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Real-time Face Recognition System using Python and OpenCV

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Abstract— Face recognition is a technique that an electronic device like a computer can determine and recognize a human face by comparing the given sample of facial attributes of that person. This subject or topic, using unbiased facial data, computer-based face recognition as an analysis is a largely unexplained part of research study.
Here in this research paper we have tried to find and present a ideal way of face detection using Python and a computer device with active integrated web cam.
This report contains how using python we have tried to implement one of the most important part of computer science, Deep learning, which can be used for detecting or recognizing human faces. We have proposed a system that can help in recognizing a human face in real-time. This can be used for various purpose and various machine and smart devices

I. INTRODUCTION

The study of recognizing someone by their face, expressions, and other physical characteristics has exploded in prominence in recent years. Face recognition technology is the subject of several studies in various regions of the world, owing to its numerous applications in diverse fields. Face recognition technology is primarily utilized in security verification, including passport authentication, biometric authentication, image processing, driver license verification, video surveillance, and a variety of other applications. Although, reliable biometric identification method already exists, such as the fingerprint verification and the retina scanner, but still, face recognition is stillz a challenging problem to solve and there is currently no full proof solutions that can claim it can handle all the situations it may encounter. Because of the numerous settings of the human face, face recognition system is always tough to display an accurate solution. Due to some of these difficulties of the face recognition problem, there are many different techniques. Furthermore, the applications cover a wide range of scenarios.

There is no denying the fact, that there are numerous different methods for identifying and confirming people, the primary incentive for face recognition is that it is a passive,

nonintrusive approach for checking and identifying people. Password verification, PIN number verification, token systems, fingerprint as well as iris scanners, are some of the examples of other methods of identification. But since, face recognition technology gives an individual a sense of being more aware, comfortable and safe, this technique is much more desirable than the other methods.

There are many face recognition applications, which can be classified into two categories: those that require facial identification and those that require facial verification. The first group of application compares a face to one in a database, while the second group does the opposite. The verification technique attempts to verify a human face based on a sample of that face.

There are many limitations in the face recognition technology. Sometimes, we see that human faces has been changed a lot over a short period of time. Another major problem can be similar faces. We see that many different people in the world can have similar faces, therefore a discrimination technique among those faces are very much needed. Otherwise, we will not be able to identity each person's face accurately. Keeping the above problems in mind, we have introduced and developed a real-time image processing face recognition system. The major advantages of this model is reduced cost, improved accuracy and increased speed. In this research paper, we have highlighted the various algorithms and techniques that can be used to face recognition application based on PCA and LDA and verified on a real-time technology. Further analysis is also carried out to check the accuracy and performance of the algorithm used.

or as a non-text image. In the following sections, we have reviewed the old work, propose the new classification scheme and discuss the results that are obtained.

There are two types of phases in Face Recognition System. Those are:

Face Detection:

Face Detection, which is also known as Facial Detection is an AI (Artificial Intelligence) based Computer Science Technology which helps to find and identify human faces in images. Face Detection Technology is used in several field such as – biometrics, including security, entertainment, law enforcement and personal safety – for tracking people.

The application i.e., Face Detection use Machine Learning and Algorithm to detect face of a particular person within an image. The algorithm generally starts by finding human eyes which is the easiest features to detect. Then the algorithm attempts to detect the mouth, eyebrows, iris, nose and the nostrils. After detecting if the algorithm confirms that it found the face it applies another additional test to confirm.

Face Recognition:

Face Recognition is a process of recognizing human face through Computer Technology which uses Biometrics to indicate facial features from a video or photograph. After that it compares the received information with the database of a saved face or known face to find match.

At first a picture of our face is clicked from an image or video which might be alone or in a crowd, then a software reads the geometry of our face. The distance between chin to forehead or the distance between our eyes is included as key factors. Then this key factors are matched with the database and if it is matched then the face is recognized.

