

# “SMART CITY SECURITY SOLUTION”



Inspiring Excellence

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## **Declaration**

We, hereby declare that this thesis is based on results we have found ourselves. Materials of work from researchers conducted by others are mentioned in references.

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## **ABSTRACT**

Security issue is one of the very leading concerns for any organization, society or for a city. There are two main challenges for smart cities which are security and privacy. Security includes illegal access of people entering the city and causing any kind of physical or nonphysical disruptions. In present days citizens are more concern about their activities of outside and inside of their house. So giving security and instant response in emergency is a big challenge. After some years it will become a very big issue to give security for this big amount of population. If we think about present and ask you do you ever think how safe is your city? If any kind of incident happens, what will be our steps for detecting criminals? How to protect you city from crimes? Here comes another important factor that is security and when it comes to find criminals, if the automation system is applied successfully in the area, it can help us to narrow down and find the criminals within very short time. Our objective is to provide a security solution to a city which can reduce crime and is also an effective way to identify criminals. We will be using fingerprint scanners and face recognition system to keep track of people. And for vehicle tracking we will use image processing system. We will automatically capture the entire vehicle photo and identify its number plate. And lastly we will match it with our database so that we can keep trace that who is the owner of the car and when the car enter and when it go out. This will also help to easily identify criminals and narrow down the range of suspects for crime scenes.

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## **Chapter 1**

### **Introduction**

We all are living in era of technology. World is now depending on technologies day by day. As following the era, now cities are converting to smart cities. Smart city is such city where there is no place for analog system and everything is digitalized. We are happy to say our Honorable Prime Minister took responsibility to transform our Bangladesh to digital Bangladesh by 2020. According to this step, we are heading to development of smart cities. Many of the developed cities in the world have 24 hours internet connection which is provided by government for general people. As the population increasing day by day, ensuring security in every aspect of the city is a challenging task for the society. It's even impossible to keep trace of everyone in a place by manually. So that, for ensuring proper security we need smart city security solution. Smart city security solution is a solution where we will ensure proper security of people by using internet and technologies. Now days we are facing so much problems to decrease crime rate. By using our solution it may decrease crime rate of a city. We will figure out from human to vehicle's proper identification before entering in an area. By using these methods we can trace anyone. One of the main purposes of our topic is decreasing dependence on human and increasing dependence on technology. Technology is more accurate than human for calculating crime rate and technology can take faster step than human being. So security solution in a smart way is very important for now days.

## **1.1 Motivation**

The concept of the smart city has been introduced to highlight the importance of Information and Communication Technologies (ICT) in the last 20 years.

In literature the term smart city is used to specify a city's ability to respond as promptly as possible to the needs of citizens.

We are trying to develop the quality of life and city core value of a smart city. As we are developing day by day so we are in great need of smart cities. Smart cities are basically more arranged and planned in every sector. As example, we can say about Shagor-Runi murder which was held in 11<sup>th</sup> February, 2012. Still police did not get any clue about killers. Even their security people did not keep any data that were entered to their home. If they had smart city security solution then automatically data would be in database and it would be easier to get criminals. But unfortunately we are not used to smart security system. There are many corruptions happening in our society regarding security issues. If we have smart way then these corruptions will be decreased. If government will use our smart way of security solution then nobody can be part of corruption because everything will happen digitally. We see that top secured cities are technologically very advanced [12]. Most of the people of these cities are very much familiar with using advance technologies. From our point of view, technology is a key factor for ensuring security. If we want to improve our life style then we must be familiar with updated technologies. So, ensuring the security of smart cities we came up with this “Smart City Security System Solution”.

## **1.2 Goals**

Our main purpose of “Smart City Security Solution” is ensuring security and decrease crime rate in a certain area. As crime issue becomes vital problem of our city. If we use technology then we will decrease crime rate and we can easily identify criminals. We will take records of our visitors via biometric system and we will detect numbers from vehicle via number plate detection so that we can easily assume criminals and their crime. Our future goal is face detection method. Biometric process is very familiar to us. Government has our finger print, if they provide us finger print record then we can easy find out where he is from and is he authentic person or not. Biometric process will help to reach our goal of getting criminal. Another process is number plate detection. It will happen automatically. By using this process we can also check validity and also identification that car’s owner. So this process will full fill our goal of getting person’s identification.

## **1.3 Methodology:**

We use a fingerprint recognition module (FPM10A) for our finger print sensor. Then we connect it with arduino. We run the arduino software and run the finger print recognition code. In this part we use the code such a way that, first we will store some finger print and information of them and will give them different ID. Then if a person enters in our city and after giving finger print it will match with our server. If it matches with the server it will show all his or her information. And if the person is authorized then the gate will open. Otherwise the get will not open and the unauthorized person has to give his full valid information to get in the city. Every person has to go through same process while leaving the city. For car number plate detection we use image processing. In this process

when a car will enter in our city a camera will take a photo of that car. The will be attached with the entrance and the exit gate. After taking the original image in our image processing system it will detect the number plate and convert the RGB image to Gray image. Then it will do median filtering. Then it will exact the plate region. It will automatically do segmentation by edge detection. Then by dilating operation it will recognize the characters and will match it with our server.

#### **1.4 Thesis Outline**

The structure of this paper is as follows. Chapter 2 presents our interest and thoughts behind this project and environment setup. List of equipment's and device's connections are given in chapter 3 and 4. In the following chapter we described the detailed procedures for the biometric fingerprint system and implementation of the process as well as the algorithms of the procedures. In chapter 6 we discussed the process of image processing to detect the number plate and extract license number from it. Conclusion, limitation and future work of our project has been given in chapter 7 and 8.

## Chapter 2

### Literature Review

Smart City concept has suggested for planned city with all activity carried out in the city supervised and controlled by technology. Our goal is to provide security to these cities. We will give securities by keeping track of all humans and vehicles entering in the city. We are doing this by two ways. One way is for vehicles and another way for humans. For taking the trace of humans entering the city we will use a finger print access system. And for the trace of vehicles we will use number plate detection using image processing. Though there are some others way to give a city security but we use this two process because this two process is much effective and less costly

We get this idea to build a smart city security system with NID (National Identity) and fingerprint detection [1] to create a safe and protected environment for all the citizens of the city. For finger print access we use a finger print sensor and then connect [5] it with the NID server. After giving the finger print it will automatically match the print with the prints from the server [4] and identify the person and his/her all information. Then it will save his/her identity, entry time in the server. Then while leaving the city they will again give a finger print and that will again match with the server. And also will keep trace of his/her leaving time. If anyone is not from this country it will give a warning so it will be easy to keep trace of foreigners. We will use pattern based [10] (image based) algorithm to detect the fingerprint which can be used to match the fingerprint of a person with his NID [1] fingerprint and keep it in the database. In addition to that[3] we found this security system can be

useful in restricted or important areas of the cities as well as in apartment, shopping mall, museum and in exhibition places too which can prevent any crime from happening and provide a secured city life.

