VISHWAKARMA GOVERNMENT ENGINEERING COLLEGE

Chandkheda, Ahmedabad

Affiliated with:

GUJARAT TECHNOLOGICAL UNIVERSITY

Final Year Report On:

FACE DETECTION FOR SECURITY PURPOSE USING COMPUTER VISION

(U.D.P.)

Under the subject of:

Project – II (2181108)

B.E.: Semester – 8th

(Department of Electronics and Communication)

Internal Guide:

Prof. Jayesh N. Diwan

Academic Year:

March 2020

Prepared and Submitted By:

(TEAM ID: 86476)

Patel Jay Jatinkumar	**Joshi Dharmik Vijay**
160170111062	**160170111038**

ACKNOWLEDGEMENT

We would like to express our special thanks of gratitude to our Project Guide and Head of the Department who gave us the golden opportunity to do this wonderful project on the topic of **Face detection for security purpose using computer vision**. Under his esteemed guidance, we have been able to research upon the current trends on the said project and it has benefitted us a lot in understanding the recent innovations in the field.

Apart from that, we are very thankful to and fortunate enough to get constant encouragement, support and guidance from all the professors of our department who have helped us in successfully completing our project work. Also, I would like to extend our sincere esteems to all staff in laboratory for their timely support.

In the end, we would also like to thank our parents and friends who constantly helped us in the financing and in the different change of phases of finalizing this project within the limited time frame and coming up with all the updates as scheduled.

Patel Jay Jatinkumar

Joshi Dharmik Vijay

SELF-DECLARATION

We, Patel Jay Jatinkumar and Joshi Dharmik Vijay; the students from Department of Electronics and Communication, having enrollment numbers 160170111062 and 160170111038 respectively, enrolled at Vishwakarma Government Engineering College, Chandkheda, Ahmedabad; as a project group, hereby certify and declare the following:

I. We have defined our project based on inputs as undergraduate student and both of us have made significant efforts to solve some of the challenges faced in market. We have attempted the project work at our college or at any location under the direct and consistent monitoring of Prof. Jayesh N. Diwan. We have adopted all ethical practices to share credit amongst all the contributors based on their contributions during the entire project work.

II. We have not developed these solutions with respect to any 3rd party directly and the efforts are made by us are under the guidance of our faculty guide.

III. The project work is not copied from any previously done projects directly. (Same project can be done in different ways but if it has been done in same manner before, upgradations are made in a significant manner.)

IV. We to the best of our knowledge are a genuine industry engaged in the professional service/social organizations.

Place: Chandkheda, Ahmedabad
Date: 31/03/2020

Patel Jay Jatinkumar

Joshi Dharmik Vijay

CERTIFICATE

This is to certify that the final year project '**Face detection for security purpose using computer vision**' of Electronics and Communication branch, under Semester 8th, has been satisfactorily completed and submitted under the subject **Project – II**, within the four walls of Vishwakarma Government Engineering College, Chandkheda, Ahmedabad. This project has been submitted satisfactorily by the following team of students in partial fulfillment of the degree of Bachelor of Engineering in Electronics and Communication Engineering.

Prepared and Submitted By:

Patel Jay Jatinkumar	**Joshi Dharmik Vijay**
160170111062	**160170111038**

Internal Guide	**Head of Department**
(Prof. Jayesh N. Diwan)	

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ABSTRACT

Face detection has attracted immense attention because it has many applications in computer vision communication and automatic control system. Face detection is a method to detect a face from an image which have several attributes in that image. Research into face detection, expression detection, face tracking, pose estimation is required. By giving a single image, challenge is to detect the face from that image. Face detection is a challenging task because faces are not rigid and it changes in size, shape, color etc. Face detection become more challenging task when given image is not clear and occluded by any other thing and not proper lightning, not facing camera etc.

A methodological study on significance of image processing and its applications in the field of computer vision is carried out everywhere around the globe currently. During an image processing operation the input given is an image and its output is an enhanced high quality image as per the techniques used. Image processing usually referred as digital image processing, but optical and analog image processing also are possible. Studies provide a solid introduction to image processing along with segmentation techniques, computer vision fundamentals and its applied applications that will be of worth to the image processing and computer vision research communities.

The aim of the project is a design, execution and examination of the computer vision systems, which processes digital video, reduces noise to a minimal level, and identifies a moving object together with estimation of its distance from the camera. For the image processing, library OpenCV was used. Two different methods were examined and implemented in control system. Some results are very similar in character and functionality with the use of security camera system, but the determining the distance of a given object is a new advanced ability of proposed system.

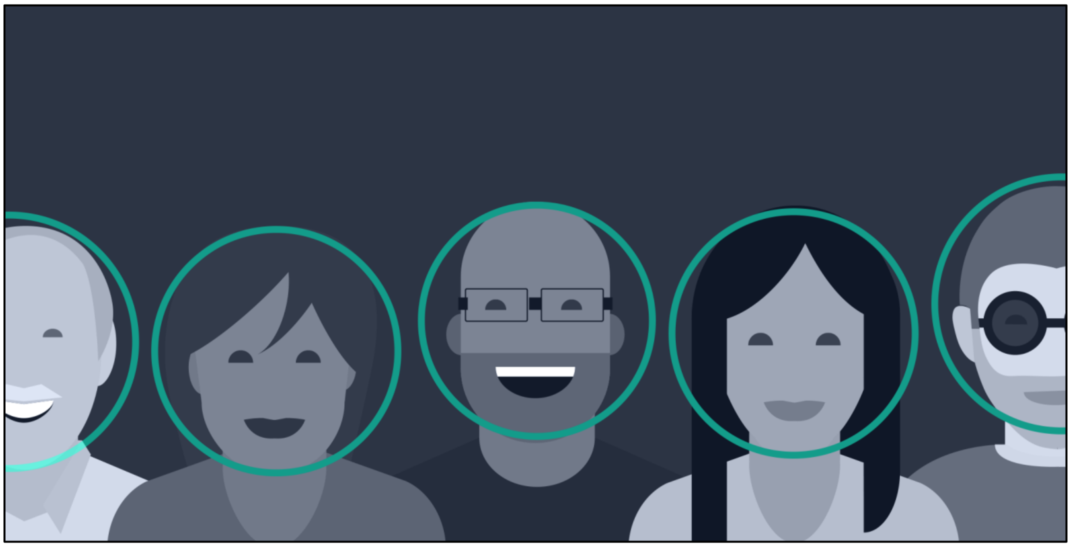
CHAPTER:1

INTRODUCTION

1.1 Problem summary and Introduction

- An increasingly large number of retailers are waking up to an unfortunate fact: despite loss prevention and asset protection professionals' best efforts, organized retail crime and return fraud continue to rise. Due to rapid development in science and technology, upcoming innovations are being built-up with strong security. But on the other hand, threats are also being posed to destroy this security level. Though enhancement in automation has made a positive impact overall, but various financial institutions like banks and applications like ATM are still subjected to thefts and frauds.
- Potential surveys and studies show that over 50% of shoplifters try a different store in the same chain and over 40% of theft is caused by employees. In order to combat these rising concerns, forward-thinking retailers have started employing facial detection solutions to protect merchandise, employees and customers from threats. And while this technology is relatively new for retail, it just might prove to be the secret sauce for preventing shrink. Face detection is a computer technology being used in a variety of applications that identifies human faces in digital images. Face detection also refers to the psychological process by which humans locate and attend to faces in a visual scene.
- Face detection can be regarded as a specific case of object-class detection. In object-class detection, the task is to find the locations and sizes of all objects in an image that belong to a given class. Examples include upper torsos, pedestrians, and cars. Face-detection algorithms focus on the detection of frontal human faces. It is analogous to image detection in which the image of a person is matched bit by bit. Image matches with the image stores in database. Any facial feature changes in the database will invalidate the matching process.
- Face detection is an important first step for applications in several areas, including biometrics, human-computer interfaces, and surveillance. Nowadays, the importance of the automatic face detection and tracking system has increased as it is

needed for video surveillance and new user interfaces. A facial detection device is a device that takes an image or a video of a human face and compares it to other image faces in a database. The structure, shape and proportions of the faces are compared during the face detection steps. In addition, distance between the eyes, nose, mouth and jaw, upper outlines of the eye sockets, the sides of the mouth, location of the nose and eyes, and the area surrounding the cheek bones are also compared.