II. RELATED WORK:

In this article, we have tried to build a face recognition system using python. We have tried to go further one step to the face detection through face recognition system, it's a system that can identify human with proper authentication. As the real-world applications, it can be used for few cases like – finding missing person, security purpose, attendance system. There are a lot of projects and research works has been done to achieve a proper and efficient face recognition system. The aim is to select the appropriate approach of face recognition that we can achieve a system with increased accuracy and speed up the entire process.

Some known algorithms of face recognition are:

- Marian Stewart Bartlett, Javier R. Movellan and Terrence J. Sejnowski developed a face recognition system which was based upon ICA and PCA. The algorithm is used here is PCA(Principle Component Analysis), it is a popular unsupervised statistical method that can be used to find useful image representation, here image is contained in pair wise relationship between pixels and the fact about ICA is that information can be contained in the higher order statistics. Where many other proposed a better version of the face recognition system using ICA (Maryam Mollaee, Mohammad Hossein Moattar had presented a face recognition system for better accuracy).
- Matthew Turk and Alex Pentland had proposed a face recognition system using Eigenfaces approach. Basically, this approach for recognition was developed by Sirovich and Kirby which was used by Turk and Pentland for face classification. They had developed a near-real-time computer system that by locating and tracking a subject's head, recognize a person by comparing the characteristics of the face to those of known individuals.
- A face recognition system using LDA algorithm was approached by K. N. Plataniotis, Juwei Lu and A. N. Venetsanopoulos. Ronald A. Fisher first formulated the LDA, this algorithm can be also used to reduce the dimensionality. LDA and PCA both approaches are linear transformation technique but being an unsupervised algorithm PCA, since it ignores class label sand and its aim is to find directions that maximize variance. LDA is supervised, it computes the direction that represents axis that maximizes the separation between many classes.
- Dhanaseely, Himavati, Srinivasan had used PCA approach to achieve a face recognition system with reduction of dimensionality and used neural network for classification based on upright frontal face detection. Neural network carries signals from one place to another which is biologically inspired, it behaves like neurons of human beings, but it requires lot of computational work.
- Maliha Khan; Sudeshna Chakraborty; Rani Astya; Shaveta Khepra had proposed a Face Recognition System using OpenCV. They even used PCA to reduce large amount of stored data to the size that is required to economically represent the data.

III. LIBRARIES USED

1. NUMPY:

Numpy is a package for computing in Python. It is a library of Python which provides multidimensional array objects, derived objects of various kind (such as matrices and masked arrays.) . Other mathematical calculations an also be performed. In our system, we used Numpy to convert our images into some form of an array so that we can store the model that has been trained.

2. OpenCV:

OpenCV is an image and video processing library that is used for video and image analysis, like face detection, photo editing, license plate reading, advanced robotic vision, and much more.

Dlib library contains implementation of 'deep metric learning' which is used for constructing our face embeddings which are used for the actual face recognition process.

The face_recognition library, which is super easy to work with and we will be using this in our code. First and foremost, we have to install dlib library before we install face_recognition library.

3. Haar Cascade Frontal Face:

Haar cascade Frontal Face Specifier is an Object Detection Algorithm which is used to detect or recognize faces in an picture or a video of real time. Haar Cascade algorithm generally uses edge/line detection features which was proposed by Viola and Jones in their research paper "Rapid Object Detection using a Boosted Cascade of Simple Features" which was published in the year 2001. This algorithm is given a lot of positive images which consists faces, and a lot of negative images which does not contains any face to train them. The model which was created from this training is available at the OpenCV GitHub repository.

