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IMAGE PROCESSING

CSE-4019

Project Title:

Smart Home Automation using Face Detection & Recognition

Team Members:

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Report Submitted for the
Final Project Review

Under the Guidance:

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SLOT: E1

INDEX:

ABSTRACT:

Computers have automated a lot of tasks in our day-to-day activities and have made the life of humans a lot easier. Calling a bell or an alert system has been there for ages. What if we could know who is standing in front of your home even before you answer the door. The project focuses on automating the task of identifying the person who is standing in front of your home and alerts you immediately. In this project we used an ML to train our model. Whenever a person comes in front of the house, then the camera module captures the image of the person. The image is then sent to the server or database and possible matches are found. If a match is found, then a notification appears.

A face recognition system is one of the biometric information processes, its applicability is easier and working range is larger than others, i.e.; fingerprint, iris scanning, signature, etc. The system uses a combination of techniques in two topics; face detection and recognition. The face detection is performed on live acquired images without any application field in mind. Processes utilized in the system are white balance correction, skin like region segmentation, facial feature extraction and face image extraction on a face candidate. The tested system has acceptable performance to recognize faces within intended limits. System is also capable of detecting and recognizing multiple faces in live acquired images.

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AIM:

- Implement a working model which will be able to detect human faces.
- After detection the model should be able to recognize faces.
- Improve our home security.
- The images captured of the person outside of our home is matched with the existing database of images we have, and if a match is found then the person is identified and his name is shown in the output

INTRODUCTION:

Facial recognition is a way of identifying or confirming an individual's identity using their face. Facial recognition systems can be used to identify people in photos, videos, or in real-time. Facial recognition is a category of biometric security. Other forms of biometric software include voice recognition, fingerprint recognition, and eye retina or iris recognition. The technology is mostly used for security and law enforcement, though there is increasing interest in other areas of use.

Ever since IBM introduced first personal computer on 1981, to the .com era in the early 2000s, to the online shopping trend in last 10 years, and the Internet of Things today, computers and information technologies are rapidly integrating into everyday human life. As the digital world and real-world merge more and more together, how to identify users and improve information security has become an important research topic accurately and effectively.

Many people are familiar with face recognition technology through the FaceID used to unlock smartphones (however, this is only one application of face recognition). Typically, facial recognition does not rely on a massive database of photos to determine an individual's identity — it simply identifies and recognizes one person as the sole owner of the device, while limiting access to others.

Beyond unlocking phones, facial recognition works by matching the faces of people walking past special cameras, to images of people on a watch list. The watch lists can contain pictures of anyone, including people who are not suspected of any wrongdoing, and the images can come from anywhere — even from our social media accounts.

When comparing the differences between different biometrics, we can see that the cost of facial recognition is low, the acceptance from user is easy, and the acquisition of information is easy. Facial recognition is the use of computer vision technology and related algorithms, from the pictures or videos to find faces, and then analysis of the identity. In addition, further analysis of the acquired face, may conduct some additional attributes of the individual, such as gender, age, emotion, etc.

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LITERATURE SURVEY:

[1] Face detection and Recognition: A review
Journal:6th International Conference on Advancements in Engineering & Technology (ICAET-2018), Feb. 23-24, 2018, Sangrur
Authors: Akanksha, Jashanpreet Kaur, Harjeet Singh, BHSBIET,Lehragaga

Summary: The facial expression recognition system contributes a resilient face recognition model based on the mapping of behavior characteristics with the physiological biometric characteristics. To study the grayscale intensity distribution of an average human face. Now Face is detected using a face detecting machine. Then we extract the features and use a euclidean distance method to match it with any image in our database.To study the grayscale intensity distribution of an average human face. Now Face is detected using a face detecting machine. Then we extract the features and use the euclidean distance method to match it with any image in our database.

[2] Face Recognition System
Journal: International Journal of Engineering Research & Technology (IJERT), 2019
Authors: Shivam Singh, Prof. S. Graceline Jasmine

Summary: Face detection ability of the system on spot or in a video. It is observed that better accuracy in recognition is achieved with the KLT algorithm and Fusion of PCA and recognition plays a vital role in a wide range of applications. It has higher accuracy.

[3] Face Recognition and Identification using Deep Learning Approach
Journal: Journal of Physics: Conference Series 1755 012006
Authors: KH Teoh , RC Ismail, SZM Naziri , R Hussin, MNM Isa and MSSM Basir

Summary: Design and develop face recognition using Deep Learning. Face recognition system using deep learning using OpenCV in python. Deep learning ensures high accuracy. Experiment results included to demonstrate accuracy.

[4] A Review Paper on Raspberry Pi and its Applications
Journal: Journal of Information Storage and Processing Systems
Authors: Hirak Dipak Ghael, Dr. L Solanki, Gaurav Sahu

Summary: This paper goes into detail regarding the technical and functional specifications of RPI. It also goes into detail regarding the inner working of RPI,

its pros and cons and many applications of the same. Through this paper we found the major applications world-wide and RPI's core pros and cons, Pros such low price, high number of GPIO and cons such as lack of real time clock and missing eMMC storage paved a clear way to finalize our Hardware which is RPI.