(Fig. 1.1 Face detection example)

- A proposed solution to the aforementioned matter is a Face Detection Security System, which can detect intruders to restricted or high-security areas, and help in minimizing human error. This system is composed of two parts: hardware part and software part. The hardware part consists of a camera, while the software part consists of face-detection and face-recognition algorithms software. When a person enters to the zone in question, a series of snapshots are taken by the camera and sent to the software to be analyzed.
- Object Detection using Haar feature-based cascade classifiers is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, “Rapid Object Detection using a Boosted Cascade of Simple Features” in 2001. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

1.2 Aim and objectives of the project

- Biometric authentication and their template security are increasing day by day over the past decade with challenging requirement in Automated Secured Personal Authentication System. The reason behind on this demand for the replacement of old-fashioned automatic personal identification tools by new one.
- There are few objectives to design face detection system. The objectives of face detection are:

a) To design real time face detection system.

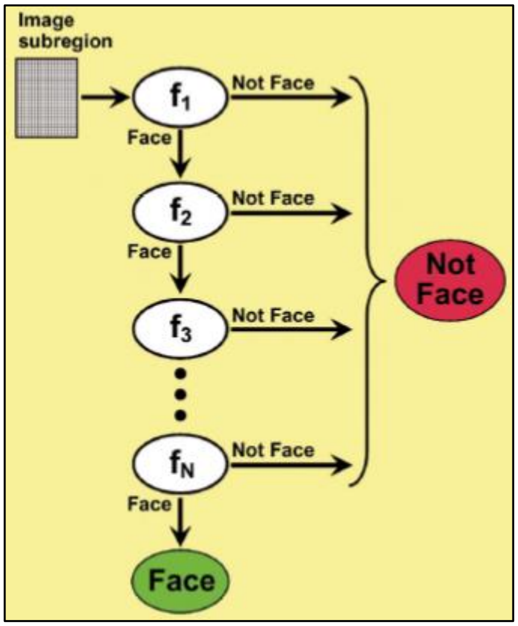
b) To utilize the face detection system based on Haar Classifier.

c) To develop face detection system using OpenCV libraries and a decent text editor.

d) To develop or improve existing algorithms to make the face detection accurately in possible on Noisy Images.

e) Performance Evaluation of proposed framework by comparing the performance of existing face detection system.

- This project is to improve the face detection system by using Haar Classifier to get higher accuracy result. Haar Classifier is used for face detection because it can detect the desire image very fast. The algorithm has been used for the detection which achieved high detection accuracy.



(Fig. 1.2 How face detection works)

- The basic aim of this project is to design an effective and secure technique for personal authentication using face detection and also evaluate the performance of the designed framework by comparing the performance of existing face detection system.
- We are going to use Haar Feature-based Cascade Classifiers to detect faces, eyes, smiles as well as eyeglasses. It is a machine learning method where a so-called cascade function is trained on a large amount of positive and negative images (positive meaning it includes the desired object and negative images lack it), which in turn can be used for object detection.

1.3 Problem Specifications

- The old-fashioned automatic personal identification tools uses traditional approaches such as Personal Identification Number (PIN), Login Id, ID card, password etc. to verify the cognizance of a person, are no longer considered as credible adequate to gratify the security concern for person identification system.
- A biometric scheme delivers automatic recognition of a person depending on some particular trait. But, there are various unfolded challenges in the existing researches in biometric personal authentication.
- Among these, major challenges of face detection systems are related to Face Template Security and Face Detection Performance. Biometric being an integral part of human body, loss of one’s biometric corresponds to loss of his/her identity. Security of face templates is one of the most important issues in any biometric authentication system.
- Following are the four types of biometric systems:
  a) Traditional Biometric Systems
  b) Biometric Key Release Systems
  c) Cancelable Biometrics Systems
  d) Biometric Key Generation Systems
- Though the last three non-traditional systems mentioned above are quite effective in resolving template Security related issues. But, in most of the systems, detection performance is affected. Speed of these systems is always slower as compared to

Conventional Face Detection Systems. Moreover, most of these systems do not perform well with Noisy Face Image datasets. 91 Due to all these issues, we require a reliable and efficient solution to solve template security related issues.

1.4 Brief literature review and Prior Art Search (PAS)

- Indian banks lost Rs 109.75 crore to theft and online fraud in year 2018. And not all the robbers were caught. To keep record of every one who enters the ATM a smart lock system with face detection can help trace the robber by the time person has arrived to the ATM and the photo of the person taken by the camera.
- Face detection can consider a substantial part of face recognition operations. According to its strength to focus computational resources on the section of an image holding a face. The method of face detection in pictures is complicated because of variability present across human faces such as pose, expression, position and orientation, skin color, the presence of glasses or facial hair, differences in camera gain, lighting conditions, and image resolution.
- There has been extensive research on the value of closed-circuit television (CCTV) for preventing crime, but little on its value as an investigative tool. This study sought to establish how often CCTV provides useful evidence and how this is affected by circumstances, analyzing 251,195 crimes recorded by British Transport Police that occurred on the British railway network between 2011 and 2015. CCTV was available to investigators in 45% of cases and judged to be useful in 29% (65% of cases in which it was available).
- Useful CCTV was associated with significantly increased chances of crimes being solved for all crime types except drugs/weapons possession and fraud. Images were more likely to be available for more-serious crimes, and less likely to be available for cases occurring at unknown times or in certain types of locations. Although this research was limited to offences on railways, it appears that CCTV is a powerful investigative tool for many types of crime.
- Major developer of software solutions for banks and retail BS/2 company presented a biometric technology-based feature of Face Detection for ATMs at “RBR: ATM & Cyber Security 2019” - the world’s leading conference focused on physical and logical ATM security. The event was held in London in October 2019 and

attracted 400+ banks and security experts from over 40 countries worldwide to discuss current problems of ATM security and methods of their solutions.

- Face Detection is one of solution modules, developed to protect ATMs from both logical and physical attacks. The Face Detection module analyzes the picture taken by the ATM camera, recognizes if a person's face is pictured and determines whether it is covered or not. The software uses sophisticated face recognition algorithms that analyze 4000 points of the human face; therefore, the results are accurate and reliable.
- If for some reason, the face of the ATM user is not detected or covered with anything at the start of a transaction, then the terminal stops the service. Several scenarios can be run on the terminal when realizing this.
    a) Display a warning message on the terminal screen.
    b) Turn off or disconnect the terminal from the network.
    c) Send an alarm notification to the security service.
- Thus, when the Face Detection function is implemented on the ATM, the user will not be able to complete the transaction and withdraw the money without showing his face.

1.5 Plan of work

- Keeping our project dimensions into consideration, it is a lengthy process to implement it by filtering the results through several stages. The stages would most commonly look like as follows:
    a) Phase-1: Design and development of a prototype and testing it.
    b) Phase-2: Developing a near real-scenario prototype with all the features and it's testing.
    c) Phase-3: The final implementation stage.

