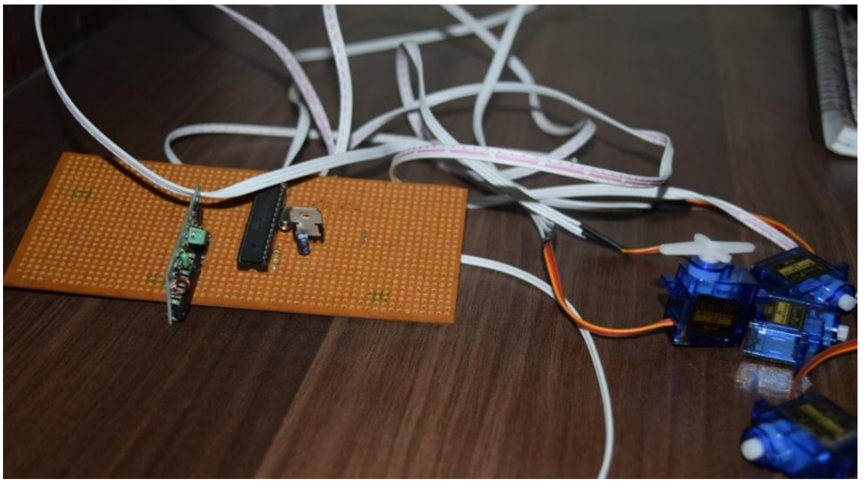


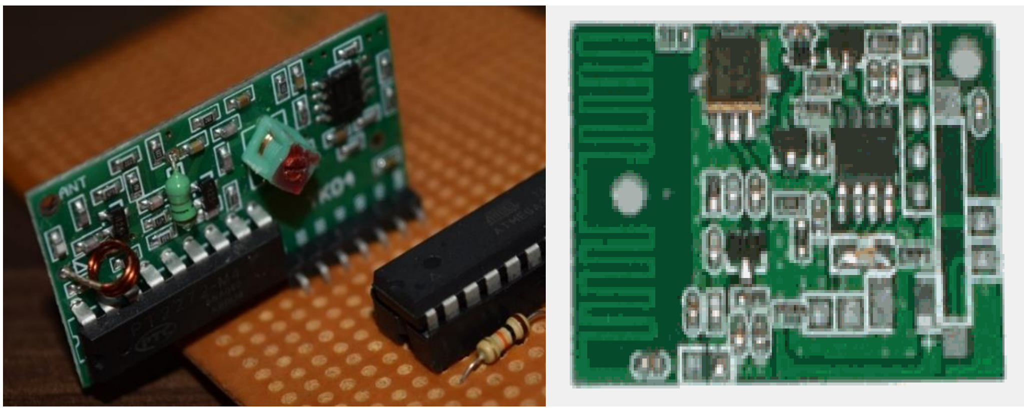
Fig 4: Hardware Module Design

The design is composed of following modules and equipment:

RFID Reader and Tags

RFID can provide identification from some distance without the need of a line of sight. RFID tags usually can support a large set of unique IDs. RFID systems have the ability to discern a number of different tags in the same area without the need of any human resources. RFID is used for capturing data automatically allowing identification of objects without the need of any contact through radio frequency. Tags can be embedded or hidden without any need for line-of-sight. They are readable through wood, plastic, any material other than metal.

Our project make use of active tags and readers. As readers with greater range are costly so for economical project, a relatively low range reader is being used. The multipurpose reader has a receiver part and a decoder part on the board. The receiver part receives the data and the decoder part decodes the data back into the form required. Moreover, if passive tags are being used, they need to be placed on the reader to get the energy for transmission of their identity number which is not feasible as every vehicle driver will need to move out and place the card, so to avoid any inconvenience, active tags are used which contain their own source and can transmit the identity without the need of reader to power them up.



(a) ***(b)***

Fig 5: (a) RFID reader (b) Active Tag Circuit

Camera Selection

Facial recognition desires for a good and accurate camera having good resolution and capabilities like pan, incline or zoom.

Raspberry Pi Camera

It is a 5MP (2592×1944 pixels) camera which comes with the Raspberry Pi itself. It has Omni vision 5647 sensor in a fixed focus module. Raspberry Pi has a built-in port for the camera. It's plug and play with the raspberry pi itself and is easy to use. This will be an economical option to be used in our project.

Modules

The Hardware module of our Project is managed through the microcontroller module which has been interfaced with Raspberry Pi to which the camera being used for image processing is connected. This module allow only authenticated personnel to enter or leave a facility making use of an automatic mechanical barrier. Further detail of the modules is explained below.

AT-MEGA 328 Microcontroller

The high-performance 8-bit microcontroller having read while write capability, 1kb EEPROM, 23 general purpose input / output lines, 32 general purpose registers, 3 flexible timers having compare modes, programmable watchdog timer having an internal oscillator, and 5 software selectable power saving modes. The operating voltage is 1.8 - 5.5 V.

Having ability to execute powerful instructions in just one clock cycle, the device maintains a balance between power consumption and processing speed. The AT-Mega 328 is commonly used in a lot of projects and systems where we usually need a simple, less powerful and cheap micro-controller.