To keep trace of vehicles we will use image processing. First when a vehicle will enter a camera [2] will be set in the gate and then it will take photo of the vehicle. Then by image processing [3] it will identify the number plate and the number. Then it will send the number-plate number to the server and it will found out the owner name and identification. And it will save it to the server. By this system we can easily identify if any stolen car entered in the city.

## Chapter 3

### Project Overview

#### 3.1 Device Setup:

We will be applying our project to small areas by adding the devices at the main entrances and exits of an area. In future, we plan to divide the whole city map into multiple small areas and place these devices at the main entrance and exits of each of these neighborhoods. The system in these small neighborhoods will work separately on their own but they will be connected to each other and can be centrally monitored. In this way, the small areas of the city will work as limbs of a body but together, the whole city will work like a fully functioning body, in order to reduce crime and identifying criminals faster. This will help us to take big step towards building our smart city. At the entrance and exit there will be a finger print sensor booth. Whoever enter or go out from the area have given his finger print so that we can keep track of every person entering and going out of the area. When someone gives his or her finger print it will match it with our data base. And if someone has any kind of criminal report it will also been shown. So it will be impossible for any unauthorized person to enter our city. For vehicles we are using image processing system. When a vehicle will enter or go out our system will capture it picture and by image processing it will identify its number plate number. And then it will match it with our server. So we will easily get the whole information of the vehicle and its owner.



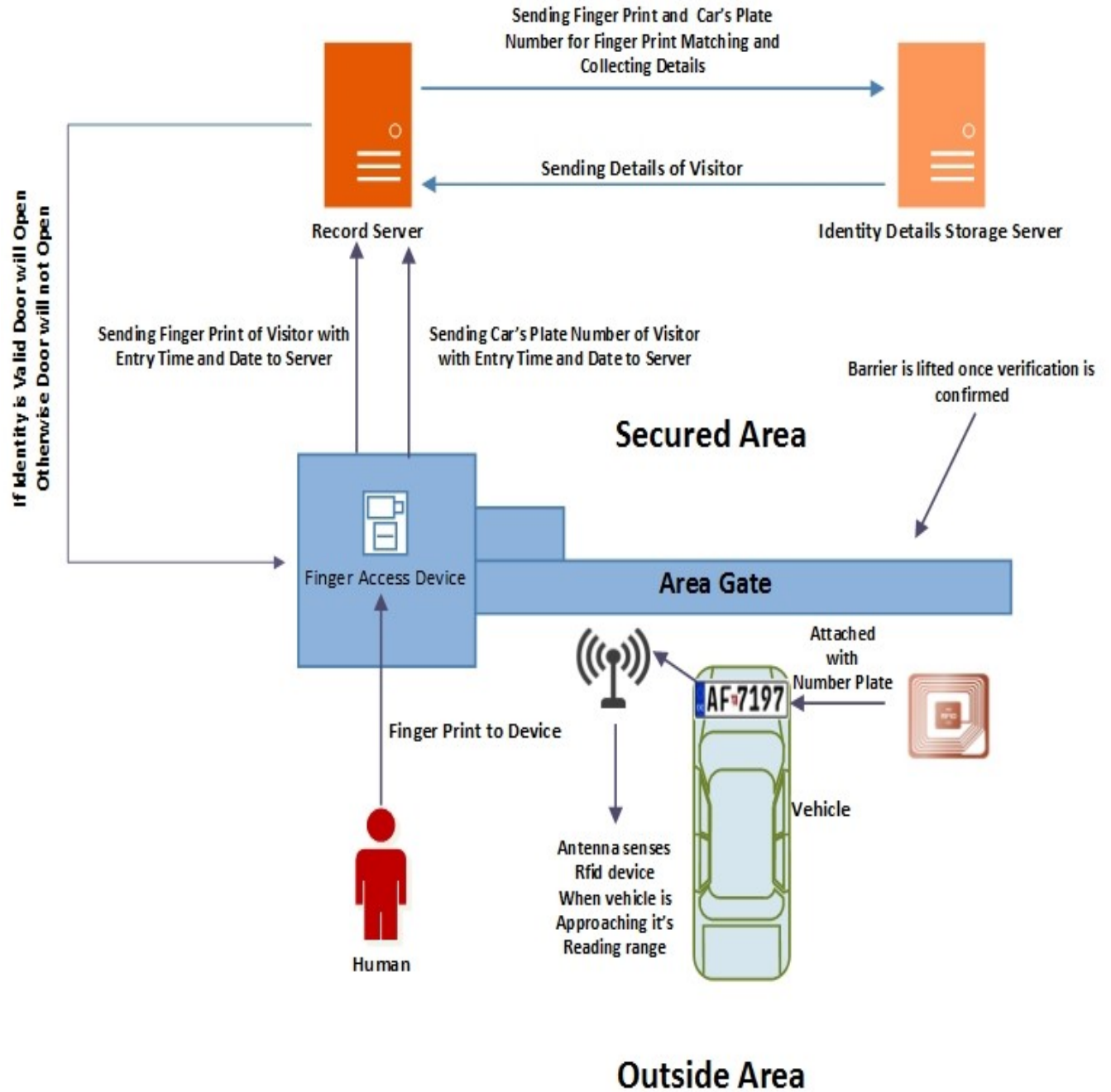


Figure 3.1: Smart City Security System Model

### **3.2 Integrated Database**

We are implementing a system where we already have a database which has NID number, fingerprints and vehicle's license plates number of every citizen of the cities. We will be tracing down every person who enters the area where we will provide a fingerprint sensor at the main entrance. If anyone who wants to enter that area will have to submit his finger print via finger access sensor. That finger access sensor will integrate with database to store that person's finger print and entry time. There will be a database of NID (National Identity) which will compare with finger print of that person to get whole details and check the person's information validity and if valid then the gate would open only. If the finger print doesn't match with NID fingerprint and details then that person's entry is restricted to that area. There will be a lots of CCTV camera installed in our city so that every kind of activities can be recorded. The visitor would also have to give his finger print before leaving the area so the system can keep track of entry and leaving time of a person.

