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Automated Lecture Attendance System By Face Recognition

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Abstract **- Authentication is a significant issue in system control in computer-based communication. Human face recognition is an important branch for biometric verification and has been widely used in many applications, such as video monitoring system, human-computing interaction, and door control system and network security. Students attendance in the classroom is very important task and if taken manually wastes a lot of time. There are many automatic methods available for this purpose i.e. biometric attendance. All these methods also waste time because students have to make a queue to touch their thumb on the scanning device. This work describes the efficient algorithm that automatically marks the attendance without human intervention. The face is the identity of a person. The methods to exploit this physical feature have seen a great change since the advent of image processing techniques. The accurate recognition of a person is the sole aim of a face recognition system and this identification maybe used for further processing. This attendance is recorded by using a camera attached in front of classroom that is continuously capturing images of students, detect the faces in images and compare the detected faces with the database and mark the attendance.**

Keywords - Raspberry Pi 3, Raspberry Pi Camera, Histogram of Oriented Gradients (HOG), Face Embedding, FaceNet

1. INTRODUCTION

Person Identification is one of the most crucial building blocks for smart interactions. Among the person identification methods, face recognition is known to be the most natural ones, since the face modality is the modality that uses to identify people in everyday lives. Although other methods, such as finger print identification, can provide better performance, those are not appropriate for natural smart interactions due to their intrusive nature. In contrast, face recognition provides passive identification that is person to be identified does not need to cooperate or take any specific action.

Basically, our project is aimed for implementing a system that is capable of identifying the students and marking their attendance. Every institute has its own method in this regard. Some are taking attendance manually using the old paper or file-based approach and some have adopted methods of automatic attendance using some biometric techniques. But in these methods students have to wait for long time in making a queue at time they enter the classroom. Smart attendance using real time face recognition provides flexibility to identify several students rather than identifying one by one. To increase the accuracy, efficiency and reliability of the recognition, algorithms are needed.

Many biometric systems are available but the key authentication is same in all the techniques. Every biometric system consists of enrolment process in which unique features of a person is stored in the database and then there are processes of identification and verification. These two processes compare the biometric feature of a person with previously stored template captured at the time of enrolment. Biometric templates can be of many types like Fingerprints, Eye Iris, Face, Hand Geometry, Signature, Gait and voice. Our system uses the face recognition approach for the automatic attendance of students in the classroom environment without students' intervention. Face recognition consists of two steps, in first step faces are detected in the image and then these detected faces are compared with the database for verification. A number of methods have been proposed for face detection i.e. AdaBoost algorithm, the Float Boost algorithm, Neural Networks, the S-AdaBoost algorithm, Support Vector Machines (SVM), and the Bayes classifier.

2. SYSTEM DESCRIPTION

2.1. Hardware

The system includes Raspberry pi 3 module with Raspberry Pi Camera Module v2 for capturing the classroom image. Raspberry Pi 3 module is a credit card sized minicomputer. It has CPU: 4× ARM Cortex-A53, 1.2GHz, GPU: Broadcom VideoCore IV, RAM: 1GB LPDDR2 (900 MHz), Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless, Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy, Storage: microSD, GPIO: 40-pin header, populated, Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI). The upgraded Raspberry Pi Camera Module v2 is the new official camera board released by the Raspberry Pi Foundation which connects to any Raspberry Pi or Compute Module. The Raspberry Pi Camera Module v2 is a high quality

8-megapixel camera based around the Sony IMX219 image sensor - allowing you to create HD video and still photographs. It is a custom designed add-on board for Raspberry Pi, featuring a fixed focus lens. It's capable of 3280 x 2464 pixel static images, and also supports 1080p30, 720p60 and 640x480p90 video. It attaches to Pi by way of one of the small sockets on the board upper surface and uses the dedicated CSi interface, designed especially for interfacing to cameras.