[5] Raspberry Pi as Internet of Things hardware: Performances and Constraints
Journal: IcETRAN 2014
Authors: Mirjana Maksimović, Vladimir Vujović, Nikola Davidović, Vladimir Milošević and Branko Perišić

Summary: This paper details about different parameters of Raspberry PI and also compares and contrast with other IoT hardware platforms such as Arduino, Udoo, phigets etc., Through our analysis we found that RPI has an operation speed of 700 MHz to 1000 MHz, supports USB 2.0 and a RAM size of 256 - 512MB. Ability to use audio-media players, Televisions, HDMI ports, Camera Serial Interface and about its GPIO.

[6] A high-efficiency energy and storage approach for IoT applications of facial recognition
Journal: Elsevier B.V
Authors: Peixoto, Solon A

Summary: This work presented a powerful approach for compressing facial features that can be used for facial recognition, maintaining or even surpassing the results obtained with uncompressed features. This uses Floor of Log (FoL). The advantage of this method is the reduction of storage and energy, maintaining accuracy. K-NN and SVM algorithm was applied to learn the better parameter of the FoL algorithm using cross-validation.

[7] IOT based Facial recognition security system
Journal: Cornell University Library. IEEE Xplore,2020
Authors: Balla, Prashanth Balraj, and K. T. Jadhao

Summary: This work presents a method of tracking the various visitors visiting places (like office, home, etc.. then implement a particular face and distinguish it from a number of stored faces with some real time variations as well. The Raspberry Pi model acts as a center of the system which will control the action of other devices. It has memory, USB and LAN ports. It works at 3.3 V and a camera of 5MP, which is going to capture the image of the visitor and it is connected to the RPI.

[8] IOT based facial recognition system for home security using LBPH algorithm
Journal: Proceedings of the International Conference on Inventive Computation Technologies (ICICT-2018)
Authors: Bhatia, Prayag

Summary: This paper proposes an idea of developing a smart IOT based face recognition system which recognizes only those faces which are stored in the database and the owner will be able to control his door from his phone or Personal computer. For face detection, Histogram of Oriented Gradients (HOG) is used. In HOG, a sliding window detector is used which is moved across the entire image where a HOG descriptor is calculated for each image.

[9] Implementation of home security and automation system based on face recognition using Iot
Journal: Journal of Information Storage and Processing Systems
Authors: Mahesh kumar, Rekha, Yashwanth, Mounika

Summary: The technique used here involves generating the 'Eigen faces'. By using the
eigen faces method the face recognition system here can extract the features of the face and compare this with the existing facial images of the database.

[10] IoT based Smart Home using Face Recognition
Journal: 2018 IJCRT
Authors: Aishwarya, Ashwini, Vaishnavi, Sharayu

Summary: Used passive infrared sensor (PIR sensor) which is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. The proposed system uses web application for communication between user and home devices.It uses effective
algorithms names Viola Jones & Eigen Face for face detection and recognition