### **3.3 Monitoring Security**

Monitoring vehicles we will use automated number detection method using camera by capturing image of its license plate number and it will differentiate pixels of number plate of a vehicle using opencv3 and will send the output of the image to our system. The system will take the output from camera and convert it into numbers and words which will save them into temporary database according to number conversion method. Then, the system will compare the vehicle's number with already saved data and check if it exists in the system. System will mark the

person who owns the vehicle and it will save the data of entry time of that area for that person and when he's leaving it will again use same method to check the vehicle's number plate and record the exit time of that area for that person. The system will automatically process all the method. It will send details to server for storage and further for cross check.

### 3.4 Data Analysis:

Over the past few years crime in Bangladesh has increased in an alarming rate according to Bangladesh Police. Here we have the various kinds of crime rates from 2002 to 2015[12]. And also how many cases have been recovered. The total numbers of all cases.

#### Comparative Crime Statistics: 2002 - 2015

| Units name | Dacoity | Robbery | Murder | Speedy Trial | Riot | Women & Child Repression | Kidnapping | Police Assault | Burglary | Theft  | Other Cases | Recovery Cases |               |           |           | Total Cases |         |
|------------|---------|---------|--------|--------------|------|--------------------------|------------|----------------|----------|--------|-------------|----------------|---------------|-----------|-----------|-------------|---------|
|            |         |         |        |              |      |                          |            |                |          |        |             | Arms Act       | Explosive Act | Narcotics | Smuggling |             |         |
| 2002       | 963     | 1397    | 3503   | 1693         | 1276 | 18967                    | 1040       | 281            | 3959     | 8245   | 68898       | 3060           | 570           | 9018      | 4746      | 17394       | 127616  |
| 2003       | 949     | 1170    | 3471   | 2179         | 890  | 20717                    | 896        | 271            | 3883     | 8234   | 66194       | 2293           | 499           | 9494      | 4499      | 16785       | 125639  |
| 2004       | 885     | 1207    | 3902   | 2053         | 754  | 13318                    | 898        | 280            | 3356     | 8605   | 67531       | 2370           | 477           | 9505      | 4182      | 16534       | 119323  |
| 2005       | 796     | 898     | 3592   | 1814         | 570  | 11981                    | 765        | 240            | 3270     | 8101   | 70046       | 1836           | 595           | 14195     | 4334      | 20960       | 123033  |
| 2006       | 795     | 843     | 4166   | 1638         | 570  | 11730                    | 722        | 337            | 2991     | 8332   | 76381       | 1552           | 308           | 15479     | 4734      | 22073       | 130578  |
| 2007       | 1047    | 1298    | 3863   | 1980         | 263  | 15217                    | 774        | 278            | 4439     | 12015  | 93224       | 1746           | 232           | 15622     | 5202      | 22802       | 157200  |
| 2008       | 885     | 1583    | 4099   | 1700         | 203  | 15246                    | 817        | 296            | 4552     | 12188  | 87417       | 1529           | 239           | 19263     | 7962      | 28993       | 157979  |
| 2009       | 764     | 1298    | 4219   | 1817         | 112  | 13997                    | 858        | 357            | 3456     | 9171   | 87022       | 1721           | 227           | 24272     | 7817      | 34037       | 157108  |
| 2010       | 656     | 1059    | 3988   | 1666         | 130  | 17752                    | 870        | 473            | 3101     | 8529   | 87139       | 1575           | 253           | 29344     | 6363      | 37535       | 162898  |
| 2011       | 650     | 1069    | 3966   | 1863         | 109  | 21389                    | 792        | 581            | 3134     | 8873   | 88355       | 1269           | 207           | 31696     | 5714      | 38886       | 169667  |
| 2012       | 593     | 964     | 4114   | 1907         | 94   | 20947                    | 850        | 659            | 2927     | 8598   | 96112       | 1115           | 289           | 37264     | 6578      | 45642       | 183407  |
| 2013       | 613     | 1021    | 4393   | 1896         | 172  | 19601                    | 879        | 1257           | 2762     | 7882   | 93930       | 1517           | 1007          | 35832     | 6437      | 44793       | 179199  |
| 2014       | 651     | 1155    | 4514   | 1716         | 79   | 21291                    | 920        | 702            | 2809     | 7660   | 90400       | 2023           | 520           | 42501     | 6788      | 51832       | 183729  |
| 2015       | 491     | 933     | 4035   | 1544         | 93   | 21220                    | 806        | 629            | 2494     | 6821   | 84137       | 2081           | 725           | 47692     | 6179      | 56677       | 179880  |
| Total      | 10738   | 15895   | 55825  | 25466        | 5315 | 243373                   | 11887      | 6641           | 47133    | 123254 | 1156786     | 225687         | 6148          | 341177    | 81535     | 454943      | 2157256 |

Figure 3.4(a): Crime statistics from 2002-15 in Bangladesh

Majority of these crimes has been filed in city areas. Here all cities crime lists are given. Here is the list with the total number of recovered cases and unsolved case list.