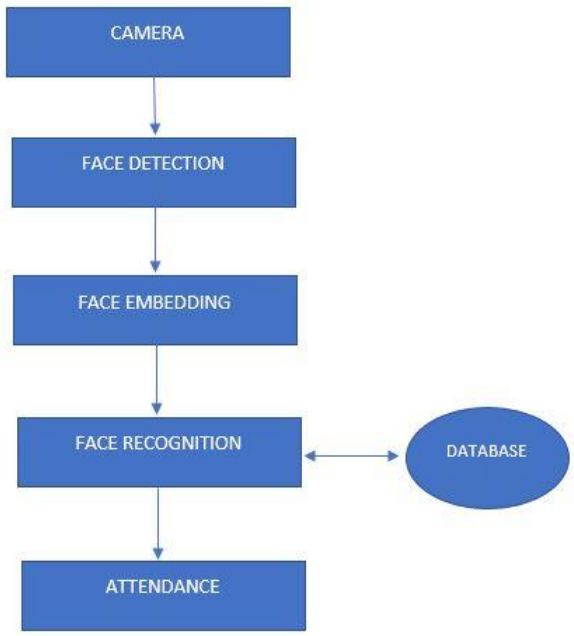
Raspberry Pi 3 Module:

Raspberry Pi Camera Module v2:

2.2. Software

The software used in this project are Python IDLE 3.6.5, PUTTY terminal, OpenCV.

3. FLOW CHART



4. ALGORITHMS

This section describes the algorithms used for the system. The system is divided into three sections as:

1. Face detection by Histogram of Oriented Gradients.
2. Features extractions using FaceNet.
3. Face Recognition using Euclidean Distance.

4.1. Histogram Of Oriented Gradient For Face Detection

Face detection is defined as finding the position of the face of an individual. In other word it can be defined as locating the face region in an image. After detecting the face of human its facial features is extracted and has wide range of application like facial expression recognition,
face recognition, observation systems, human PC interface and so forth. Detecting face in an image of single person is easy but when we consider a group image of an image containing multiple faces, the task becomes difficult.
For the application of face recognition, detection of face is very important and the first step. After detecting face the face recognition algorithm can only be functional. Face detection itself involves some complexities for example surroundings, postures, enlightenment etc.

Histogram of Oriented Gradients (HOG) is a feature descriptor widely employed on several domains to characterize objects through their shapes. Local object appearance and shape can often be described by the distribution of local intensity gradients or edge directions. HOG is widely utilized as a feature described image region for object detection such as human face or human body detection. To increase the efficiency of the object searching, gamma and colors of the image should be normalized. The object search is based on the detection technique applied for the small images defined by sliding detector window that probes region by region of the original input image and its scaled versions.

The first step in HOG detection is to divide the source image into blocks (for example 16×16 pixels). Each block is divided by small regions, called cells (for example 8×8 pixels). Usually blocks overlap each other, so that the same cell may be in several blocks. For each pixel within the cell the vertical and horizontal gradients are obtained. The simplest method to do that is to use 1-D Sobel vertical and horizontal operators:

$Gx(y,x) = Y(y,x+1) - Y(y,x-1)$; $Gy(y,x) = Y(y+1,x) - Y(y-1,x)$

$Y(y,x)$ is the pixel intensity at coordinates x and y. $Gx(y,x)$ is the horizontal gradient, and $Gy(y,x)$ is the vertical gradient.

4.2.1. Feature Extraction usinf FaceNet

FaceNet is a Deep Learning architecture consisting of convolutional layers based on GoogLeNet inspired inception models developed by Google researchers. FaceNet returns a 128-dimensional vector embedding for each face. Having been trained with triplet loss for different classes of faces (by classes I mean faces from different people) to capture the similarities and differences between them, the 128-dimensional embedding, returned by the FaceNet model, effectively clusters faces. Hence this vector would be closer for similar faces and farther apart for dissimilar faces. This FaceNet architecture is trained over a dataset with a very large number of faces belonging to numerous classes.

4.2.2. Face Embedding

The Face Embedding (encoding) analyses images and returns numerical vectors that represent each detected face in the image in a 128-dimensional space. The vector representation is computed by using FaceNet. The vectors of visually similar faces will be close to each other in the 128-dimensional space. The Face Embedding model can be used for organizing, filtering, and ranking images according to visual similarity. Face embedding is basically feature of an image.

In our application face embedding(encoding) is obtained from normalization layer that is last layer of FaceNet. Face embedding can be of different dimensional space like 64d,128d,256d and 512d. Among all of the listed dimensional spaces 128d gives better validation accuracy, hence we preferred using 128-dimensional space in our application.