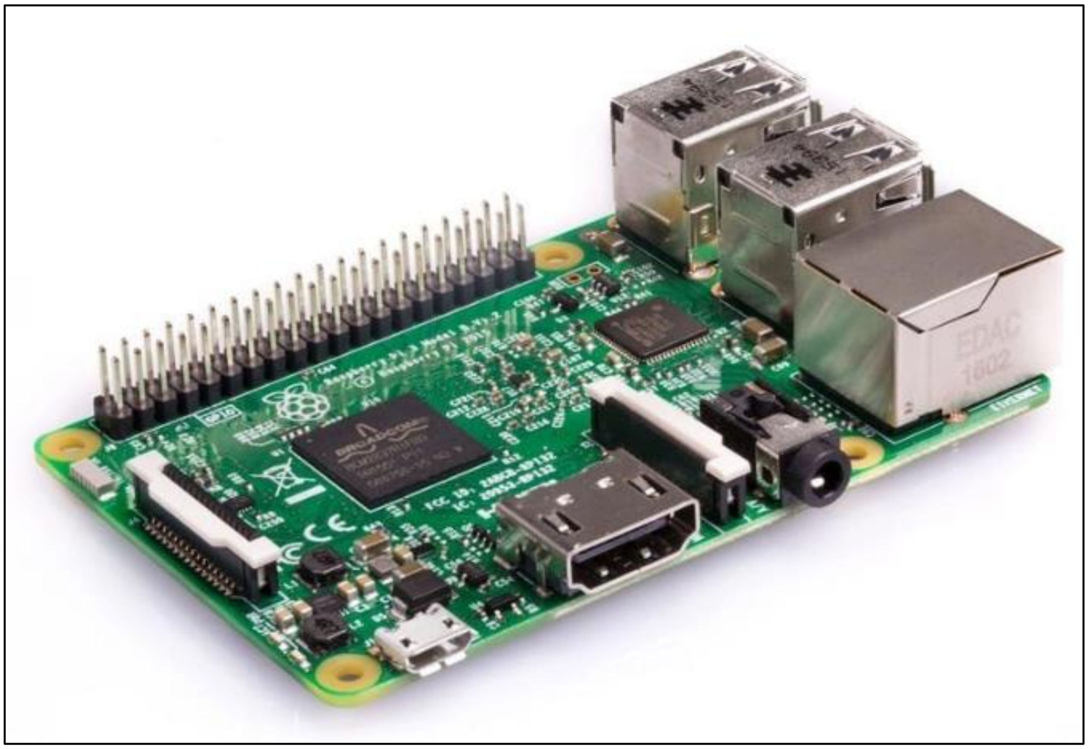
1.6 Materials / Tools required

- Listing out the hardware & software requirements, we have tried to encapsulate the key components that will be of prime importance for our project as shown in the table:

SERIAL NUMBER	COMPONENT
1	Raspberry Pi 3 Model B
2	Raspberry Pi camera module (RKI-1598)
3	Laptop
4	Connections + Soldering
5	Design Apparatus components Requirements
6	Red LED + Resistor (1K)
7	Wires + misc.

Some specific components are explained as below:

1) <u>RASPBERRY PI 3 MODEL B</u>



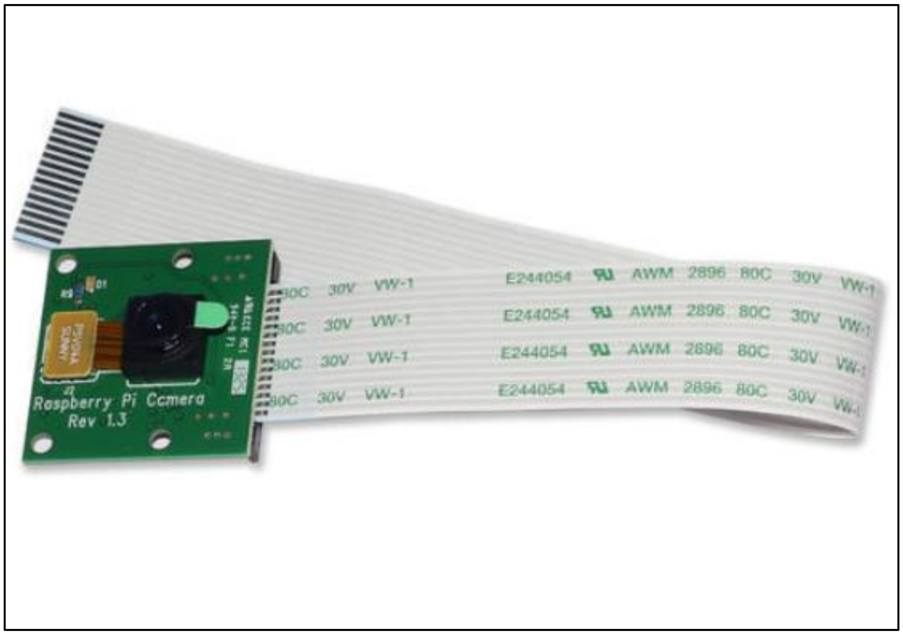
(Fig. 1.3 Raspberry pi 3 model B)

- The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It’s capable of doing everything you’d expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

- What's more, the Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras.

2) Raspberry Pi camera module (RKI-1598)

- The Raspberry Pi Camera Module is a custom designed add-on for Raspberry Pi. It attaches to Raspberry Pi by way of one of the small sockets on the board upper surface. This interface uses the dedicated CSi interface, designed especially for interfacing to cameras.



(Fig. 1.4 Raspberry Pi camera module (RKI-1598))

- The board itself is tiny, at around 25mm x 20mm x 9mm. It also weighs just over 3g, making it perfect for mobile or other applications where size and weight are important. It connects to Raspberry Pi by way of a short ribbon cable.
- The sensor itself has a native resolution of 5 megapixels, and has a fixed focus lens onboard. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p30, 720p 60 and 640x480p60/90 video.

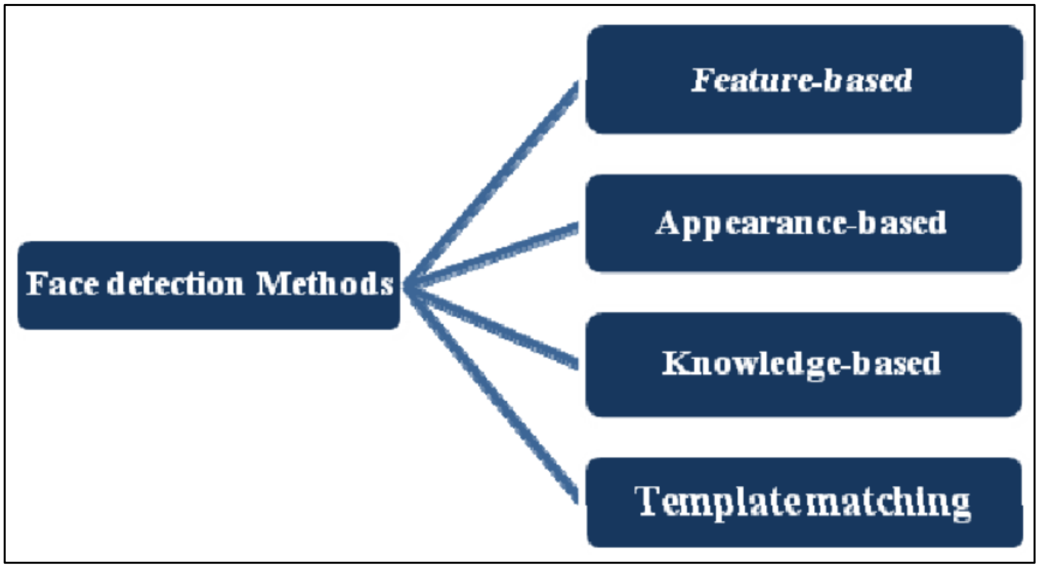
CHAPTER: 2

DESIGN

2.1 ANALYSIS

- **FACE DETECTION METHODS**

  Yan, Kriegman, and Ahuja presented a classification for face detection methods. These methods divided into four categories, and the face detection algorithms could belong to two or more groups. These categories are as follows-



(Fig 2.1 Different types of Face Detection Methods)

1. **KNOWLEDGE BASED:** The knowledge-based method depends on the set of rules, and it is based on human knowledge to detect the faces. Ex- A face must have a nose, eyes, and mouth within certain distances and positions with each other. The big problem with these methods is the difficulty in building an appropriate set of rules. There could be many false positive if the rules were too general or too detailed. This approach alone is insufficient and unable to find many faces in multiple images.
2. **FEATURE BASED:** The feature-based method is to locate faces by extracting structural features of the face. It is first trained as a classifier and then used to differentiate between facial and non-facial regions. The idea is to overcome the

limits of our instinctive knowledge of faces. This approach divided into several steps and even photos with many faces they report a success rate of 94%.