### Crime Statistics - 2015

| Unit Name        | Dacoity    | Robbery    | Murder      | Speedy Trial | Riot      | Woman & Child Repression | Kidnapping | Police Assault | Burglary    | Theft       | Other Cases  | Recovery Cases |            |              |             | Total Cases  |               |
|------------------|------------|------------|-------------|--------------|-----------|--------------------------|------------|----------------|-------------|-------------|--------------|----------------|------------|--------------|-------------|--------------|---------------|
|                  |            |            |             |              |           |                          |            |                |             |             |              | Arms Act       | Explosive  | Narcotics    | Smuggling   |              |               |
| DMP              | 45         | 205        | 239         | 226          | 26        | 1550                     | 146        | 118            | 642         | 1711        | 5795         | 263            | 195        | 8365         | 201         | 9024         | 19727         |
| CMP              | 5          | 61         | 105         | 67           | 25        | 357                      | 51         | 30             | 128         | 262         | 1497         | 101            | 40         | 2090         | 43          | 2274         | 4862          |
| KMP              | 9          | 15         | 30          | 19           | 0         | 146                      | 7          | 3              | 49          | 95          | 574          | 21             | 13         | 659          | 2           | 695          | 1642          |
| RMP              | 0          | 19         | 20          | 12           | 4         | 131                      | 8          | 18             | 39          | 66          | 463          | 23             | 30         | 733          | 179         | 965          | 1745          |
| BMP              | 2          | 11         | 15          | 5            | 0         | 110                      | 4          | 8              | 33          | 50          | 371          | 17             | 0          | 557          | 2           | 576          | 1185          |
| SMP              | 19         | 14         | 37          | 22           | 4         | 139                      | 10         | 8              | 25          | 89          | 819          | 11             | 5          | 183          | 8           | 207          | 1393          |
| Dhaka Range      | 150        | 164        | 1237        | 558          | 0         | 5052                     | 205        | 113            | 471         | 1565        | 20522        | 367            | 68         | 12430        | 520         | 13385        | 43422         |
| Chittagong Range | 107        | 133        | 688         | 151          | 28        | 3886                     | 98         | 163            | 406         | 906         | 13618        | 498            | 59         | 8012         | 224         | 8793         | 28977         |
| Sylhet Range     | 26         | 26         | 252         | 70           | 3         | 943                      | 33         | 43             | 76          | 326         | 5445         | 54             | 11         | 3787         | 211         | 1851         | 9094          |
| Khulna Range     | 41         | 112        | 439         | 151          | 2         | 3478                     | 79         | 41             | 250         | 513         | 8972         | 330            | 119        | 1020         | 1217        | 5453         | 18571         |
| Barisal Range    | 31         | 47         | 175         | 58           | 1         | 1497                     | 53         | 20             | 156         | 266         | 6766         | 26             | 22         | 5797         | 27          | 1095         | 10165         |
| Rajshahi Range   | 37         | 66         | 446         | 159          | 0         | 2339                     | 70         | 40             | 72          | 441         | 9259         | 313            | 144        | 1988         | 2072        | 8326         | 21255         |
| Rangpur Range    | 17         | 50         | 328         | 44           | 0         | 2587                     | 34         | 23             | 146         | 460         | 9898         | 53             | 10         | 496          | 1355        | 3406         | 16993         |
| Railway Range    | 2          | 10         | 24          | 2            | 0         | 5                        | 8          | 1              | 1           | 71          | 138          | 4              | 9          | 395          | 118         | 627          | 889           |
| <b>Total</b>     | <b>491</b> | <b>933</b> | <b>4035</b> | <b>1544</b>  | <b>93</b> | <b>21220</b>             | <b>806</b> | <b>629</b>     | <b>2494</b> | <b>6821</b> | <b>84137</b> | <b>2081</b>    | <b>725</b> | <b>47692</b> | <b>6179</b> | <b>56677</b> | <b>179880</b> |

Figure 3.4(b): Crime in city areas in Bangladesh of 2015

So this is a major concern to ensure security for the citizens without further advancement of security system. Implementing our security system can ensure safety of the public and trace down any criminals.

## Chapter 4

### List of Equipment

#### 4.1 Arduino UNO R3:

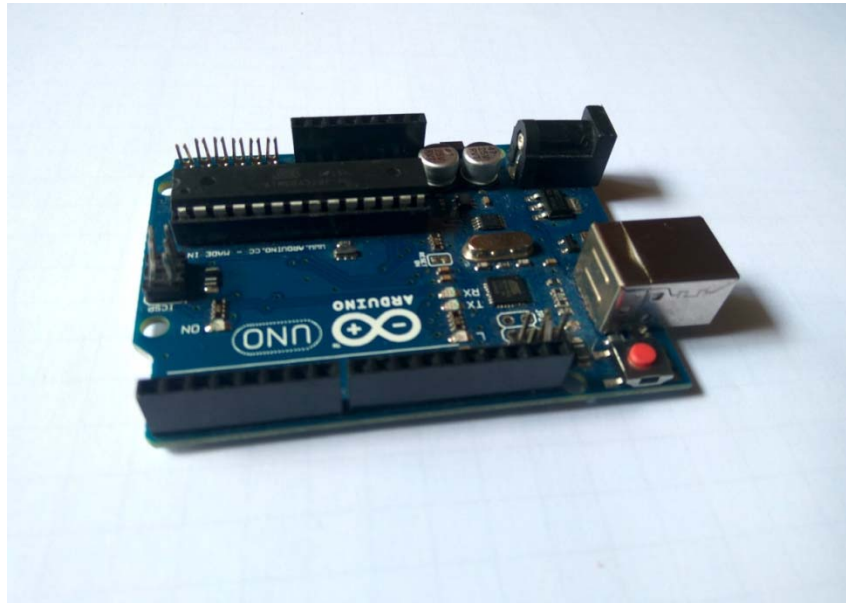


Figure 4.1: Arduino Uno R3

|                 |  |
|-----------------|--|
| Microcontroller | board based on the ATmega328                                     |
| Type            | An open-source, prototyping platform.                            |
| Pin             | 14 digital input/output pins                                     |
| Input type      | 6 analog inputs  |
| Oscillator      | 16 MHz crystal oscillator  |
| Functions       | USB connection, a power jack, an ICSP header, and a reset button |

Table 4.1: Arduino Uno Specification

## 4.2 Storage Server:

|              |  |
|--------------|--|
| Data type    | Access and load data                       |
| System       | Secured and easy management system         |
| Network Type | Integrated with SAN (storage area network) |
| Connection   | Connection to multiple record server       |

Table 4.2: Storage Server Specification

## 4.3 Fingerprint Sensor (Fingerprint Recognition Module (FPM10A)):

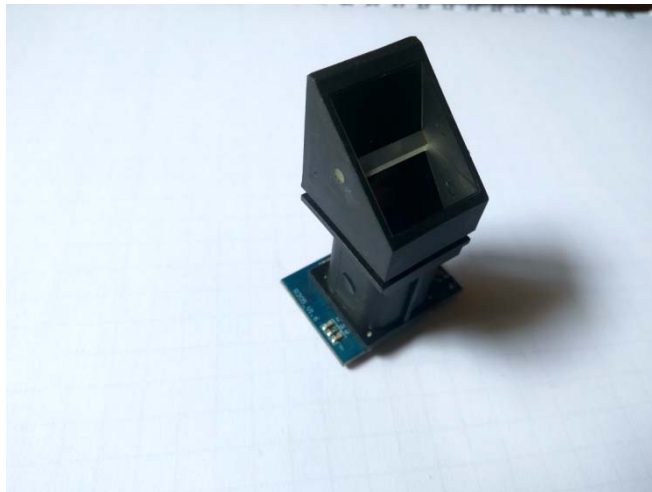


Figure 4.3: Fingerprint Recognition Module (FPM10A)

|            |   |
|------------|---|
| Type       | Connecting the sensor to computer via USB-serial converter. |
| Sketch     | Uploads Blank Sketch  |
| Sensor     | LED blink indicates the sensor is working.                  |
| Connection | Connect with Arduino  |