#dimension	Validation accuracy
64	86.8% ± 1.7
128	87.9% ± 1.9
256	87.7% ± 1.9
512	85.6% ± 2.0

Sample Image:

Encoding:

4.3. Face recognition using euclidean distance

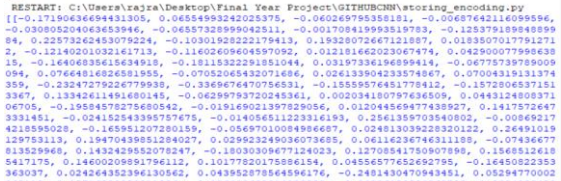
A facial recognition is a technology capable of identifying or verifying a person from a digital image or a video frame from a video source. There are multiple methods in which facial recognition systems work, but in general, they work by comparing selected facial features from given image with faces within a database. It is also described as a Biometric Artificial Intelligence based application that can uniquely identify a person by analyzing patterns based on the person's facial textures and shape. In mathematics, the Euclidean distance is the "ordinary" straight-line distance between two points in Euclidean space.

Steps for Finding Euclidean Distance Between Two Face Images:

STEP 1: Getting face encoding of image1 and image2

Image1:

Image2:



Encoding of Image1

Encoding of Image2

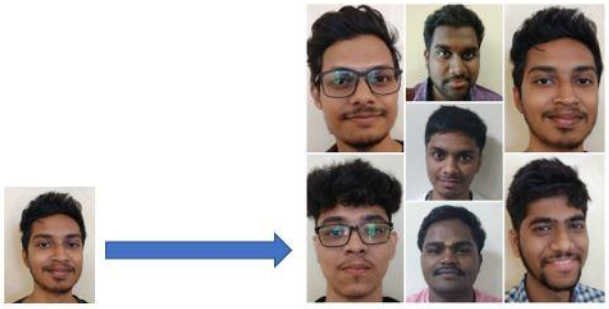
STEP 2: Finding Euclidean Distance between Image1 and Image2.

In Python Euclidean distance between two images is calculated by,

Euclidean distance = np. linalg.norm(np.array(e1) - np.array(e2))
Where,
e1 = Encoding of Image1
e2 = Encoding of Image2

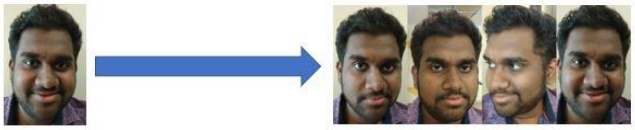
4.3.1. Histogram plot for finding threshold between same and different set of images

Obtaining Histogram Plot for Different Set of Images:
In this, Histogram can be plot by passing an image through different set of images



Obtaining Histogram Plot for Same Set of Images:

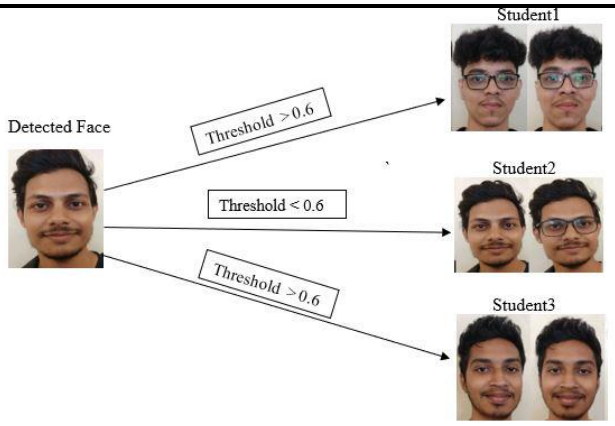
In this, Histogram can be plot by passing an image through same set of images



4.4. Recognition Of Face

For recognition of faces, first step is to find out threshold value for same set of images and also for different set of images. Threshold values is nothing but Euclidean distance between two images. Threshold value for a class is obtained by histogram plot. By using this threshold value one can recognize face. Threshold value for same set of images or faces comes out to be less than 0.6 and for different set of images or faces comes out to be greater than 0.6 which can be seen in histogram plot.Now this helps in recognizing faces in an image.