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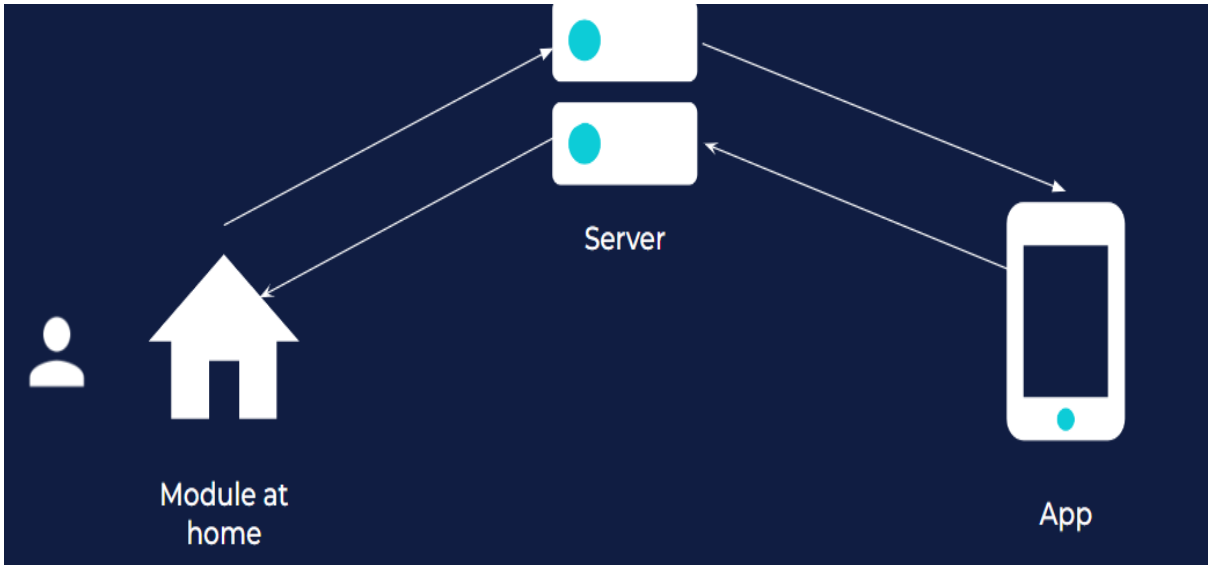
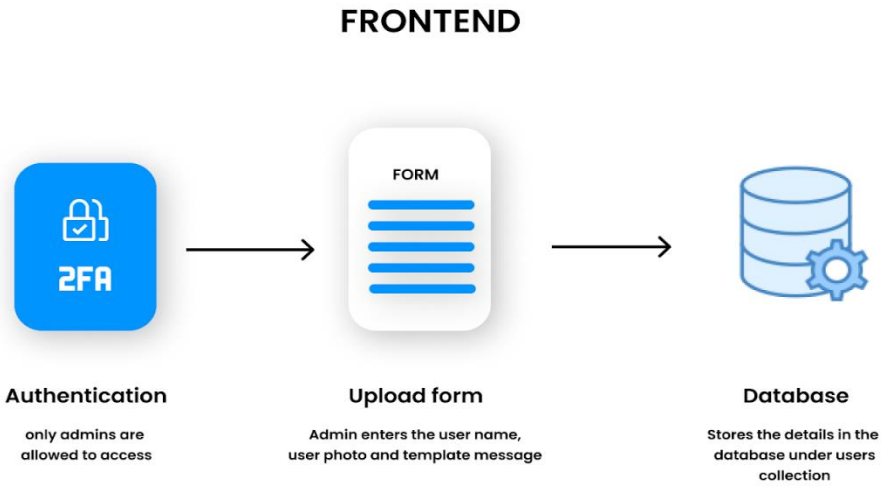
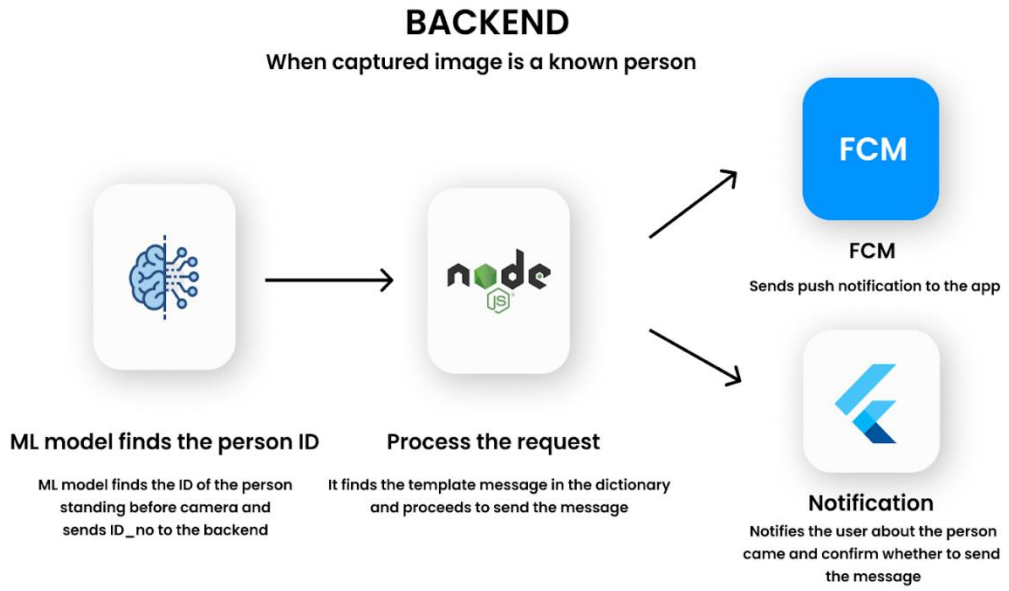
PROPOSED SYSTEM DESIGN ARCHITECTURE:

We propose a model in which a unit will be installed at home along with an app for the house owner to manage people and get notifications. While a visitor is in front of the home, the camera module would be ac is already in the known list. If the person is identified, it will send a notification to the house owner activated and it will run the face recognition model to identify whether the person's app, so that he/she gets notified about a visitor at home regardless of whether they are at home.