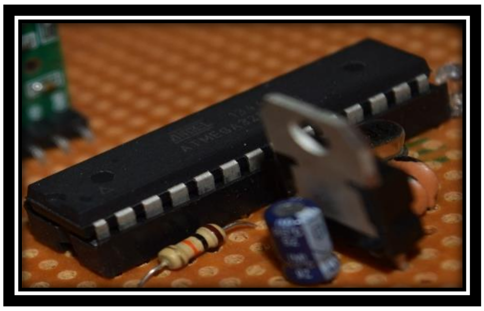


Fig 6: AT-MEGA 328 Microcontroller

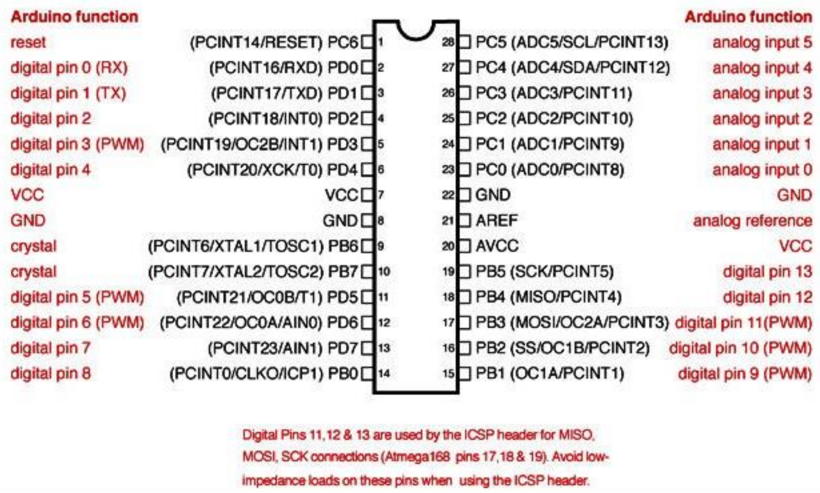


Fig 7: Pin configuration of AT-MEGA 328

We use the above mentioned device because of its processing speed and power. The machine cycle i.e. the time needed by a microcontroller to complete one smallest instruction for AT 328 is one clock pulse while that for other options like AT 89S51 is 12 clock pulses. This gives the extra edge to 328 over 89S51 in terms of processing speed. Moreover, with the use of an oscillator, the speed is increased with a 64 MHz cycle. Thus the use of AT-Mega 328 is preferred as compared to 89S51.

Raspberry Pi 3.0

Raspberry pi is a single board computer. It is a credit card sized device and has strong data processing capability. Moreover, It is light weight and easier to carry.

Its key features include:-

- 4 USB ports
- LAN port
- 3.5 mili meter audio jack port
- HDMI as well as camera port
- 1.2 GHz processor (quad core one) with 1 GB RAM
- Bluetooth and Wi-Fi
- 40 GPIO pins

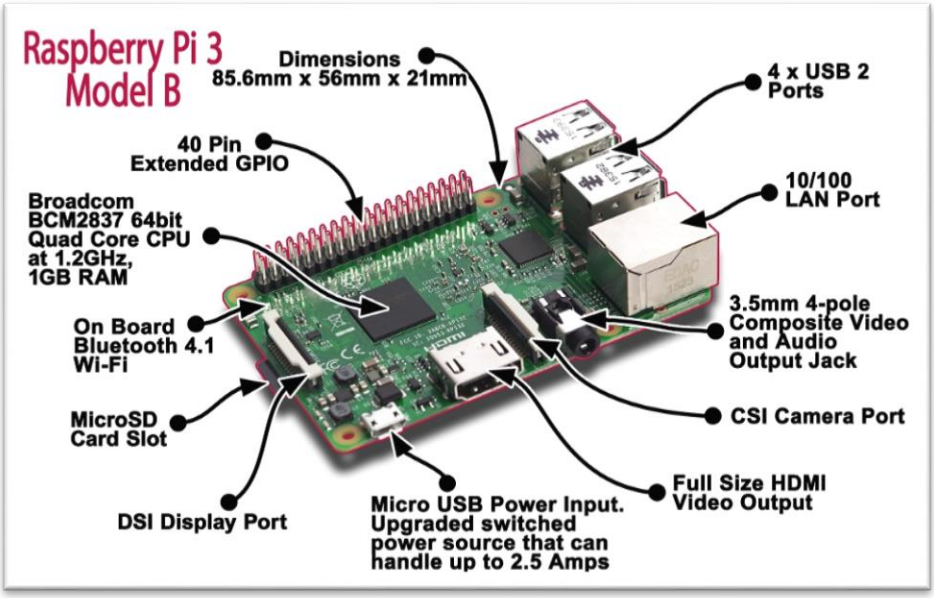


Figure 8: Raspberry Pi 3.0

The main purpose of using Raspberry Pi is to make the image processing faster and easier as well as to reduce the load from the Microcontroller as it would not be feasible for microcontroller to perform image processing because the process would increase the load on microcontroller.

Motors

Motors are devices which use electrical energy and produce mechanical energy. The purpose of motors in our project is to control the movement of barriers on the main entrance as well as the parking lots. There are different types of motors that can be used for this task. A brief explanation is given below.

Servo Motors

A servomotor allows one to precisely control angular or linear position. It comprises of a suitable motor which has been coupled to some sensor for positioning feedback. Moreover, it requires a sophisticated controller designed especially for it. Servomotors find their use in many applications which include robotics, automatic manufacturings and CNC machinery.

Servomotors generally find used as an alternative to the stepper motor with features like higher performance. Stepper motors contain built-in output steps so it is not very smooth. Like a stepper has a defined step of minimum 0.7 degrees so it can't stop till the end of the step. A servomotor, on other hand, have no such defined steps. Also, the torque of servomotors is much greater than stepper. The torque is inversely dependent on rounds per minute. So in servo motors, shafts and gears are used to decrease rpm to increase torque. A small sized servomotor has a torque of almost 90 grams. For same amount of torque from a stepper motor you will need the stepper motor of a very large size than the servo one. Having bigger systems, where a potent motor represents a growing proportion of the system cost, servomotors find themselves ahead.