Table 4.3: Fingerprint Recognition Module (FPM10A) Specification

#### 4.4 Camera (Logitech C170 V-u0026):



Figure 4.4: Web Camera



|                 |  |
|-----------------|--|
| Video           | Video calling (640 x 480 pixels) with recommended system |
| Video Capture   | Video capture: Up to 1024 x 768 pixels                   |
| Type            | Logitech Fluid Crystal™ Technology                       |
| Photo           | Up to 5 megapixels (software enhanced)                   |
| Noise reduction | Built-in microphone with noise reduction                 |
| USB             | Hi-Speed USB 2.0 certified (recommended)                 |
| Clip            | Universal clip fits laptops, LCD or CRT monitor.         |

Table 4.4: Camera (Logitech C170 V-u0026)

#### 4.5 Raspberry Pi 2 ModelB:



Figure 4.5: Raspberry Pi 2 Model B



|              |   |
|--------------|---|
| SoC          | Broadcom BCM2836 (CPU, GPU, DSP, SDRAM) |
| Memory       | 1 GB (shared with GPU)                  |
| Port         | USB ports: 4                            |
| Storage      | Micro SD                                |
| Network      | Network: 10/100Mbps Ethernet            |
| Power Rating | 800 mA (4.0 W)                          |
| Power source | 5 V via MicroUSB or GPIO header         |

Table 4.5: Raspberry Pi 2 Model B Specification

#### 4.6 IR optical Sensor – TCRT5000L



Figure 4.6: Raspberry Pi 2 Model B

|                         |   |
|-------------------------|---|
| Current                 | Typical output current under test: $I_c = 1 \text{ mA}$ |
| Wavelength              | Emitter: 950 nm   |
| Peak operating distance | 2.5 mm  |
| Detector type           | Phototransistor   |

Table 4.6: Raspberry Pi 2 Model B Specification

## Chapter 5

### Implantation of biometric process

#### 5.1: Biometric Process

We used biometric finger print access process for ensuring identity of visitors. We used “Arduino” microcontroller and finger print sensor for detection. Our biometric system is created by using “adafruit finger print” library and if we say about our algorithm then we can say first of all visitors need to give their finger print on our finger print sensor. It will take visitor’s pattern of finger print image. That captured image is called “Live scan”, which is stored and used for Biometric process. Second step is sending image for storage.

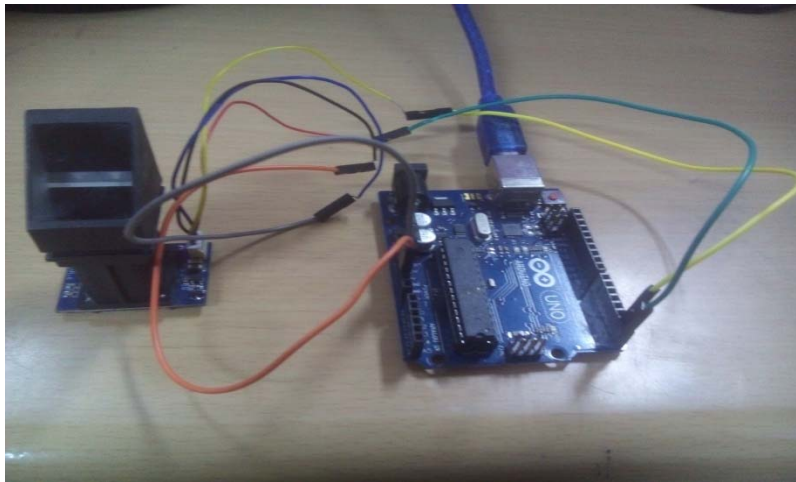


Figure 5.1(a): Fingerprint connection with arduino

Then it will start work for finger matching. For this time if same person again give his/her finger print image then after storing it will compare patter of previous scanned image and new image. If both patterns matched, then it will ensure us that this person is not new in the area, If not he needs to enroll again. There will be

record in database for visitors and it will cross check validity and it will check with national ID card's finger print. There will be storage of full details of people where authority can check his or her details.