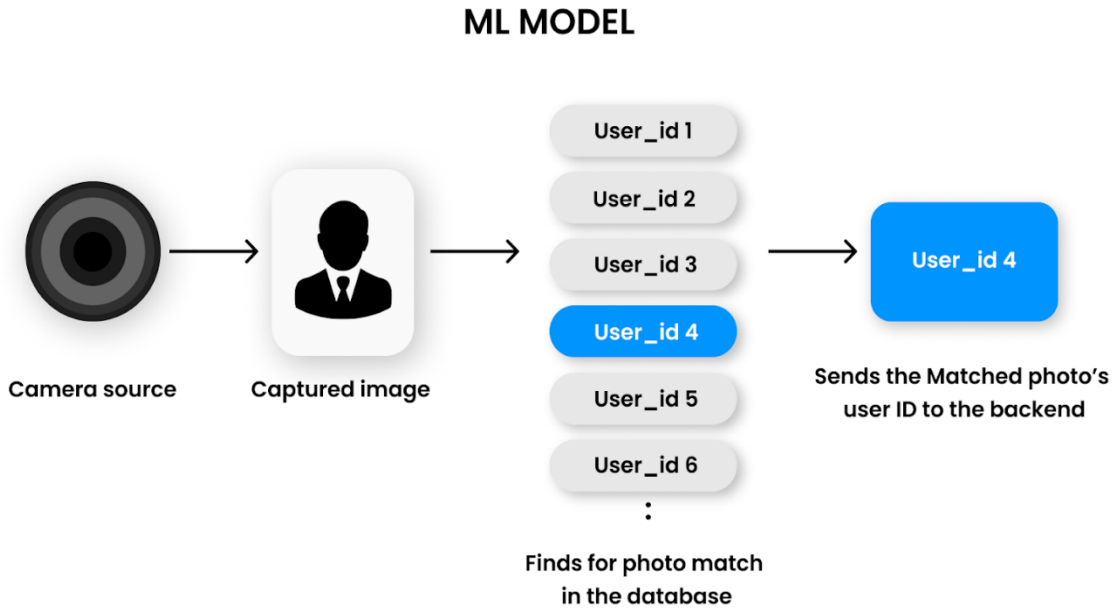




In the backend, the captured image is matched with the images from the database. If a match is found then the match is shared with the owner, with the name of the person. If a match is not found then the unknown person's tag come.



The below diagram explains the basic working of our project, staring from capturing the image to finally recognizing and sending the notification.



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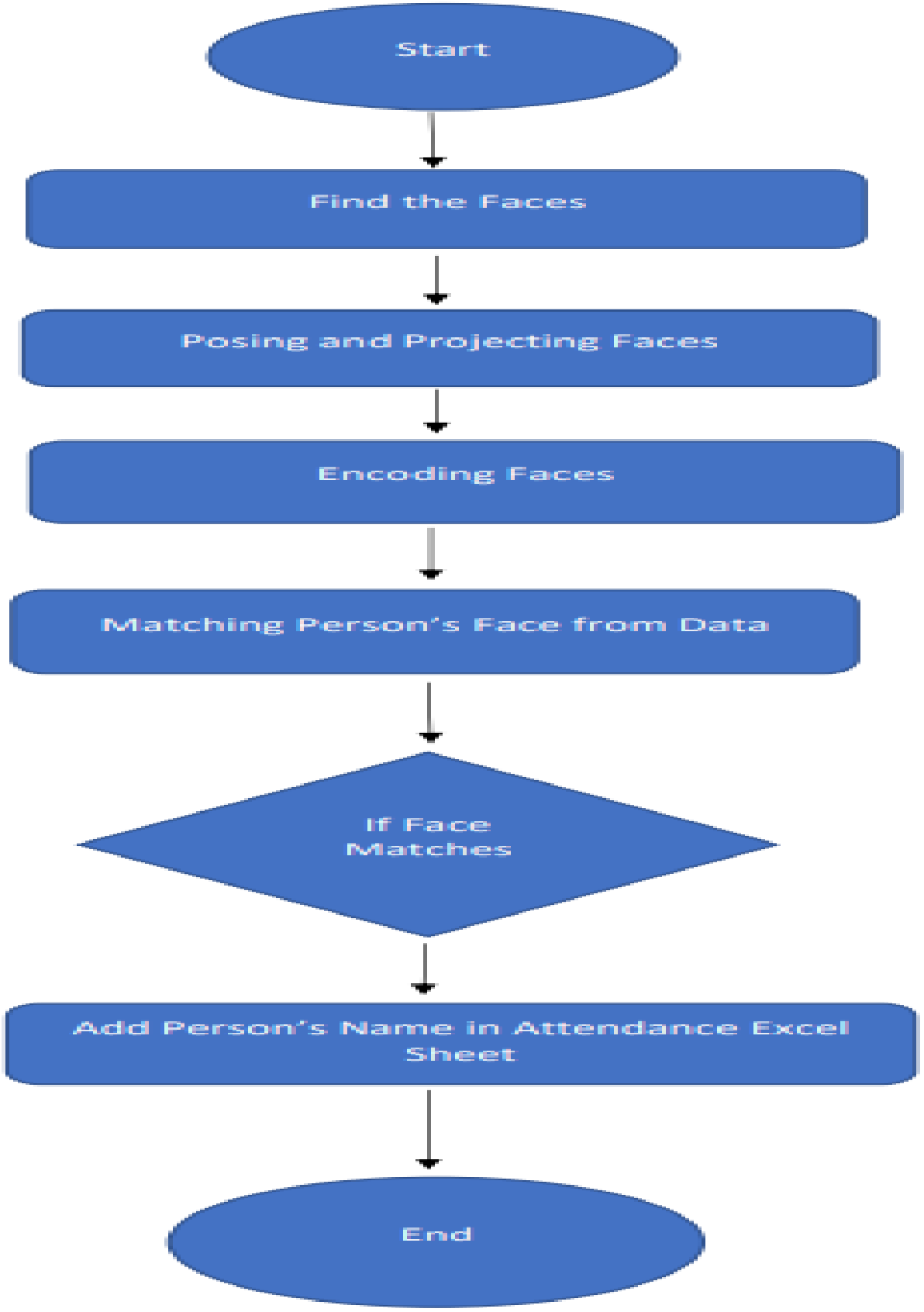
WORKFLOW DIAGRAM:



HARDWARE & SOFTWARE REQUIREMENTS:

Hardware:

1. A camera or webcam
2. A computer or laptop or smartphone
3. Internet connection

Software:

1. Microsoft visual studio code
2. Python language
3. OpenCV
4. Images to be stored in database

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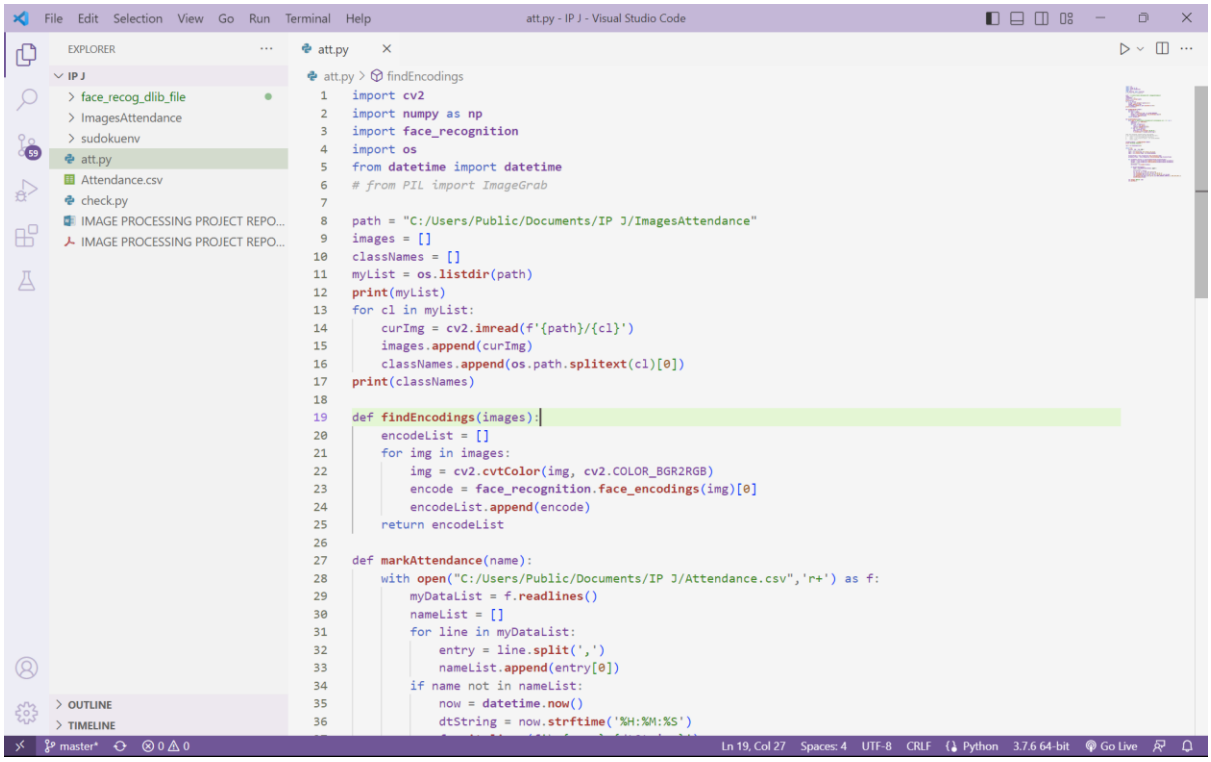
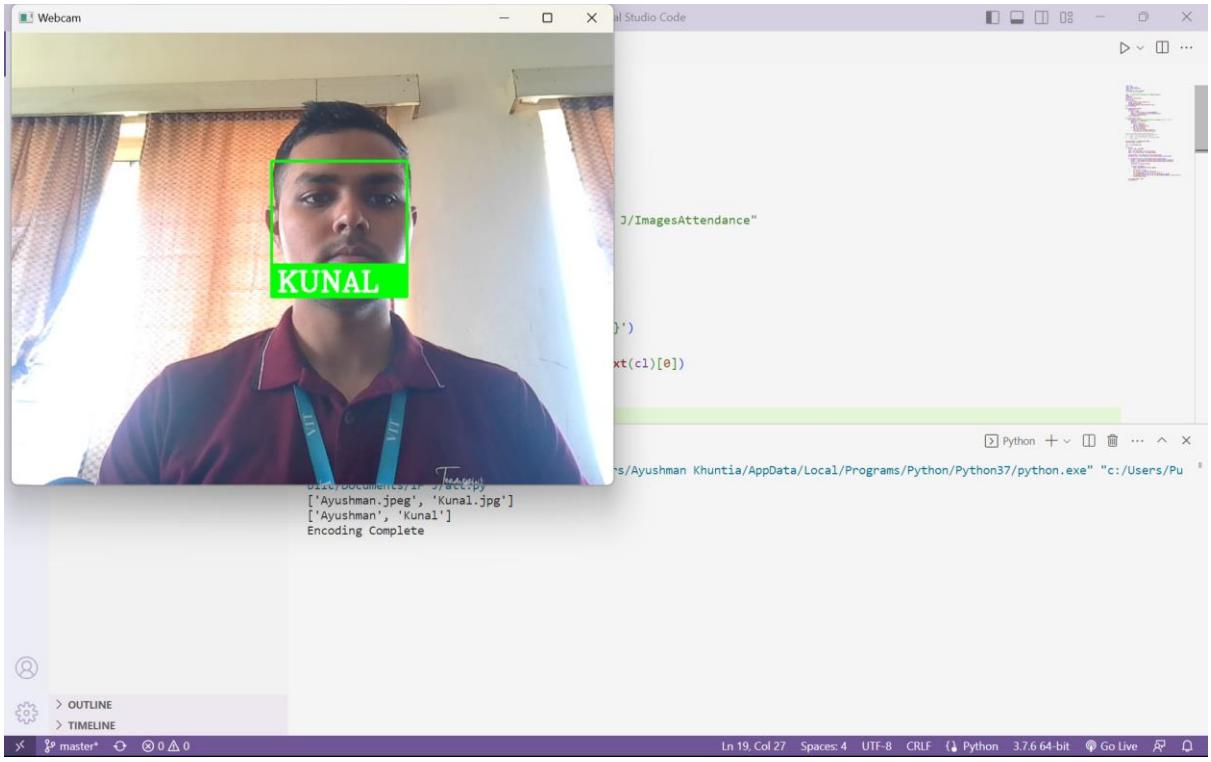
CODE:

```
import cv2
import numpy as np
import face_recognition
import os
from datetime import datetime

path = 'ImagesBasic'
images = []
classNames = []
myList = os.listdir(path)
print(myList)
for cl in myList:
    curImg = cv2.imread(f'{path}/{cl}')
    images.append(curImg)
    classNames.append(os.path.splitext(cl)[0])
print(classNames)

def findEncodings(images):
    encodeList = []
    for img in images:
```

```
        img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        encode = face_recognition.face_encodings(img)[0]
        encodeList.append(encode)
    return encodeList

def markPresence(name):
    with open('Presence.csv','r+') as f:
        myDataList = f.readlines()
        nameList = []
        for line in myDataList:
            entry = line.split(',')
            nameList.append(entry[0])
        if name not in nameList:
            now = datetime.now()
            dtString = now.strftime('%H:%M:%S')
            f.writelines(f'\n{name},{dtString}')


encodeListKnown = findEncodings(images)
print('Encloding Complete')

cap = cv2.VideoCapture(0)

while True:
    success, img = cap.read()
    imgS = cv2.resize(img,(0,0),None,0.25,0.25)
    imgS = cv2.cvtColor(imgS, cv2.COLOR_BGR2RGB)

    facesCurFrame = face_recognition.face_locations(imgS)
    encodesCurFrame = face_recognition.face_encodings(imgS,facesCurFrame)

    for encodeFace,faceLoc in zip(encodesCurFrame,facesCurFrame):
        matches = face_recognition.compare_faces(encodeListKnown,encodeFace)
        faceDis = face_recognition.face_distance(encodeListKnown,encodeFace)
        #print(faceDis)
        matchIndex = np.argmin(faceDis)

        if matches[matchIndex]:
            name = classNames[matchIndex].upper()
            #print(name)
            y1,x2,y2,x1 = faceLoc
            y1, x2, y2, x1 = y1*4, x2*4, y2*4, x1*4
            cv2.rectangle(img,(x1,y1),(x2,y2),(0,255,0),2)
            cv2.rectangle(img,(x1,y2-35),(x2,y2),(0,255,0),cv2.FILLED)
            cv2.putText(img,name,(x1+6,y2-6),cv2.FONT_HERSHEY_COMPLEX,1,(255,255,255),2)
            markPresence(name)

    cv2.imshow('Webcam',img)
    cv2.waitKey(1)
```