3. **TEMPLATE MATCHING**: Template Matching method uses pre-defined or parameterized face templates to locate or detect the faces by the correlation between the templates and input images. Ex- a human face can be divided into eyes, face contour, nose, and mouth. Also, a face model can be built by edges just by using edge detection method. This approach is simple to implement, but it is inadequate for face detection. However, deformable templates have been proposed to deal with these problems.
4. **APPEARANCE BASED:** The appearance-based method depends on a set of delegate training face images to find out face models. The appearance-based approach is better than other ways of performance. In general appearance-based method rely on techniques from statistical analysis and machine learning to find the relevant characteristics of face images. This method also used in feature extraction for face recognition.

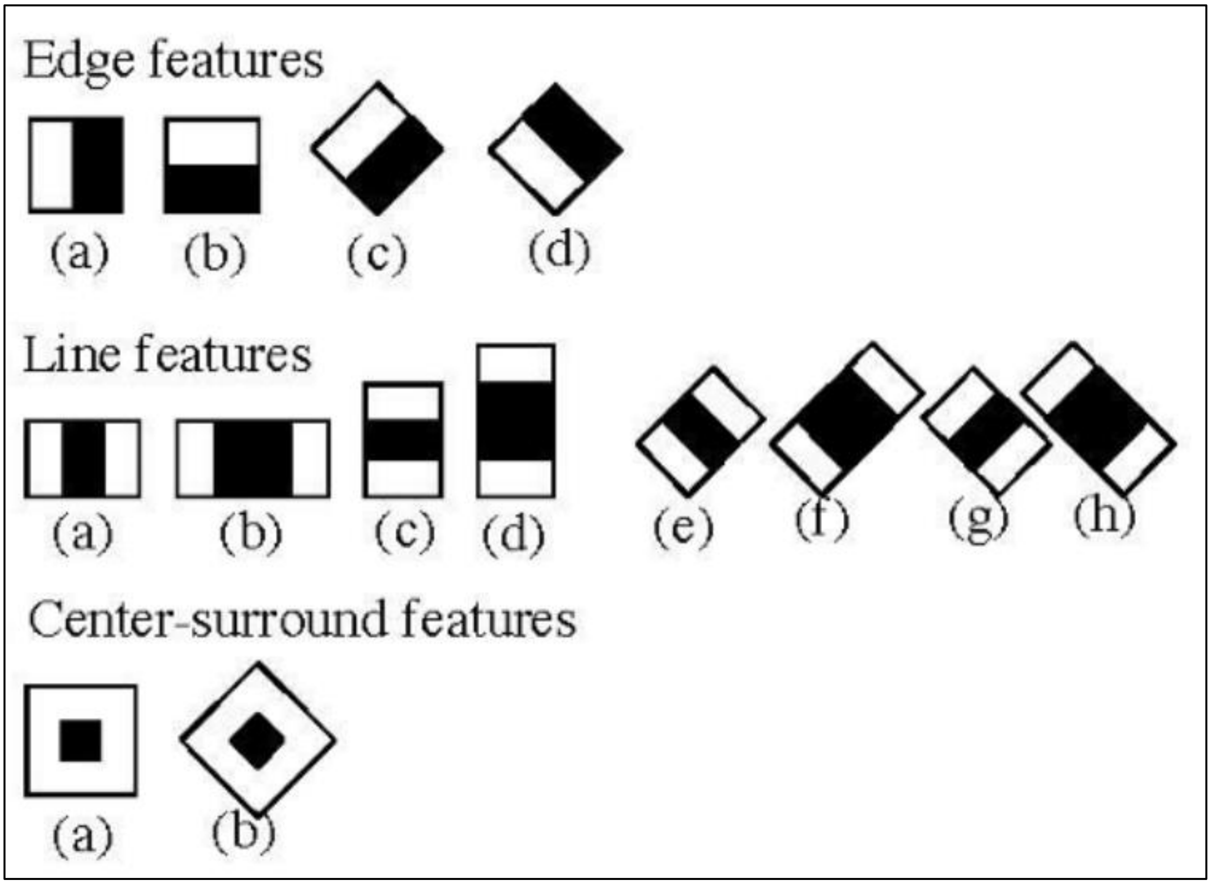
- Numerous robust algorithms have been developed and claimed to have accurate performance to tackle face detection and recognition problems. These algorithms or methods are the most successfully and widely used for face detection and recognition applications. The algorithms are as follow:
  a) Principle Component Analysis (PCA)
  b) Linear Discriminant Analysis (LDA)
  c) Skin color based algorithm
  d) Wavelet based algorithm
  e) Artificial neural networks based algorithm

2.2 DESIGN METHODOLOGY

- After selecting the face detection method, the next step is to use Haar-Like features algorithm, which is proposed by Voila and Jones for face detection. This algorithm used for finding the location of the human faces in a frame or image. All human faces shares some universal properties of the human face like the eyes region are darker than its neighbor pixels and nose region is brighter than eye region.
- A Haar Cascade is based on “Haar Wavelets” which Wikipedia defines as: “A

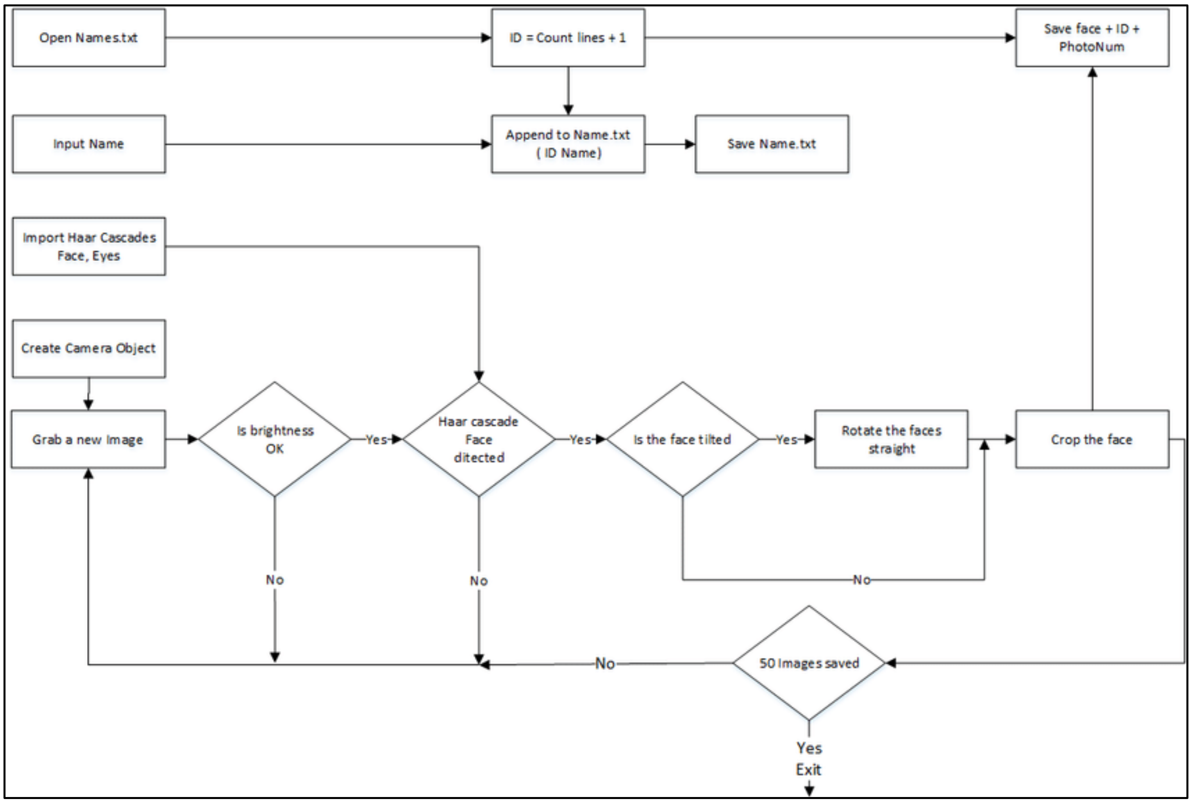
sequence of rescaled "square-shaped" functions which together form a wavelet family or basis."