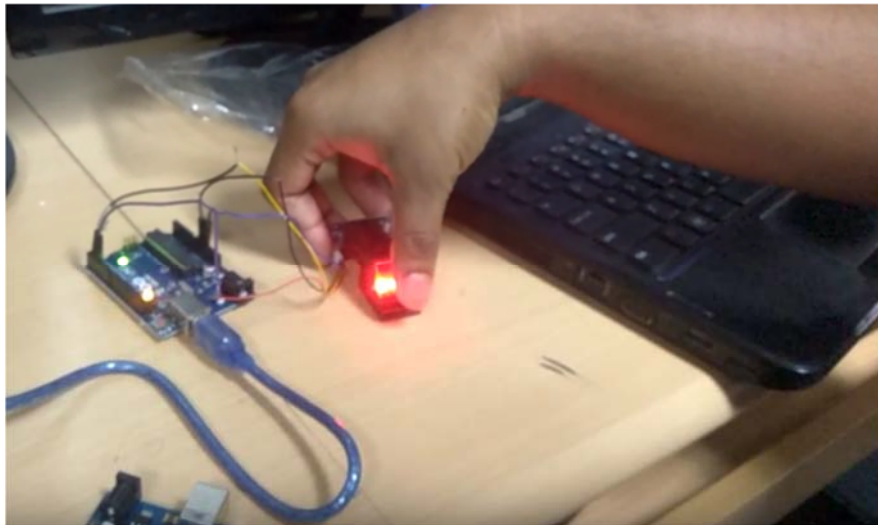


Figure 5.1(b): Fingerprint Verification

## 5.2 Steps of algorithm

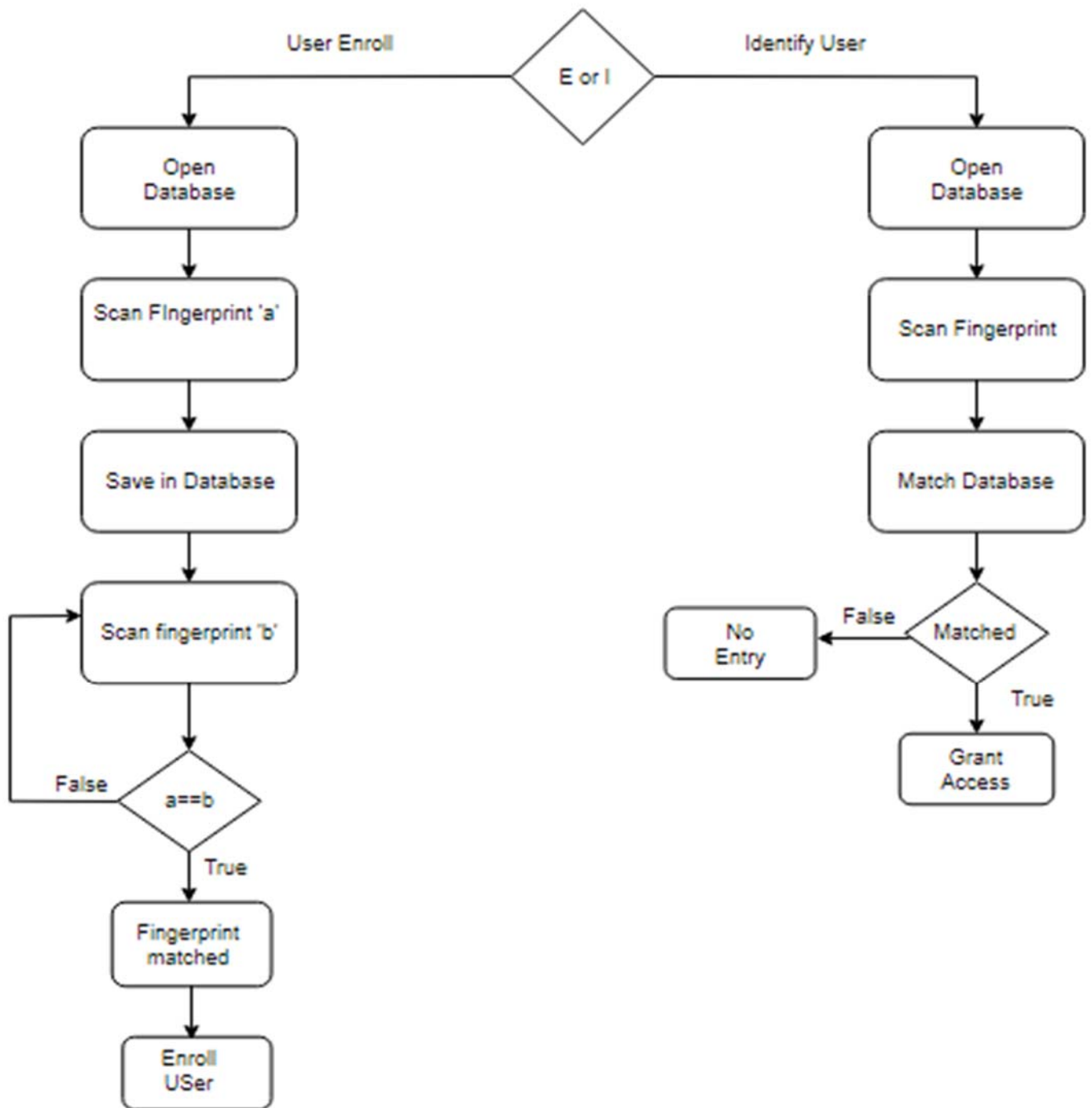


Figure 5.2 (a): Fingerprint Algorithm

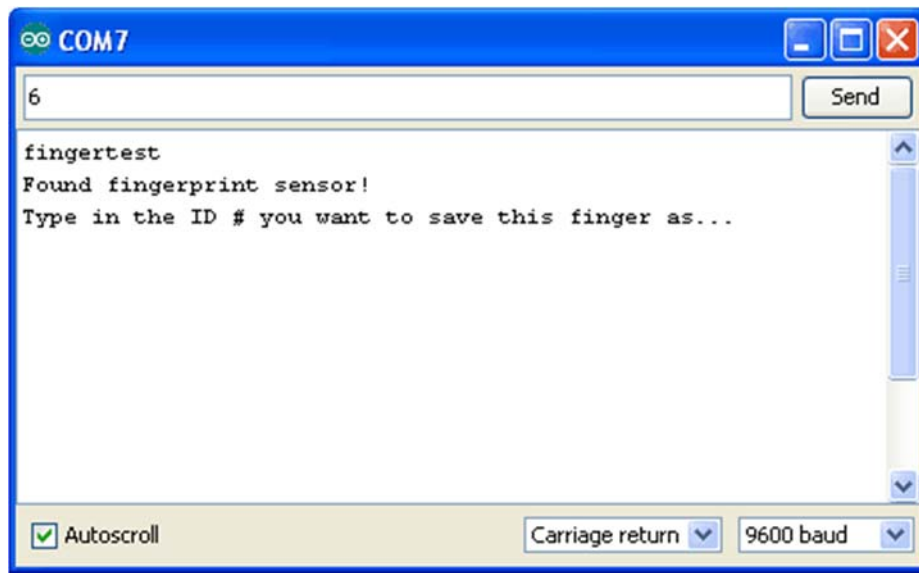


Figure 5.2 (b): Fingerprint input

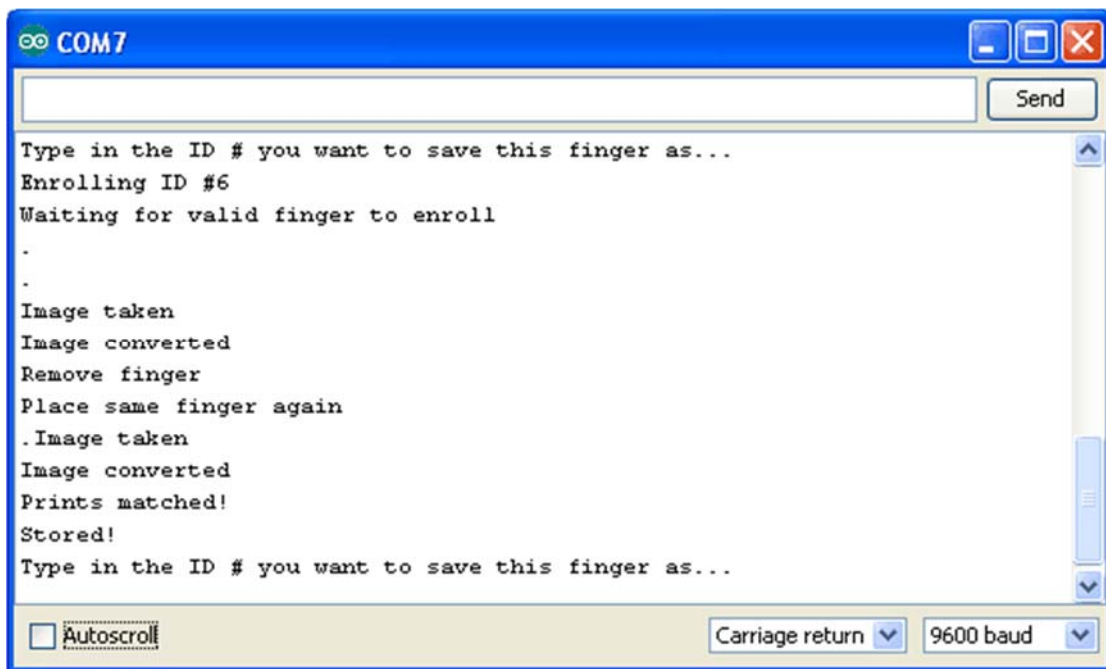


Figure 5.2(c): Fingerprint Cross check process

### **5.3 Result:**

Fingerprint will be a design made up from claiming ridges Also valleys around our fingertip skin. While storing the finger prints to database, scanner takes a picture for pattern and saves it to its memory. After that same time performing scan operation, it once more takes example from claiming finger print of that client who need to access. This pattern will be compared with stored patterns form memory. So this task called Digital image processing system. After doing various iterations and matching algorithm it finds the exact match or it will give error.

## Chapter 6

### Vehicle Identification

#### 6.1 Number Plate Detection for Vehicle

We used an Arduino UNO with the Raspberry Pi 2 and a webcam is connected with the arduino. The webcam and the Arduino are all connected to the Raspberry PI and controlled by it automatically.

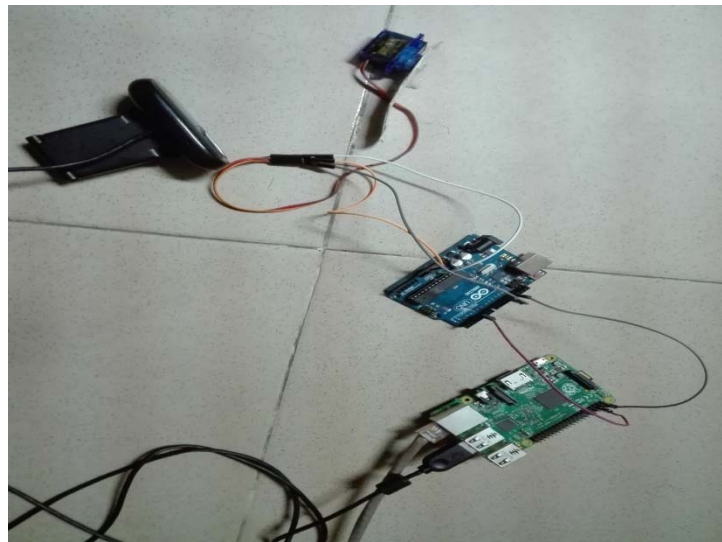


Figure 6.1: Raspberry pi connection

When a car comes near to the entrance, the sensor detects it immediately. The sensor will send a signal to the Arduino indicating that a car needs to be verified to enter the area. The Arduino will send a signal to the Raspberry pi 2 about the car. When Raspberry PI receives the signal from Arduino it will activate the webcam to take a photo of the car which standing in front of the entrance, and then the photo will be sent to the process which recognizes the car's license plate in the image and extract the number from the number plate and will send the number to cross check the database for it, After the verification is done and if this car is authorized