SCREENSHOTS:





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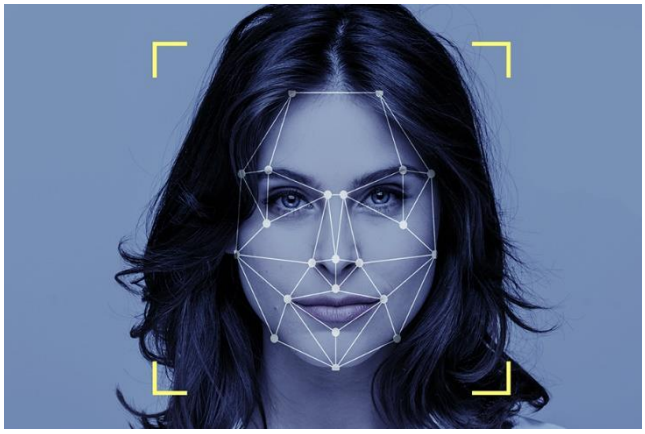
METHODOLOGY:

Supervised ML implementation

A facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces. Such a system is typically employed to authenticate users through ID verification services, and works by pinpointing and measuring facial features from a given image.



Step 1: Finding the faces

To identify the faces, we are using the concept of Histogram of Oriented Gradients or HOG. Repeating HOG across every pixel in the image we end up with every pixel being replaced by an arrow. These arrows are called gradients and they show the flow from light to dark across the entire image. (available in Dlib)

HOG stands for **Histogram of Oriented Gradients**, which is a feature extraction method used in computer vision and image processing for object detection and recognition. HOG works by computing the gradient orientation and magnitude of the pixels in an image and grouping them into local histograms of oriented gradients. These local histograms are then normalized and concatenated to form a feature vector that is used to represent the image.