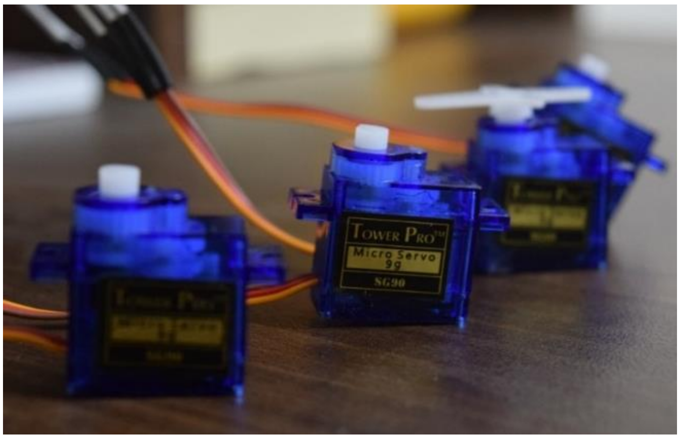


Fig 9: Servo Motor

Other Components

1. Resistor

Resistor of the value 10k is used here. A resistor is a two-terminal passive component which implement electrical resistance as circuit element. These are used to reduce the flow of current in electronic circuits, to split voltages and terminate transmission lines among other uses.

2. Voltage Regulator

Voltage regulator is designed to perform automated maintenance of a constant voltage level to 5V. It may be simply a feed forward design or can include negative feedback control loop. It can also make use of some electromechanical mechanism or even electronic components.

3. Crystal Oscillator

A local oscillator (crystal) is an oscillator circuit that make use of mechanical resonance of some vibrating crystal to produce an electrical signal with some precise frequency. It usually is used to generate clock pulses of 16MHz.

4. Capacitor

Capacitor is a device used to store charge and these are widely used in electrical circuits in a lot of devices. Unlike resistor, no energy is dissipated by an ideal capacitor. Instead, it stores energy as a field between the plates.

5. LED

Light Emitting Diode would glow when Raspberry Pi gives signal to microcontroller.

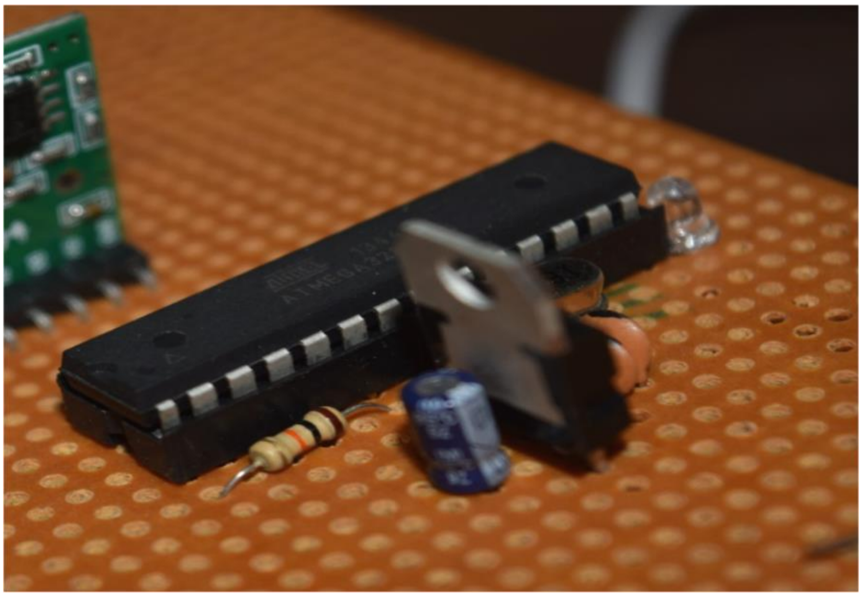


Fig 10: Minor components of the circuit

3.1.3 Software Design

The software and the interface has been explained below.

Python

We have used Python because it is easy to process images with it as it is faster as well as easy to learn for beginners. Python is supported by Raspberry pi for image processing purpose and it also supports Open CV as well as Visual Studio as a compiler. Itself it is a command line interface language however for full programs, above compilers can be used. It’s computing time is less than other languages and it is also more hardware oriented. Moreover, it is also easier to use and execute than other competitors in the market. Python possess a large library, which is cited as one of Python's major strengths thus providing some tools suitable for many tasks.

NOOBS

In getting started with Raspberry Pi, some operating system is needed. New Out of Box Software or NOOBS is an operating system manager for Raspberry Pi and is an easy installation manager for Raspberry Pi. It is a disk image that can be copied onto a newly formatted SD card. Following operating systems are presently a part of NOOBS;

- Raspbian
- Pidora
- LibreELEC
- OSMC
- Arch Linux

Code for Microcontroller Programming and Compiler

To program the microcontroller used in the hardware, we make use of C & Arduino for AT-Mega 328 because of its immense library of inbuilt functions and easiness to use the language for code. The microcontroller which has been used in the hardware is meant for performing the very basic functions in the system as explained in previous topics.

a) Establishment of communication with Raspberry Pi module
b) Directing mechanical barriers through Servo motors
c) Displaying the status of the AT 328 final decision making with the help of LED.

Algorithms

The algorithms used have been listed here.

- PCA is used for face recognition.
- Algorithm to match the results of Image processing & RFID

Techniques

Dimensionality and computation reduction techniques have been used in the system which include:

1. PCA for dimensionality reduction.
2. Eigen vectors & Euclidean Distance for computation

4. Chapter 4

4.1 Testing and Evaluation

4.1.1 Design Evaluation

The evaluation process has been performed under certain lightening and face orientation conditions which include specified lightening and orientation good enough for recognition process. The threshold value of confidence level has been fixed at 85 for normal recognition. If increased, the recognition process can be relaxed further and vice versa. The whole process has been explained and demonstrated below.

The model of our project is as shown in the figure;

Fig 11: The designed model

Creating the Data Base

Database needs to be created and images of people who are to be recognized are to be stored there. First of all, good images are needed to be selected for recognition. They are then to be cropped and converted to gray scale and then stored in a folder (in our case "Yale Faces"). Similarly tag numbers are to be stored in the controller for matching as well. Incoming images from live feed are to be matched here.

Following images show the loading of these images into the processor for recognition and matching process.

Fig 12: Loading images from database

After the loading, next step is to go for the working for each type.