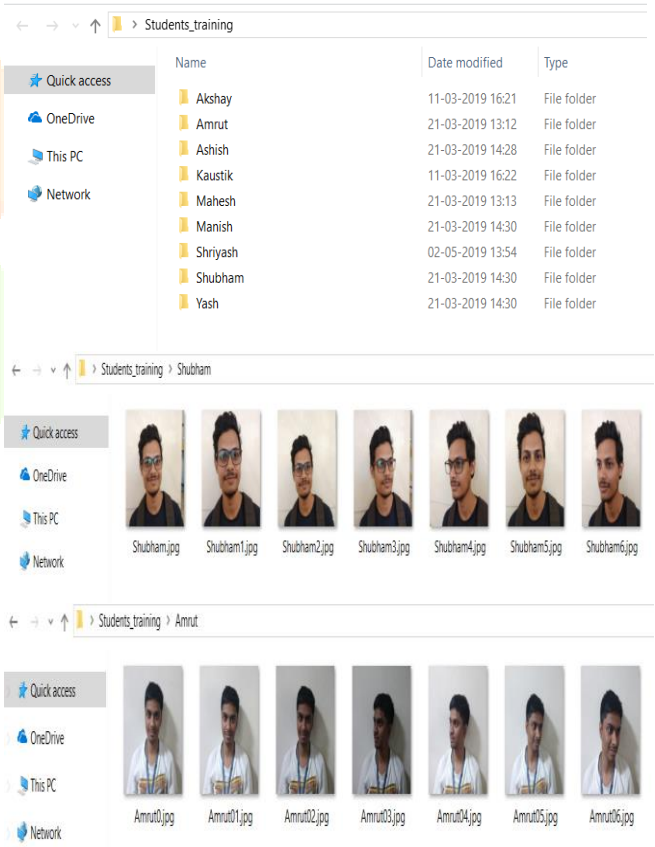
In our case we pass all the detected face or faces one by one over different classes. Here one class contains faces of one student likewise there are many classes, in our case total nine classes are present. The detected faces are passed over different classes, if the detected face belongs to that class the threshold value will be less than 0.6 and that face will be recognized and if the threshold value comes out greater than 0.6 then detected face does not belong to that class, and it check for next class.
If detected face does not belong to any class then that face is not present in database and hence it will show it as unknown face in the output.



Face Recognized:

5. FORMATION OF DATABASE

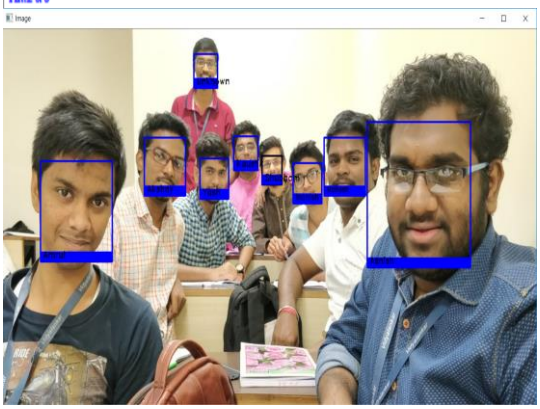
Students images were taken using camera and stored inside a folder name ‘ students_training’ . Classes for each student are made in which different images of those student are stored.



6. FINAL OUTPUT

Euclidean distance is calculated between face encoding of detected face and face encoding stored in database. If the Euclidean distance between that image is less than set threshold value 0.6, then system will print its corresponding name.

```
RESTART: C:\Users\rajra\Desktop\Final Year Project\GITHUBCNN\bounding_box.py
Ashish
Yash
kaustik
Mahesh
Shubham
Image not found
Manish
Akshay
Amrut
```



7. FUTURE SCOPE

Over the past few years, we have seen major developments to facial recognition technology. We now live in an age that our predecessors have only dreamed in fiction and film. Face recognition is one of the newer developments of biometric identifiers that doesn' t require as much time or intrude on the person its verifying. Other biometric identifiers, such as fingerprint scanners and voice recognition, requires many different pieces in order to function. Face recognition is a highly effective biometric technology that holds a lot of potential. Today, one of the fields that uses facial recognition the most is security. Facial recognition is a very effective tool that can help law enforcers recognize criminals and software companies are leveraging the technology to help users access their technology. This technology can be further developed to be used in other avenues such as ATMs, accessing confidential files, or other sensitive materials. This can make other security measures such as passwords and keys obsolete.

Another way that innovators are looking to implement facial recognition is within subways and other transportation outlets. They are looking to leverage this technology to use faces as credit cards to pay for your transportation fee. Instead of having to go to a booth to buy a ticket for a fare, the face recognition would take your face, run it through a system, and charge the account that you' ve previously created. This could potentially streamline the process and optimize the flow of traffic drastically. The future is here.

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