The HOG method has become popular for pedestrian detection, where it has been shown to achieve high accuracy and robustness in various conditions. The steps involved in the HOG method for object detection are:

- **Pre-processing:** The input image is converted to grayscale, and local contrast normalization is applied to reduce the influence of illumination changes.

- **Gradient computation**: The gradients of the image are computed in both the x and y directions using finite differences. The gradient magnitude and orientation are then calculated from these gradients.

- **Cell grouping**: The image is divided into small rectangular regions called cells, and the gradient orientation and magnitude within each cell are used to compute a histogram of oriented gradients.

- **Block normalization**: The histograms from adjacent cells are grouped together to form larger blocks, which are then normalized to reduce the effect of illumination changes and improve the robustness of the features.

- **Feature vector**: The normalized histograms from all the blocks in the image are concatenated to form a feature vector that is used for object detection.

The resulting feature vector can be fed into a machine learning algorithm such as an SVM for object detection and recognition. The HOG method has been successfully applied to various object recognition tasks, including face detection, car detection, and animal detection.

Step 2: Different perspective of images

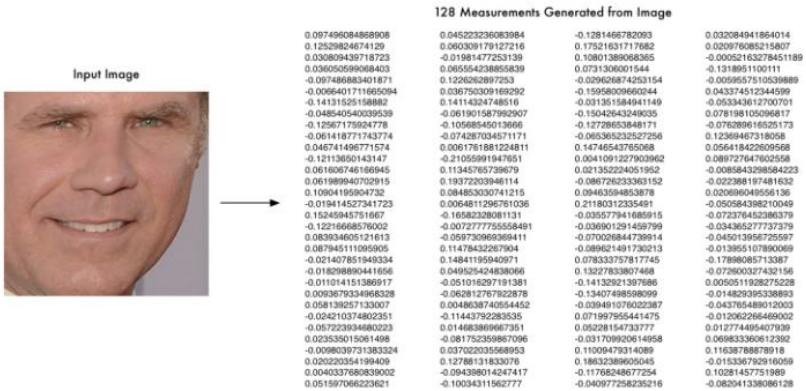
We must deal with the problem that faces turned in different directions look totally different to a computer. To account for this, we will try to warp each picture so that the eyes and lips are always in the sample place in the image.
Here we use face landmark estimation.

Face landmark estimation

Now for whatever position it is, we will warp the image and find 68 specific positions. Now we can proceed with the encoding process without any issues.

Step 3: Encoding faces

Researchers have discovered that the most accurate approach is to let the computer figure out the measurements to collect itself. Deep learning does a better job than humans at figuring out which parts of a face are important to measure.

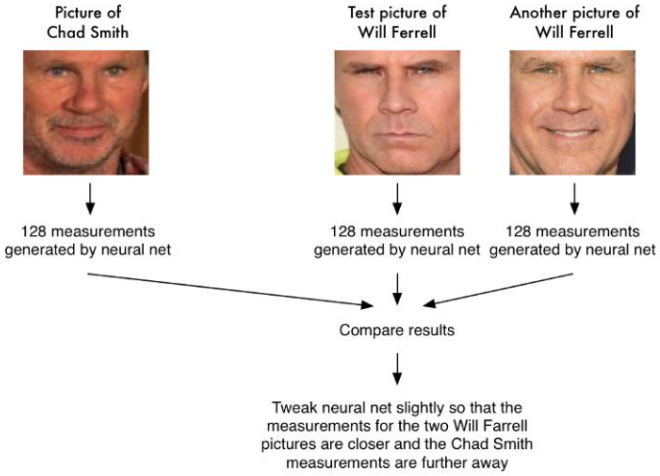


Process

The training process works by looking at 3 face images at a time:

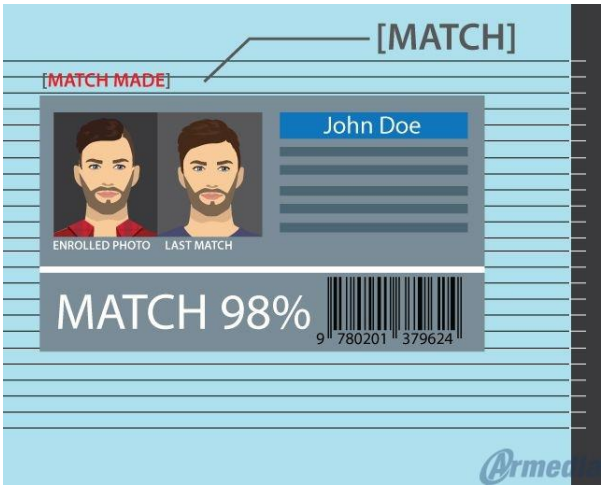
- Load a training face image of a known person
- Load another picture of the same known person
- Load a picture of a totally different person

For each picture, it generates 128 measurements.