Working for Faculty Case

For this case, we suppose that GC Sohail is a faculty member and has the vehicle tag as well as he is registered as a faculty member with his images in database, so he needs to make use of both of these.

First of all, he is supposed to show his face for recognition purpose. It has been shown in the figure below that once GC Sohail comes in front of camera, how his face would be recognized.

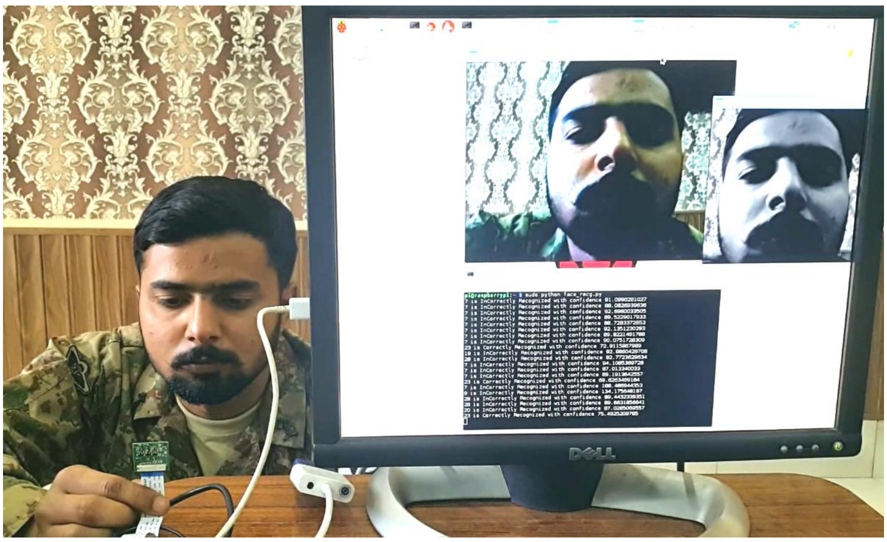


Fig 13: Face recognition of GC Sohail

After the face has been recognized with desired confidence level, next step is verification through RFID. Now the light on the tag shows that it is transmitting at the moment. Once any signal is being received at the main room i.e. the control room, the LED fixed here would glow to depict the reception. It can be seen in the figure below.

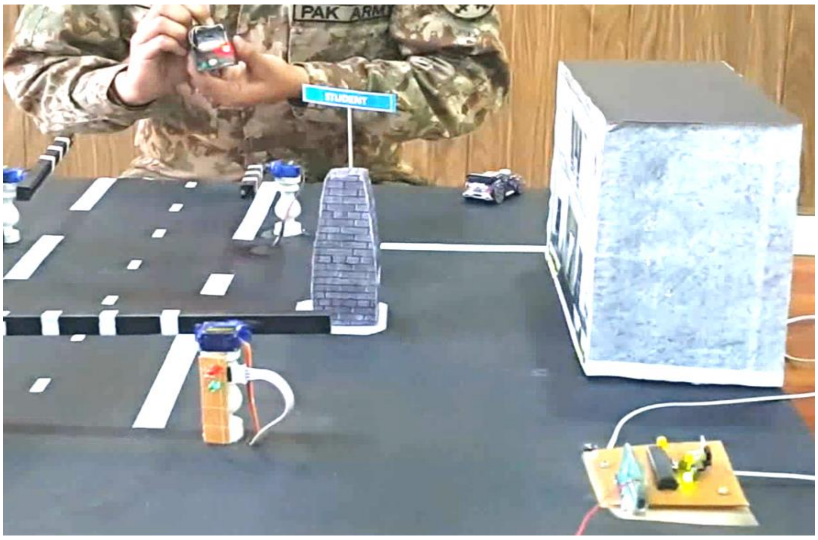


Fig 14: Verification through RFID

The green LED placed beside the main barrier indicates that the tag has been verified and the specified person is granted access to enter. So the barriers will start operating now as seen from the figure.

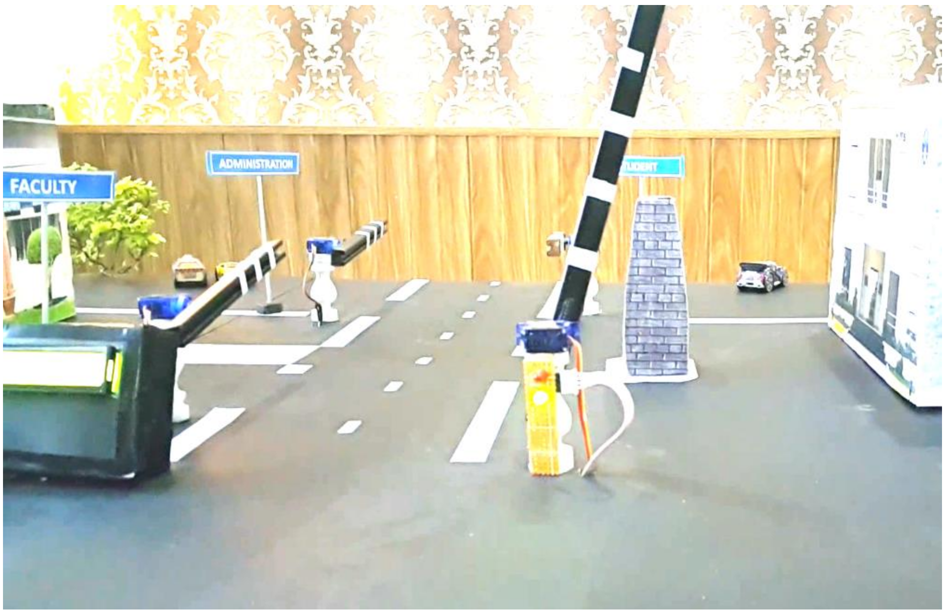


Fig 15: Main barrier opening

The main barrier is seen open here and the required parking's barrier will follow. Since the case was for faculty, the faculty parking barrier is open and none other. So the vehicle can only be parked in the mentioned parking.