to enter, a signal from raspberry pi will be sent back to the Arduino to indicate that it's authorized in the database and has permission to enter the area ,Then a signal from the arduino will be sent to the servo motor to open the gate for the car so that it can enter the area, the car will have 30 seconds time to enter and then it will close the gate automatically, but before closing it the gate system will make sure that the car has entered the area. If after checking the database no match found for the car raspberry pi will send a signal to arduino that the car is not authorized to enter the area and then arduino will signal the servo motor not to open the gate for unauthorized vehicle.

## 6.2 Process for extracting license number

The process to extract the license number from the number plate has several steps. The camera will be placed and that can capture license plate for all kind of vehicles like truck, car, motorcycle etc. When a vehicle's image is taken to extract the license plate, it will go through following steps.

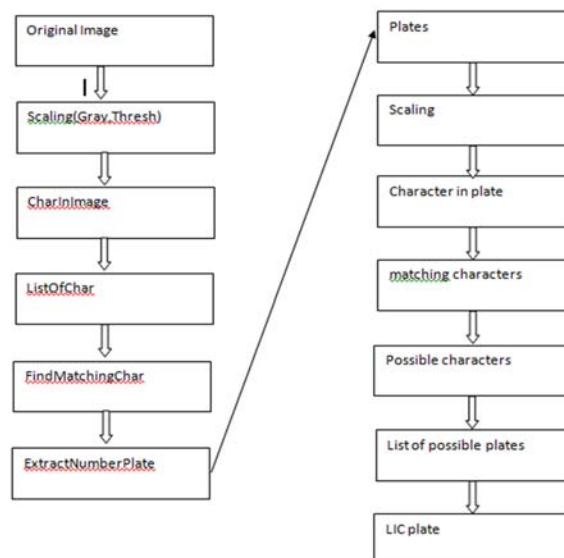


Figure: 6.2(a) Diagram of step



**1. Original image:** First step is capturing image of number plate. Camera will capture number plate from car and take it as input. We will process this image for extracting number from that number plate. In this step camera will provide us real time images time to time from different types of vehicle.



Figure 6.2(b): Original image

**2. Image Gray Scale:** We used opencv3 for Image Gray Scale Scene step. In this step we will convert colored images to gray scale. Images will be in RGB format and it will convert to grey. In gray scale mode, it will be easier to process. There will be two matrixes where first one will represent source matrix and second one will be destination matrix. Source will be converted to destination as gray mode.