Step 4: Finding the person's name from the encoding

We train a classifier (preferably SVM) that can take in the measurements from a new test image and tells which known person is the closest match. Running this classifier takes milliseconds. The result of the classifier is the name of the person.



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ADVANTAGES:

Compared with the traditional card recognition, fingerprint recognition and iris recognition, face recognition has many advantages, including but limited to non-contact, high concurrency, and user friendly.
It has high potential to be used in government, public facilities, security, e-commerce, retailing, education, and many other fields.
Today's modern face recognition techniques comes with advantages such as:

- Helps find missing people
- Protects businesses against theft
- Improves medical treatment
- Strengthens security measures
- Makes shopping more efficient
- Reduces the number of touchpoints
- Improves photo organization

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AREAS OF CONCERN:

Facial recognition is an innovative technology that has the power to change our future. However, like any innovation, some consequences and risks are involved when implementing this new system in society. As with any technology, there are drawbacks to using facial recognition, such as the violation of rights and personal freedoms that it presents, potential data theft and the risk of overreliance on inaccurate systems.

- Threatens privacy
- Imposes on personal freedom
- Violates personal rights
- Data vulnerabilities
- Misuse causing fraud and other crimes
- Technology is still new
- Errors can implicate innocent people
- Technology can be manipulated

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APPLICATIONS:

The advantages of security and safety have prompted many industries to implement facial recognition technology into their daily operations. Look at how and where this technology can be applied.

1. **AUTOMOBILE SECURITY:**
   Facial recognition technology is sometimes used by ride-sharing apps to confirm that a given passenger is who they say they are. Or alternatively, the same technology can guarantee that the passenger is approaching the right driver.

2. **ACCESS CONTROL**
   Outside of cars and smartphones, facial recognition can be used in the home to grant access to certain IoT devices in addition to entry into the home itself. As this technology becomes more and more advanced, people will feel better protected against home invasions and robberies.

3. **IMMIGRATION**
   Immigration offices exist as an extension to more well-known government segments. Facial recognition technology is used to enforce stricter border control, particularly when it comes to criminals and persons of interest who attempt to cross the border.

4. **EDUCATION**
   For schools using this technology, the main benefit they see is tracking student attendance as well as maintaining the security of their campus. Unfortunately, technology can be very biased and studies have shown evidence for the software to be banned.

5. **HEALTHCARE**
   Applications of facial recognition technology are used in hospitals, especially those working in assisted living. The software serves to keep track of everything that is going on within a hospital, ensuring patients are safe and the premise is secure.

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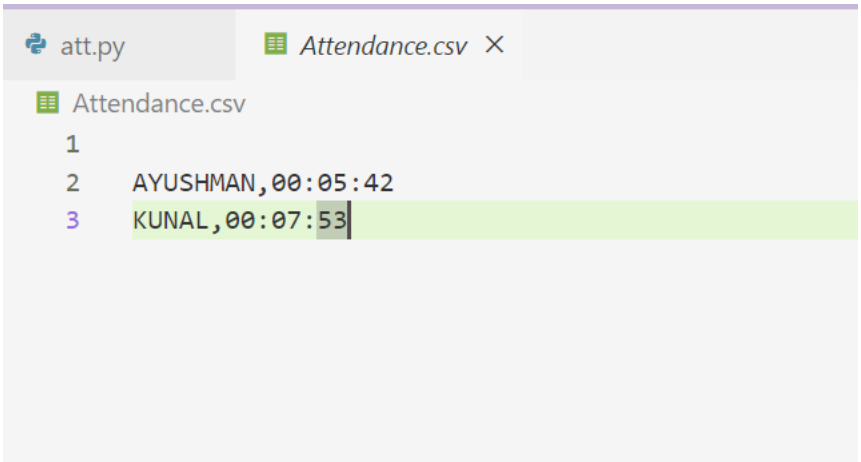
RESULTS & DISCUSSIONS:

When we run our program then the webcam detect the face and it matches with the database. If the face matches, then it will add the name and entry timing of that person in the log book excel sheet.



After capturing the photo at the door, face recognition is done to check whether the person standing in front of the door is a family member or identified one. The camera captures the photo of the person. Now the system searches the local database which consists of the photos of the family members or the authorized persons and checks if the photo captured matches with any of the available photos. It will determine if the person is a stranger or not. If the person is a stranger, then his photo will be sent to the owner's phone which will warn the owner. So, this will help to improve the security of the home.

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CONCLUSION & FUTURE WORK:

In this project, we suggest and illustrate a smart home security method that is both affordable and secure for our house. With the aid of cameras and face recognition, we have the system. We can identify the visitor at the door using real-time face recognition, and we can notify the owner via an app. So, it can be implemented in the practical field. Besides, the cost of the project is not too much. It requires less cost and provides security to our home. Here it has provided utmost security so it is quite impossible for any burglar to enter the room without the concern of the owner. If available financial and technical support from the concerned Government section and organizations are found, then it will be possible to commercialize the proposed lock for the benefit of the people of the country. Some new technologies such as fingerprint scanning, voiceprint identification

also can be inserted. Moreover, it could be useful for various sensors such as gas sensor, fire sensor for more improvement of the security of home.

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THANK YOU!

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