Fig 16: Faculty parking barrier opening

So the faculty parking barrier is open and the case working is good.

Working for Student

Similarly the working for student has been demonstrated by GC Haseeb however in this case, we would not focus on opening of the main barrier rather go straight for the specific parking barrier opening here.

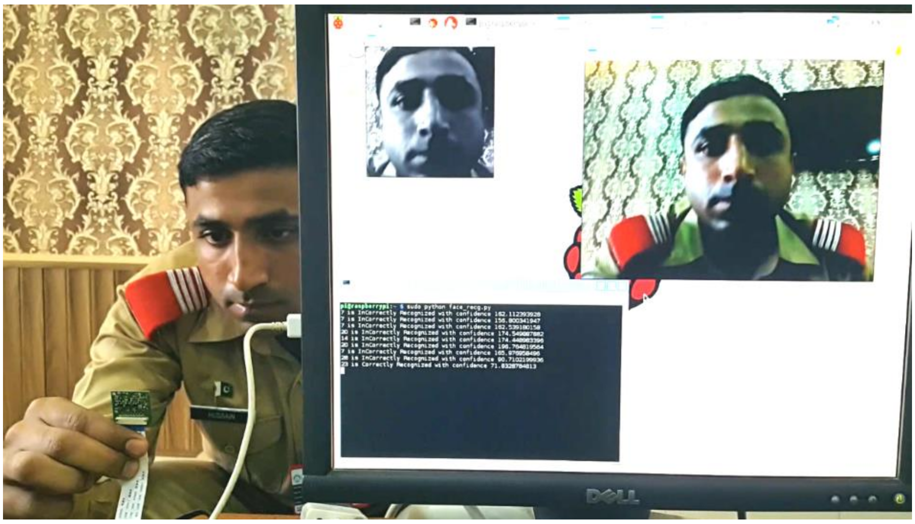


Fig 17: Face recognition of GC Haseeb

After facial recognition, next step is the verification using RFID. Here again, as any signal will be received in the control room, the LED fixed here would glow to depict the reception. It can be seen in the figure below.

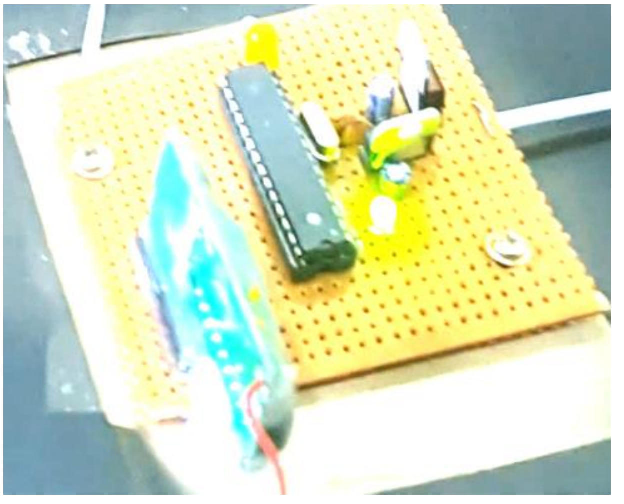


Fig 18: RFID verification

The required parking's barrier will follow the opening of main barrier. Since the case was for faculty, the student parking barrier is open and others stay closed. So the vehicle can only enter in the student parking.

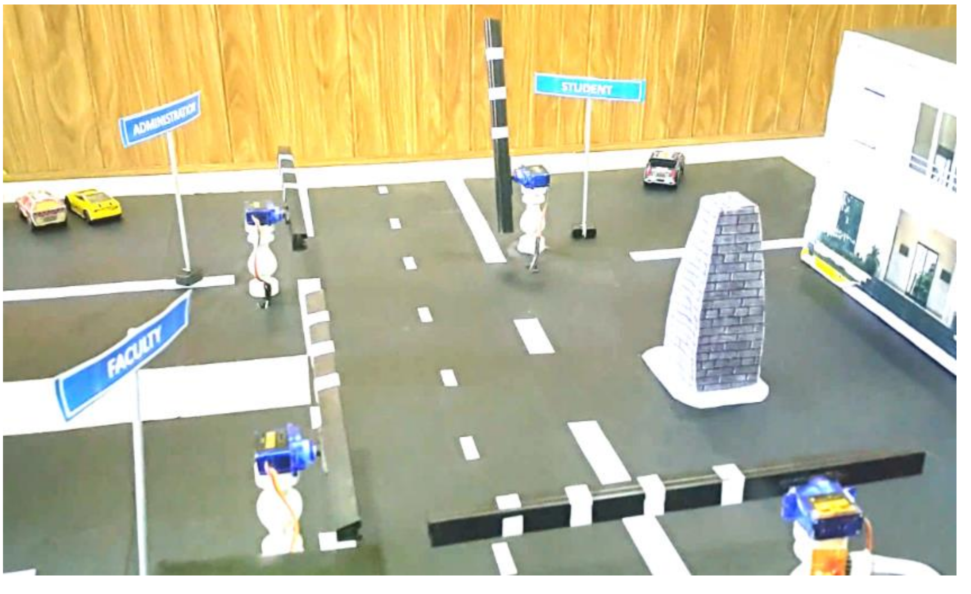


Fig 19: Student parking barrier opening

Working for Administration

The working of administration parking once someone from that branch follows the very same process as well. Demonstration is carried out by GC Fahad. First step of face recognition is shown below.