- It is based on the Haar Wavelet technique to analyze pixels in the image into squares by function. This uses machine learning techniques to get a high degree of accuracy from what is called "training data". This uses "integral image" concepts to compute the "features" detected. Haar Cascades use the Adaboost learning algorithm which selects a small number of important features from a large set to give an efficient result of classifiers.



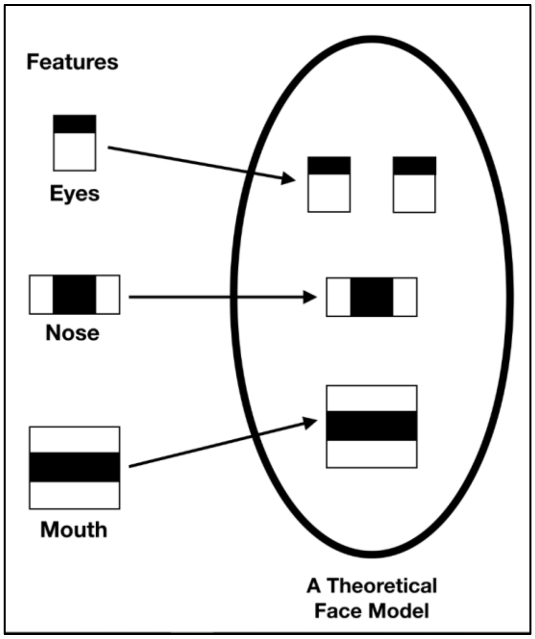
(Fig. 2.2 Haar-like features for face detection)

- Haar Cascades use machine learning techniques in which a function is trained from a lot of positive and negative images. This process in the algorithm is feature extraction. The Haar-like algorithm is also used for feature selection or feature extraction for an object in an image, with the help of edge detection, line detection, center detection for detecting eyes, nose, mouth, etc. in the picture. It is used to select the essential features in an image and extract these features for face detection.



(Fig 2.3 Haar cascade image collection flow chart)

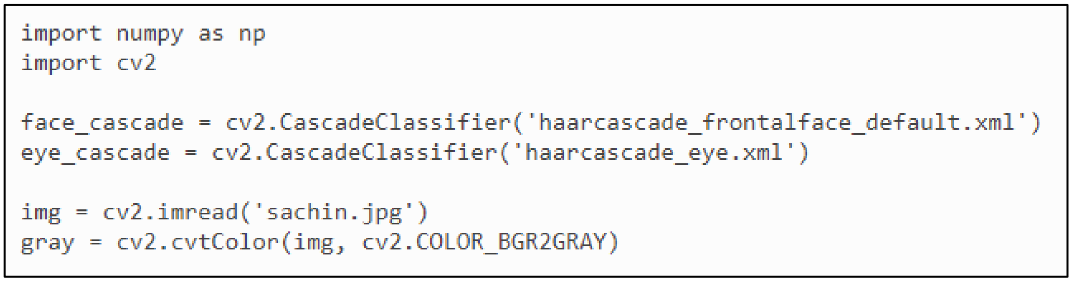
- The next step is to give the coordinates of x, y, w, h which makes a rectangle box in the picture to show the location of the face or we can say that to show the region of interest in the image. After this, it can make a rectangle box in the area of interest where it detects the face. There are also many other detection techniques that are used together for detection such as smile detection, eye detection, blink detection, etc.
- This is used when doing the detection since it would be slow to do it with lots of features, instead, the classifier consists of a cascade of features when detecting. So the initial Haar feature might just check if the image could possibly be a face (in the case of face detection), then the following stages have a few more of the most essential Haar features. This is a favorable method since early on images not containing the desired object are discarded and not processed anymore.



(Fig. 2.4 Theoretical Face Model)

2.3 IMPLEMENTATION STRATEGY:

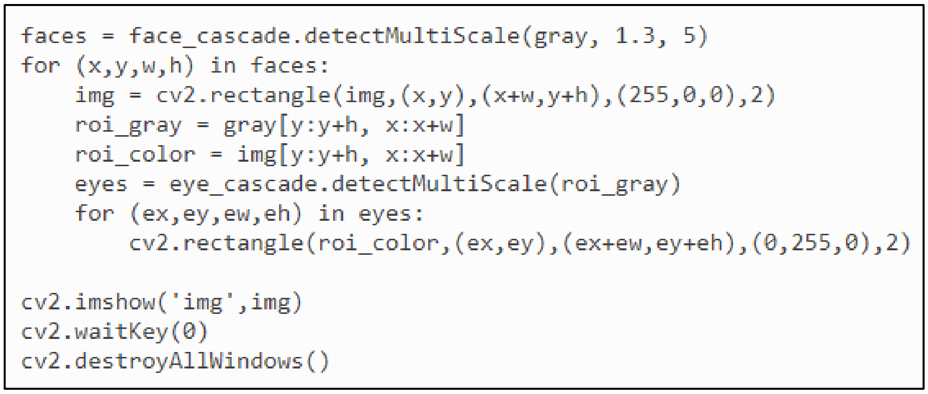
- Here we will deal with detection. OpenCV already contains many pre-trained classifiers for face, eyes, smile etc. Those XML files are stored in opencv/data/haarcascades/ folder. Let's create face and eye detector with OpenCV. First we need to load the required XML classifiers. Then load our input image (or video) in gray scale mode.



```
import numpy as np
import cv2

face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')
eye_cascade = cv2.CascadeClassifier('haarcascade_eye.xml')

img = cv2.imread('sachin.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
```

(Fig. 2.5 Setting up workspace)