Figure 6.2(c): Image Gray Scale

**3. Image Thresh Scene:** In this step, image will be segmented for detecting text region. This method is simplest method for segmentation. It can be used to create binary images from image gray scale. Thresh processes replace each pixel in an image with a black pixel if the image intensity  $I(i, j)$  is less than some fixed constant  $T$  where  $I(i, j) < T$  and for white pixel if the image intensity  $I(i, j)$  is greater than constant  $T$ , for this equation will be  $I(i, j) > T$ . when we get result it will show dark image to completely black and white image to completely white. For automation of thresh holding methods, computer should automatically select the threshold  $T$ . Sezgin and Sankur (2004) which categorize thresholding methods into the following six groups based on the information the algorithm manipulates [13].

**Histogram shape-based methods:** where the peaks, valleys and curvatures of the smoothed histogram are analyzed

**Clustering**-based methods: where the gray-level samples are clustered in two parts and they are background and foreground (object), or alternately are modeled as a mixture of two Gaussians.

**Entropy**-based methods: Which result that use the entropy of the foreground and background regions and the cross-entropy between the original and binaries image etc [13].

**Object Attribute**-based methods: It searches a measure of similarity between the gray-level and the binaries images.

**Spatial** methods: It uses higher-order probability distribution and/or correlation between pixels

**Local** methods: In this method the threshold value on each pixel to the local image characteristics. Here different  $T$  is selected for each pixel in the image.



Figure 6.2(d): Image Thresh Scene

**4. Find Possible Characters in Scene:** Third step is find possible characters in scene. In this step, detect candidate text region. It will detect possible characters which are can be plate number. Then it will remove non-text regions based On Basic Geometric Properties. There are several geometric properties for discriminating between text and non-text regions. They are Aspect ratio, Eccentricity, Euler number, Extent and Solidity. Then remove non-text regions based on stroke width variation. Stroke width is a measure of the width of the curves and lines that make up a character. Text regions tend to have little stroke width variation, whereas non-text regions tend to have larger variations [14].



Figure 6.2(e): Finding Possible Characters

**5. Vectors of possible characters in scene:** Fifth step is found out vectors of possible characters in scene. In this step, it will detect vectors of possible characters [15]. It will reduce unused vectors. Because of reduction of unused

vectors, it makes easy for finding vectors of possible characters. Here is the image of vectors of possible characters in scene.



Figure 6.2(f): Vectors of possible characters

**6. Vectors of matching characters in scene:** Next step is vectors of matching character of images. In this step, we will check vectors of vectors of matching characters in scene.



Figure 6.2(g): Vectors of matching characters

**7. Vectors of possible plates:** Sixth step is identified vectors of possible plates. In this step, we will find out vectors of plates which are detectable. After extraction of previous step we will find out it.



Figure 6.2(h): Vectors of possible plates

**8. Repeat step number 2 (Image gray Scale Scene):** Now, step number 2 will be repeated. In this step we will convert vectors of possible plates to gray scale.



Figure 6.2(i): Image gray scale

**9. Repeat step number 3, 4, 5, 6, 7:** In this step, we will repeat image thresh hold; find possible characters, vectors of possible plates, vectors of matching characters.



Figure 6.2(j): Step repeating

**10. Longest vectors of matching characters in plate:** Tenth step is longest vectors of matching characters in plate. In this step, we will find out longest vectors among matching characters in number plate. There are several characters in there but it will detect only longest vectors from number plate.



Figure 6.2(k): Longest vectors of matching characters

**11. Recognize characters in plate:** In this step, we will recognize characters in plate.



Figure 6.2(l): Recognizing characters



**12. Possible plate in string characters:** In this step, we will detect most possible character in string format.



Figure 6.2(m): String characters

**13. License number extraction to text:** Finally we will extract numbers from number plate as text format. Then it will check with existing database for finding validation.



Figure 6.2(n): License number extraction



After extracting the license plate from the original image the license number will be saved in the system and will be sent to match with the database with an existing license number. If match is found raspberry pi will send a signal to arduino to open the gate so that they vehicle can enter. Arduino will send a signal to the gate so the gate will keep opened for 30 seconds. On the other hand if there is no match found raspberry pi will send the message to arduino that the vehicle doesn't exist and not to open the gate. Arduino then will not send any signal top open the gate.

## **Chapter 7**

### **Limitations**

We faced few problems while we were doing experiments and tests on this project. To implement the full system inside raspberry pi we faced issue with internet connection and device setup. The system has to be connected with the internet all the time so that system can automatically update the database and its library when needed. Furthermore, the process to verify number plate is not fully accurate. Numbers like 1 and I, o and 0 similar characters can be found not accurate to detect the original license plate. Not only that but also if someone does not correctly places his finger on the fingerprint sensor the biometric sensor requires more prints to verify the person which is time consuming.

## Chapter 8

### Conclusion and Future Work

#### 8.1 Conclusion

In this world of increasing population and crime rates current systems are not enough to provide proper security to every citizen in a city. Our smart security system is a first step to make a secured and safe city through automated system by keeping track of every citizen and vehicles entering any city or area. If applied in large scale, it will be easier to identify criminals and reduce the crime rate. In many countries there are already many security systems which can keep track of vehicles entering an area. But, we are not only keeping track of vehicles but also every human entering the city by an automated biometric fingerprint entry system which makes the security stricter. With the smart security system we suggested we can also monitor the number of times of and entry date of visitors which can also be useful to analyze data and be alarmed beforehand observing any abnormal activity. Though our system was only tested based on small area, we believe that with proper authorization and effort it can be an ideal automated security system which will be a huge step to build a smart and secured city.

#### 8.2 Future work

At the early stages, we will be applying our project to small areas by adding the devices at the main entrances and exits of an area. We also have plans to add face recognition process which will reduce the time of verifying human who will enter the area and make it will make the whole system faster. In future, we plan to divide the whole city map into multiple small areas and places. These devices will be planted at the main entrance and exits of each of these neighborhoods. The system

in these small neighborhoods will work separately on their own but they will be connected to each other and can be centrally monitored. In this way, the small areas of the city will work as limbs of a body but together, the whole city will work like a fully functioning body, in order to reduce crime and identifying criminals faster. This will help us to take big step towards building our smart city.

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