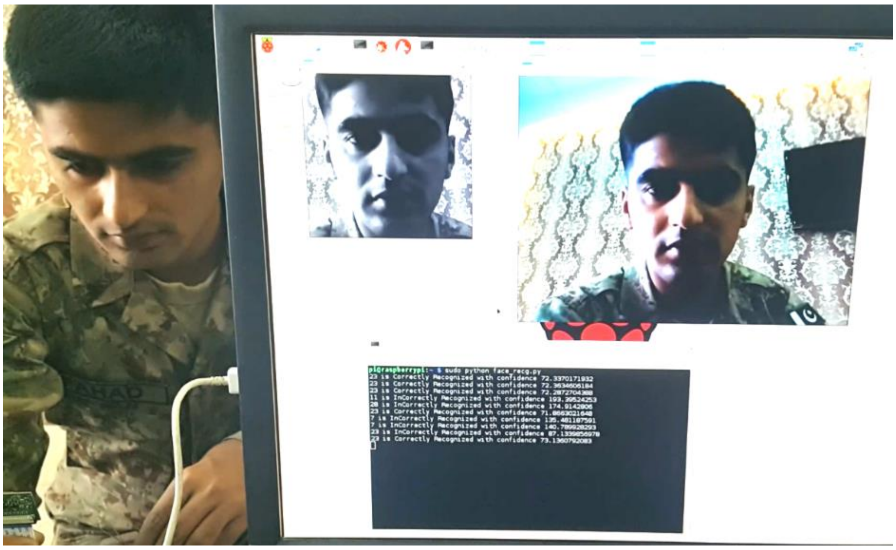


Fig 20: Face recognition of GC Fahad

Next step is the verification by RFID. As a signal will be received, the LED fixed at the control room would glow to depict the reception. It has been shown in the figure below.

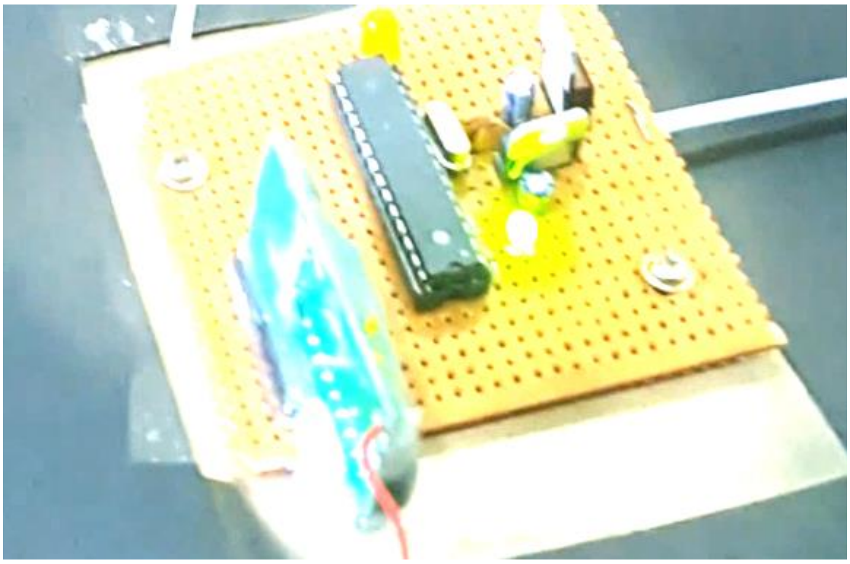


Fig 21: RFID verification

The last step is the opening of required parking's barrier following the main barrier. Since the case depicted here by GC Fahad is for administration, the respective parking barrier is open while others stay closed. So the vehicle can only enter in the respective parking.

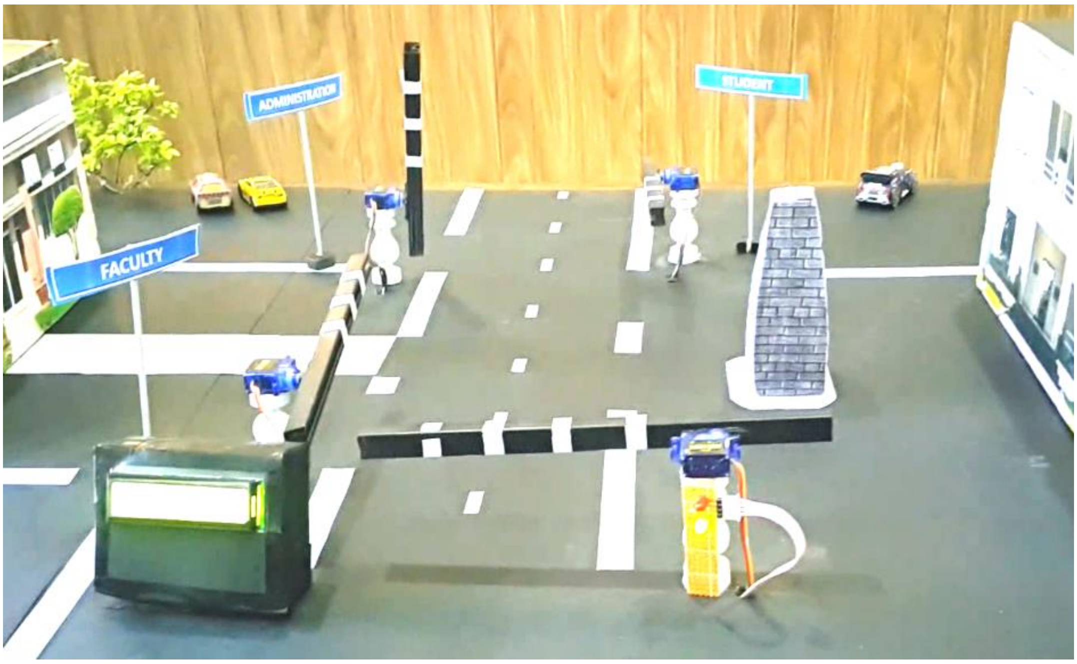


Fig 22: Administration parking barrier opening

5. Chapter 5

5.1 Future Work

The project has been implemented using Raspberry pi and is a stand-alone project. However, improvements can be made in future. Any stand-alone projects have advantages and limitations at the same time. So a room for improvement always stay there. Use of technology is a good step but at the same time, there can be misuse of it for different purposes so any single technical method is not enough. Here are a few recommendations for future work regarding the project.