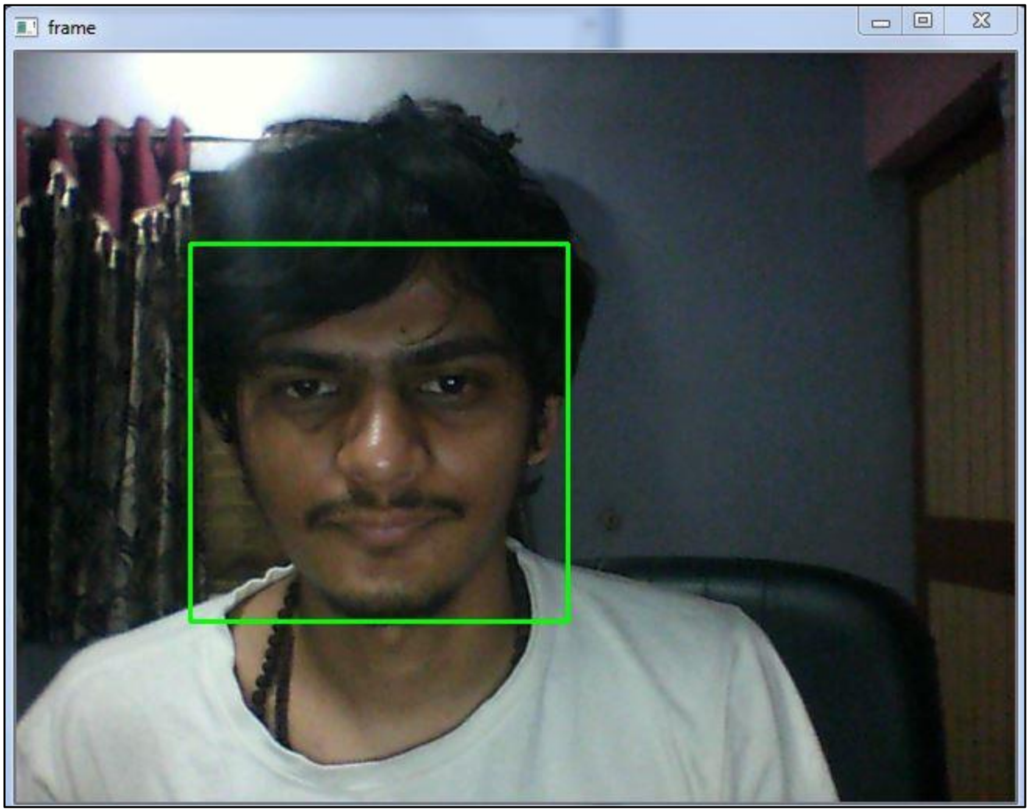
- Now we find the faces in the image. If faces are found, it returns the positions of detected faces as Rect(x, y, w, h). Once we get these locations, we can create a ROI for the face and apply eye detection on this ROI (since eyes are always on the face).



```
faces = face_cascade.detectMultiScale(gray, 1.3, 5)
for (x,y,w,h) in faces:
    img = cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)
    roi_gray = gray[y:y+h, x:x+w]
    roi_color = img[y:y+h, x:x+w]
    eyes = eye_cascade.detectMultiScale(roi_gray)
    for (ex,ey,ew,eh) in eyes:
        cv2.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0),2)

cv2.imshow('img',img)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

(Fig. 2.6 Detecting different facial components)

- Thus we can find face and eyes detected from the above setup. Now we are ready to implement this setup for our live facial detection and expand it further to meet our specific project requirements.



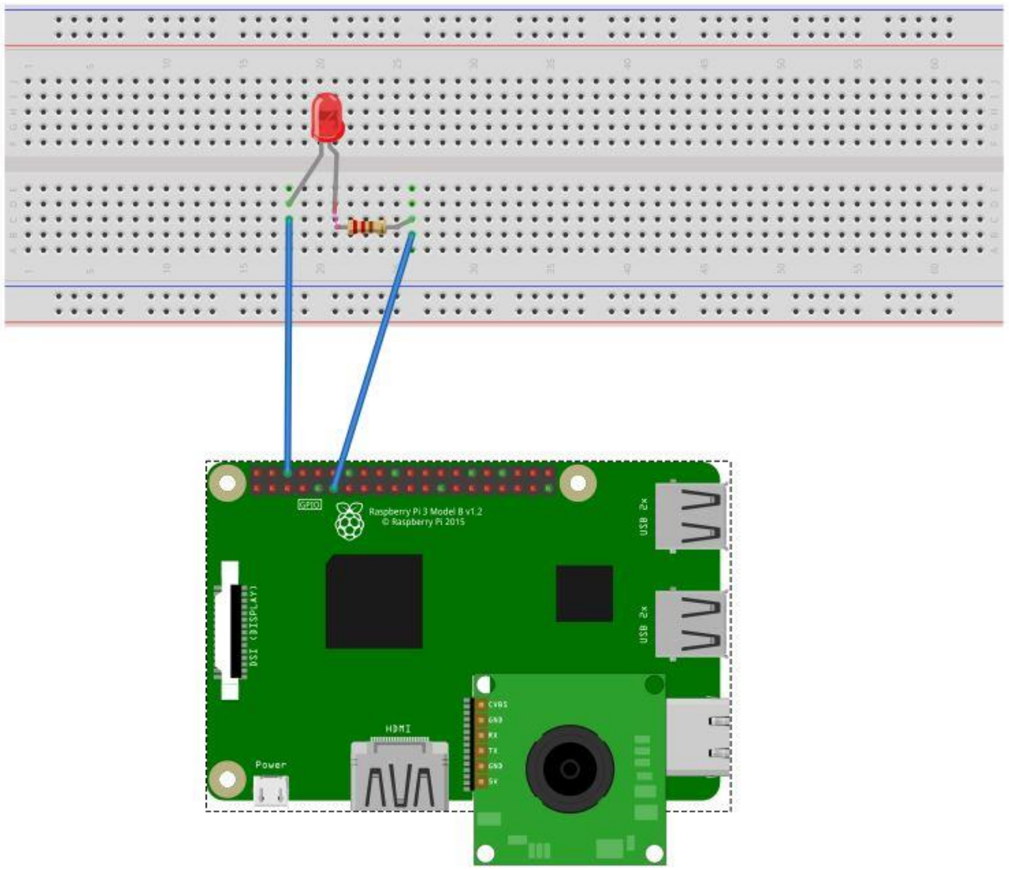
(Fig. 2.7 Snapshot of result)

CHAPTER: 3

IMPLEMENTATION

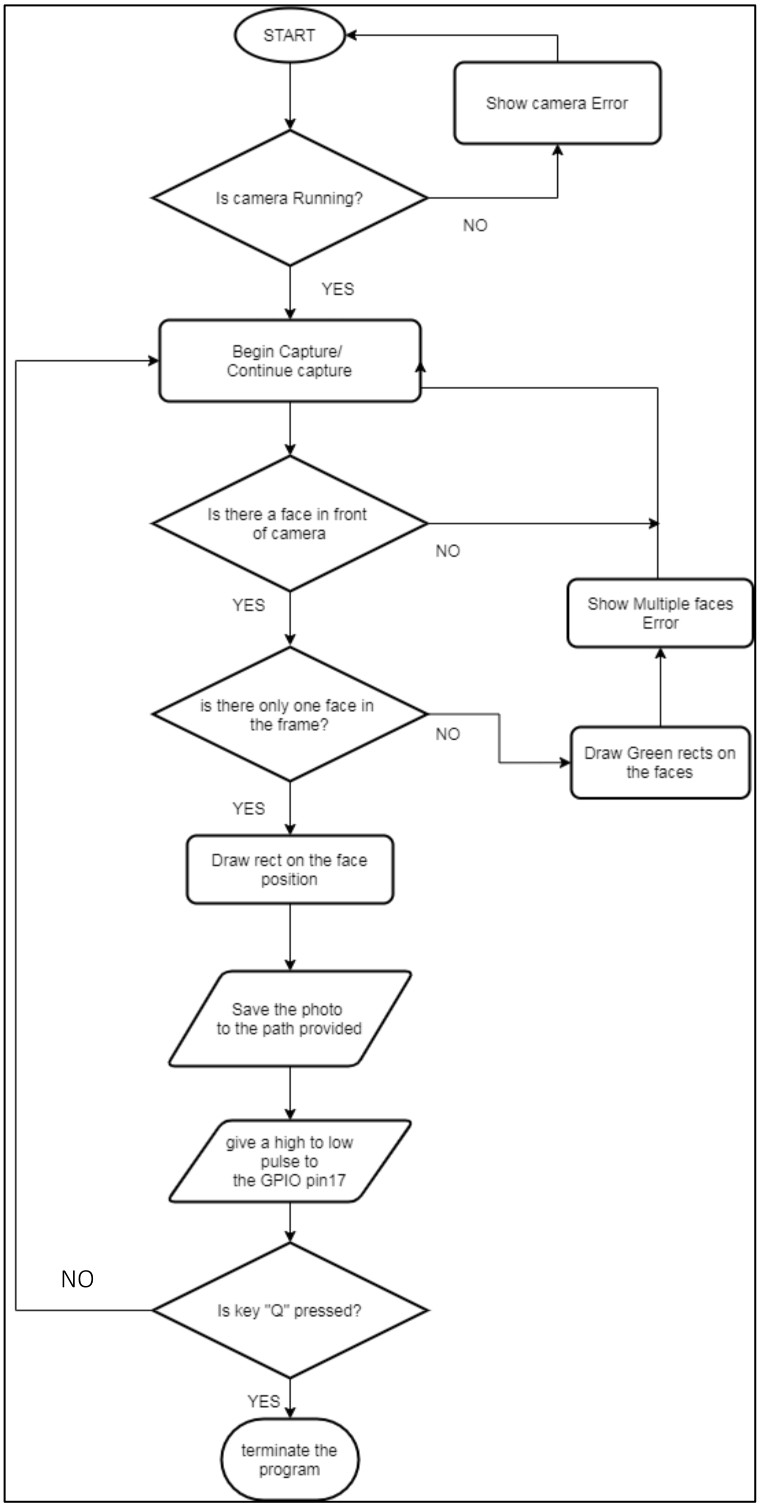
3.1SCHEMETIC:

- A schematic, or schematic diagram, is a representation of the elements of a system using abstract, graphic symbols rather than realistic pictures. A schematic usually omits all details that are not relevant to the key information the schematic is intended to convey, and may include oversimplified elements in order to make this essential meaning easier to grasp.



(Fig. 3.1 Schematic of connections)

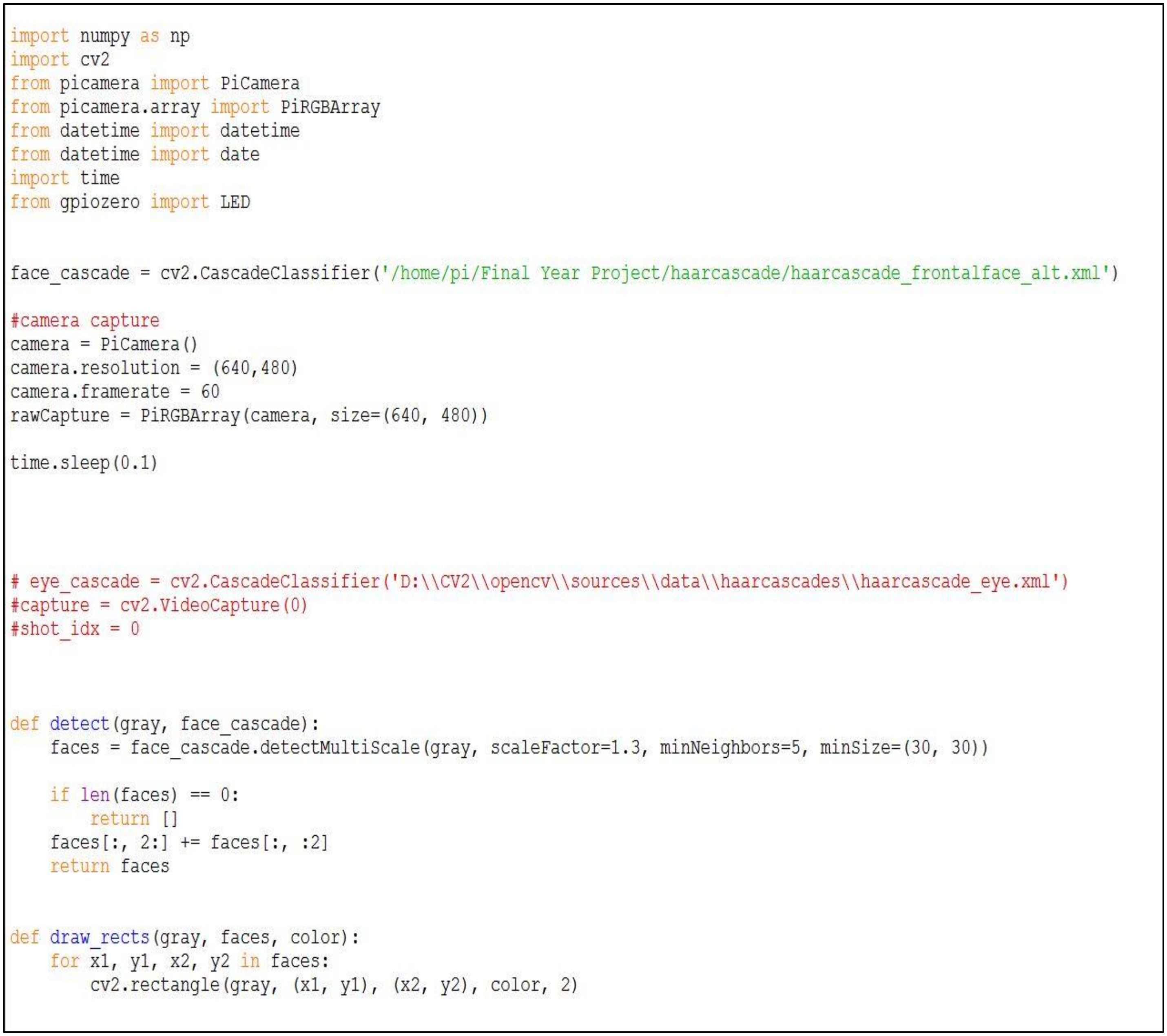
3.3 FLOWCHART


START
Show camera Error
Is camera Running?
NO
YES
Begin Capture/ Continue capture
Is there a face in front of camera
NO
YES
Show Multiple faces Error
is there only one face in the frame?
NO
Draw Green rects on the faces
YES
Draw rect on the face position
Save the photo to the path provided
give a high to low pulse to the GPIO pin17
NO
Is key "Q" pressed?
YES
terminate the program

(Fig. 3.2 Flowchart)

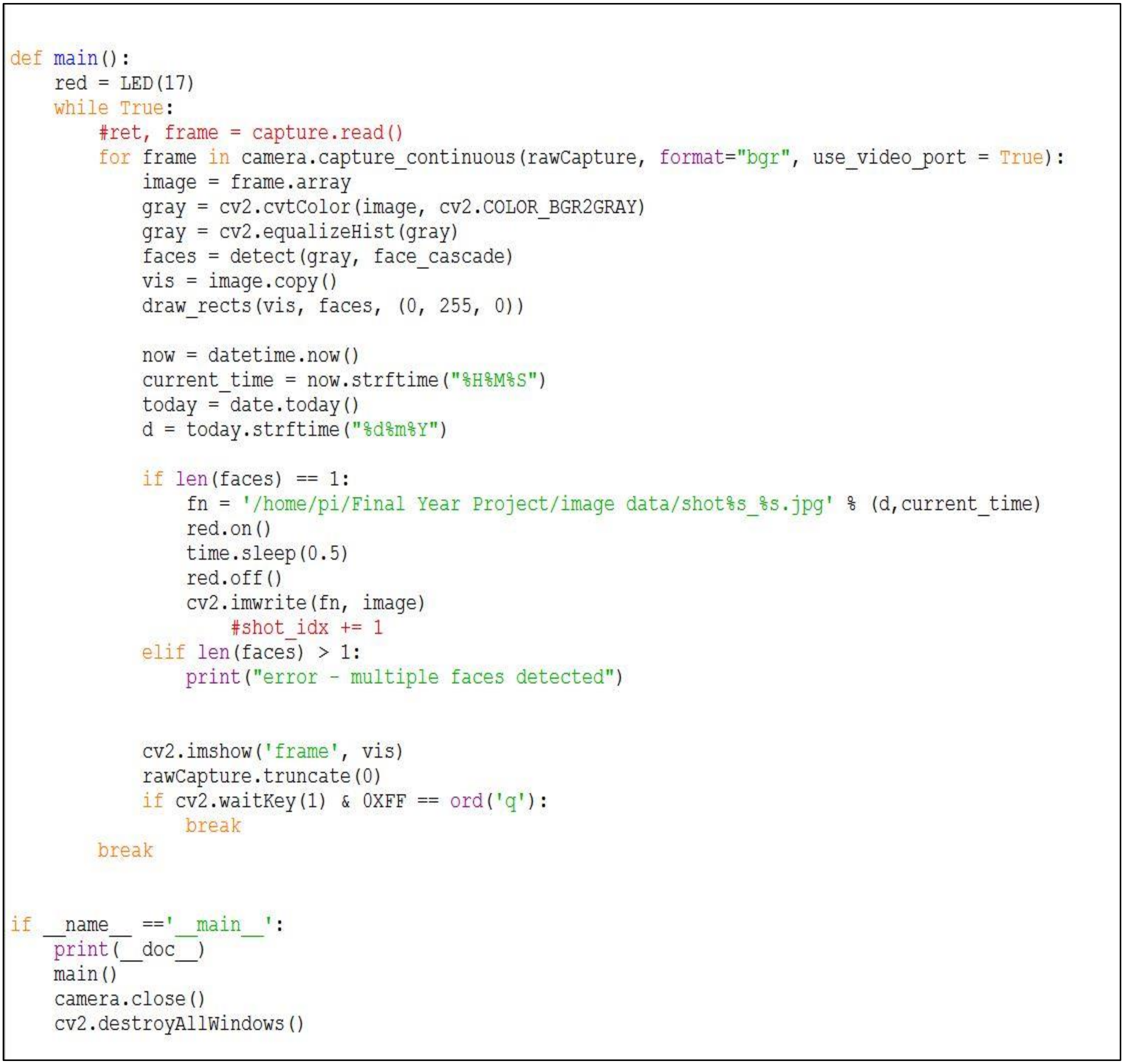
3.4 PROJECT CODE:

- The code implemented in this project is mentioned below.