5.1.1 Biometric Authentication

As stated earlier, any method is not considered enough to deal with problems. So the biometric authentication methods can be combined with the already present face recognition technique to produce better results and result in a better and efficient system. Some of the biometric authentication techniques include;

1. Fingerprint scan
2. Hand geometry
3. Retina and Iris patterns
4. Earlobe geometry
5. Voice recognition etc.

5.1.2 Multiple Face Detection

Multiple face detection and recognition algorithms can be made as it will ensure better efficiency in different conditions and scenarios. In the project, only one face can be detected at a time. For multiple face detection, an algorithm can be used which can detect more than one face in the image thus improving the performance of the system.

5.1.3 Security Modules

Due to unsatisfactory security conditions in the country, security is another major concern at many places. For this purpose, a manual security checkup can be included with dog sniffing and manual checking of the vehicle before entering. It will require human resources to be implemented along the system as well.

6. Chapter 6

6.1 Conclusion

The project is a prototype developed which can be used at entry point of an organization. The system not only increases the efficiency of face recognition but also has made the entire process faster than usual. So any vehicle approaching will be checked whether he is a registered one and has permission to enter the premises of the building or not.

6.1.1 Advantages

The projects has following advantages based upon our results.

- The face recognition process has been made faster by reducing the complexity involved in computation.
- The efficiency of the system is increased by combination of RFID and face recognition technique.

6.1.2 Drawbacks

Following are the drawbacks in the system deduced from the results.

- Light must be optimum for the system to recognize an image. It has been made project suitable only at locations where light is optimum
- Face must be completely in front of the camera for feature extraction (Non-frontal view of the face)
- Facial changes due to aging cannot be detected using the process
- At lower confidence level once too strict recognition is needed, the system will take time to compute the results or to recognize a face

7. Bibliography

7.1 Previous Projects Done In MCS

Project title	Group members	Year
Automatic Face Recognition System	Badar Munir Shehryar Ahmad Afaq Rafiq Muhammad Faraj	2014

7.2 References

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- Face Recognition Using Principal Component Analysis Method by Liton Chandra Paul & Abdulla Al Sumam, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 1, Issue 9, November 2012

- M. Turk and A. Pentland, “Face Recognition using Eigen faces,” Proc. IEEE Conf. on Computer Vision and Pattern Recognition, pp. 586-591, 1991

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- https://qph.ec.quoracdn.net/main-qimg-675082c9b42f0388d4f40ae3d25dfa7b-c?convert_to_webp=true

- https://www.element14.com/community/servlet/JiveServlet/showImage/102-80899-15-252356/Pi3+Breakout+Feb+29+2016.png

8. Code

8.1 AT-Mega 328 Microcontroller Code

```
#include <Servo.h>

Servo Main_Servo;
Servo Servo_1;
Servo Servo_2;
Servo Servo_3;

int RFID_1 = A2;
int RFID_2 = A3;
int RFID_3 = A4;
int RFID_4 = A5;
int Pi = 12;

int RFID_1_State = 0;
int RFID_2_State = 0;
int RFID_3_State = 0;
int RFID_4_State = 0;
int Pi_State = 0;

void setup() {
 pinMode(8, OUTPUT);
 pinMode(7, OUTPUT);

 pinMode(RFID_1, INPUT);
 pinMode(RFID_2, INPUT);
 pinMode(RFID_3, INPUT);
 pinMode(RFID_4, INPUT);

 Main_Servo.attach(6);
 Servo_1.attach(9);
 Servo_2.attach(10);
 Servo_3.attach(11);
 digitalWrite(8, LOW);
 digitalWrite(7,LOW);
 servo_test();  }
```

```
void servo_test(void)
{
  Main_Servo.write(150);
  delay(200);
  Main_Servo.write(50);
  delay(200);

  Servo_1.write(150);
  delay(200);
  Servo_1.write(50);
  delay(100);

  Servo_2.write(150);
  delay(200);
  Servo_2.write(50);
  delay(100);

  Servo_3.write(150);
  delay(200);
  Servo_3.write(50);
  delay(100);

  //digitalWrite(8, HIGH);
  delay(1000);
  //digitalWrite(8, LOW);   }

  void Main_open(void)
  {
      Main_Servo.write(150);
      delay(4000);
      Main_Servo.write(50);
      delay(5000);
 }
 void One_open(void)
 {
      Servo_1.write(150);
      delay(4000);
      Servo_1.write(50);
      delay(200);
 }
 void Two_open(void)
 {
      Servo_2.write(150);
```

```
    delay(4000);
    Servo_2.write(50);
    delay(200);
}
void Three_open(void)
{
    Servo_3.write(150);
    delay(4000);
    Servo_3.write(50);
    delay(200);
}

void loop() {
  Pi_State = digitalRead(Pi);
  if(Pi_State == HIGH)
  {
     RFID_1_State = digitalRead(RFID_1);
    if(RFID_1_State == HIGH)
    {
      digitalWrite(8, HIGH);
      digitalWrite(7,LOW);
       Main_open();
       One_open();
       RFID_1_State = LOW;
    }
   RFID_2_State = digitalRead(RFID_2);
   if(RFID_2_State == HIGH)
   {
      digitalWrite(8, HIGH);
      digitalWrite(7,LOW);
       Main_open();
       Two_open();
       RFID_2_State = LOW;
   }
    RFID_3_State = digitalRead(RFID_3);
    if(RFID_3_State == HIGH)
    {
      digitalWrite(8, HIGH);
      digitalWrite(7,LOW);
       Main_open();
       Three_open();
       RFID_3_State = LOW;
    }
```

```
  RFID_4_State = digitalRead(RFID_4);
  if(RFID_4_State == HIGH)
  {
   digitalWrite(7, HIGH);
   digitalWrite(8,LOW);
   RFID_4_State = LOW;   }

  delay(2000);
  digitalWrite(8, LOW);
  digitalWrite(7,LOW);
  Pi_State = LOW;
 }
 else
 {
  digitalWrite(7,LOW);
  digitalWrite(8,LOW);
  } }
```

PIC Code

```
void main(void)
{
while(1)
{
if((!PIN_A0) && (!PIN_A1))
{
lcd_gotoxy(1,1);
lcd_putc("    WELCOME     ");
}
else if((!PIN_A0) && (PIN_A1))
{
lcd_gotoxy(1,1);
lcd_putc("Access Granted  ");
}
else if((PIN_A0) && (!(PIN_A1))
{
lcd_gotoxy(1,1);
lcd_putc("Access Denied   ");
}}}
```

8.2 Python Code

```
#include "opencv2/core/core.hpp"
#include "opencv2/contrib/contrib.hpp"
#include "opencv2/highgui/highgui.hpp"
#include <iostream>
#include <fstream>
#include <sstream>

using namespace cv;
using namespace std;

static Mat norm_0_255(InputArray _src) {
   Mat src = _src.getMat();
```

Create and return normalized image

```
    Mat dst;
    switch(src.channels()) {
    case 1:
        cv::normalize(_src, dst, 0, 255, NORM_MINMAX, CV_8UC1);
        break;
    case 3:
        cv::normalize(_src, dst, 0, 255, NORM_MINMAX, CV_8UC3);
        break;
    default:
        src.copyTo(dst);
        break;
    }
    return dst;
}
```

Getting reference image from file

```
static void read_csv(const string& filename, vector<Mat>& images, vector<int>&
labels, char separator = ';') {
    std::ifstream file(filename.c_str(), ifstream::in);                //reading saved image
    if (!file) {
         string error_message = "No valid input filename.";          // if did not find the
                                                                              image file
        CV_Error(CV_StsBadArg, error_message);
    }
    string line, path, classlabel;
    while (getline(file, line)) {
        stringstream liness(line);
        getline(liness, path, separator);
        getline(liness, classlabel);
```

```
        if(!path.empty() && !classlabel.empty()) {
            images.push_back(imread(path, 0));
            labels.push_back(atoi(classlabel.c_str()));
        }
    }
}

int main(int argc, const char *argv[]) {

// Check for valid command line arguments

    // if no arguments were given.

    if (argc < 2) {
        cout << "usage: " << argv[0] << " <csv.ext> <output_folder> " << endl;
        exit(1);
    }
    string output_folder = ".";
    if (argc == 3) {
        output_folder = string(argv[2]);
    }
```

Get the path to CSV

```
 string fn_csv = string(argv[1]);
    // vectors to hold the images and labels.
    vector<Mat> images;
    vector<int> labels;
    // read the data. fail if no valid
    // input filename .
    try {
        read_csv(fn_csv, images, labels);
    } catch (cv::Exception& e) {
        cerr << "Error opening file \"" << fn_csv << "\". Reason: " << e.msg << endl;
        // quit
        exit(1);
    }
    // quit if there are not enough images
    if(images.size() <= 1) {
        string error_message = "Add more images";
        CV_Error(CV_StsError, error_message);
    }
    // getting the height from the first imag
    int height = images[0].rows;
    //that the training data (which we learn the cv::FaceRecognizer on)
    Mat testSample = images[images.size() - 1];
```

```
    int testLabel = labels[labels.size() - 1];
    images.pop_back();
    labels.pop_back();
```

Eigenfaces model & training it with CSV file

```
    Ptr<FaceRecognizer> model = createEigenFaceRecognizer();
    model->train(images, labels);

    string result_message = format("Predicted class = %d / Actual class = %d.",
predictedLabel, testLabel);
    cout << result_message << endl;
    // getting the eigenvalues of this Eigenfaces model:
    Mat eigenvalues = model->getMat("eigenvalues");

    Mat W = model->getMat("eigenvectors");
    // sample mean from the training data
    Mat mean = model->getMat("mean");
    // display the image or save
    if(argc == 2) {
        imshow("mean", norm_0_255(mean.reshape(1, images[0].rows)));
    } else {
        imwrite(format("%s/mean.png", output_folder.c_str()),
norm_0_255(mean.reshape(1, images[0].rows)));
    }
    // display or save the Eigenfaces
    for (int i = 0; i < min(10, W.cols); i++) {
        string msg = format("Eigenvalue #%d = %.5f", i, eigenvalues.at<double>(i));
        cout << msg << endl;
        // get eigenvector #i
        Mat ev = W.col(i).clone();
        // reshaping to original size & normalize
        Mat grayscale = norm_0_255(ev.reshape(1, height));
        // image showing and applying Jet colormap for better result.
        Mat cgrayscale;
        applyColorMap(grayscale, cgrayscale, COLORMAP_JET);

        if(argc == 2) {
            imshow(format("eigenface_%d", i), cgrayscale);            // show the image
        } else {
            imwrite(format("%s/eigenface_%d.png", output_folder.c_str(), i),
norm_0_255(cgrayscale));//save the image
        }
    }
```

```
    for(int num_components = min(W.cols, 10); num_components < min(W.cols,
300); num_components+=15) {
        // slice the eigenvectors from the model
        Mat evs = Mat(W, Range::all(), Range(0, num_components));
        Mat projection = subspaceProject(evs, mean, images[0].reshape(1,1));
        Mat reconstruction = subspaceReconstruct(evs, mean, projection);
```

Normalizing the result

```
        reconstruction = norm_0_255(reconstruction.reshape(1, images[0].rows));

        if(argc == 2) {
            imshow(format("eigenface_reconstruction_%d", num_components),
reconstruction);
        } else {
            imwrite(format("%s/eigenface_reconstruction_%d.png",
output_folder.c_str(), num_components), reconstruction);
        }
    }

    if(argc == 2) {
        waitKey(0);
    }
    return 0;
}
```