```
import numpy as np
import cv2
from picamera import PiCamera
from picamera.array import PiRGBArray
from datetime import datetime
from datetime import date
import time
from gpiozero import LED


face_cascade = cv2.CascadeClassifier('/home/pi/Final Year Project/haarcascade/haarcascade_frontalface_alt.xml')

#camera capture
camera = PiCamera()
camera.resolution = (640,480)
camera.framerate = 60
rawCapture = PiRGBArray(camera, size=(640, 480))

time.sleep(0.1)




# eye_cascade = cv2.CascadeClassifier('D:\\CV2\\opencv\\sources\\data\\haarcascades\\haarcascade_eye.xml')
#capture = cv2.VideoCapture(0)
#shot_idx = 0



def detect(gray, face_cascade):
    faces = face_cascade.detectMultiScale(gray, scaleFactor=1.3, minNeighbors=5, minSize=(30, 30))

    if len(faces) == 0:
        return []
    faces[:, 2:] += faces[:, :2]
    return faces


def draw_rects(gray, faces, color):
    for x1, y1, x2, y2 in faces:
        cv2.rectangle(gray, (x1, y1), (x2, y2), color, 2)
```

(Fig. 3.3 Code-I)

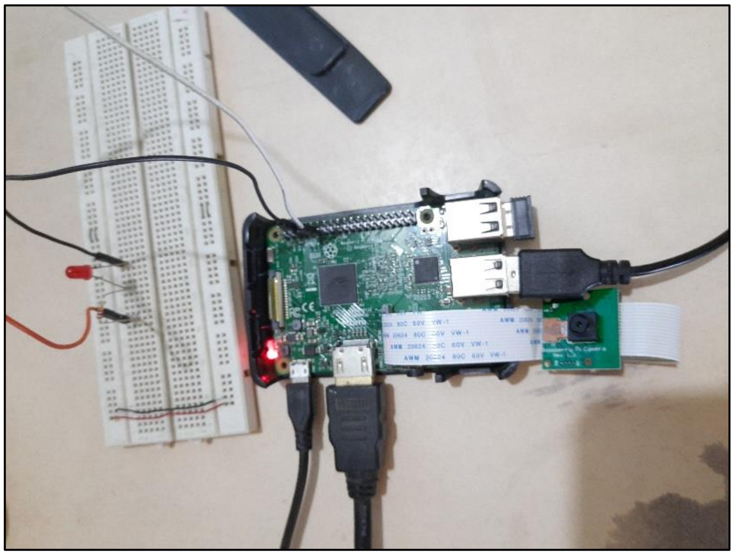


```python
def main():
    red = LED(17)
    while True:
        #ret, frame = capture.read()
        for frame in camera.capture_continuous(rawCapture, format="bgr", use_video_port = True):
            image = frame.array
            gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)
            gray = cv2.equalizeHist(gray)
            faces = detect(gray, face_cascade)
            vis = image.copy()
            draw_rects(vis, faces, (0, 255, 0))

            now = datetime.now()
            current_time = now.strftime("%H%M%S")
            today = date.today()
            d = today.strftime("%d%m%Y")

            if len(faces) == 1:
                fn = '/home/pi/Final Year Project/image data/shot%s_%s.jpg' % (d,current_time)
                red.on()
                time.sleep(0.5)
                red.off()
                cv2.imwrite(fn, image)
                    #shot_idx += 1
            elif len(faces) > 1:
                print("error - multiple faces detected")


            cv2.imshow('frame', vis)
            rawCapture.truncate(0)
            if cv2.waitKey(1) & 0XFF == ord('q'):
                break
        break


if __name__ =='__main__':
    print(__doc__)
    main()
    camera.close()
    cv2.destroyAllWindows()
```

(Fig. 3.4 Code-II)

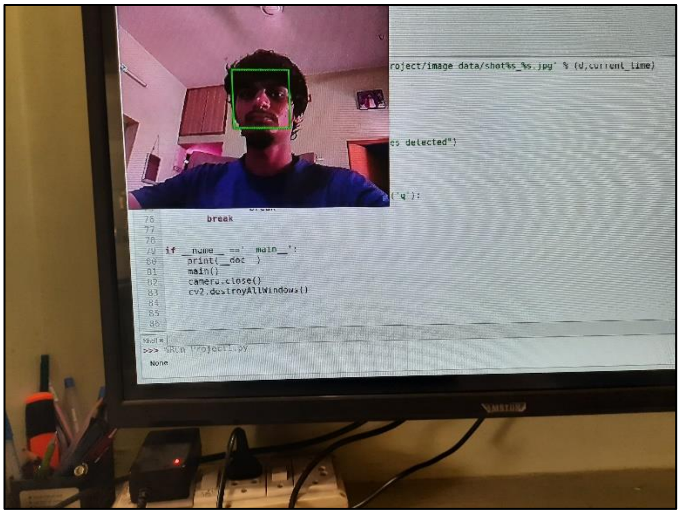
3.5 IMPLEMENTATION:

CONNECTIONS:



(Fig. 3.5 Connection)

SCREEN OUTPUT:

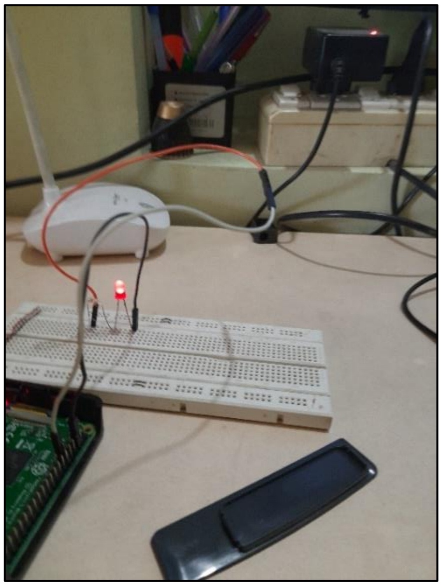


```
roject/image data/shot%s_%s.jpg' % (d,current_time)

es detected")

('q'):
        break

if __name__ == '__main__':
    print(__doc__)
    main()
    camera.close()
    cv2.destroyAllWindows()
```

```
>>> %Run Project1.py
 None
```

(Fig. 3.6 Screen output)

DOOR LOCK OUTPUT:



(Fig. 3.7 Door lock output)

CHAPTER: 4

SUMMARY

- From this project we understood working methods of various face detection algorithms. Moreover, we got an opportunity to learn python and as the project was on image processing it has helped us understand how the actual operation of image processing techniques works on real time Images.
- We also worked with the Linux based operating system ‘Raspbian’, which gave us the overview of the actual Linux OS and the basic operations in terminal using Linux commands. The project has not much but a little part of embedded programming.
- From that we learned to access GPIO in a Raspberry Pi. The ultimate goal was to stop robbers from robbing money from the ATM and in case if they get successful in the robbery the facial portrait of criminal captured by the camera can help us catch robbers which is fulfilled by the project.

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