4. Local Binary Pattern Histogram:

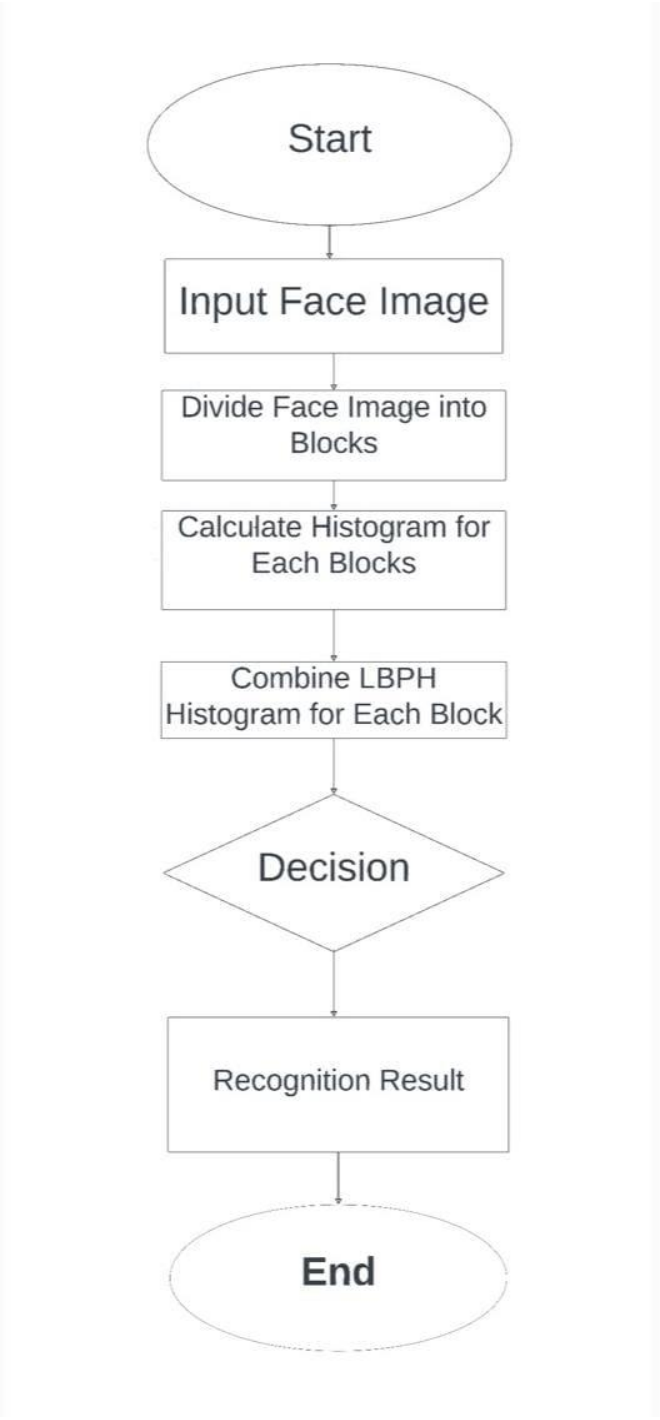
LBPH (Local Binary Pattern Histogram) is a type of Face-Recognition algorithm which is used to recognize or detect the face of a person. It is well known for its performance and how it able to recognize or detect the faces of a person from both sides i.e., front face and side face.

III. METHODOLOGY

In our project, we made a system which will recognize a person's face with accuracy. Our system generally captures images through webcam and save it. And the output of our system is that it will recognize a person's face with accuracy. The steps of our methods are as follows:

- At first, when a person came in front of the webcam the webcam starts taking pictures of that person and saves that images. Our device can take n number of images depending of user's choice.
- Our system consists of three steps:
  1. Capturing images.
  2. Trained all captured images.
  3. Recognition of face.
- Our system takes 100 pictures at a time at the time of capturing images. When the system finishes taking 100 images of a person it automatically stops capturing, otherwise if the user wants to take images less than 100 then he/she can stop capturing images by pressing 'q'.
- While taking the pictures the users have to give an ID along with the name of the person whose face is be to detected. After assigning an ID the details are saved in a csv excel file with an unique id which will be used for recognizing faces.
- One database csv file has also been created to save the name of the persons whose images are captured by our system.
- We use Local Binary Pattern Histogram method to convert the bits which are generated by Haar Cascade Frontalface Specifier to computer understandable binary digits which makes the task machine understandable to successfully continue with the recognition process.
- After successfully capturing images of a person and convert it to machine readable code our system trained that images for recognition.
- After completion of the training process the system then recognize the persons wit the help of the database with accuracy.

V. FLOW CHART OF THE PROPOSED ALGORITHM



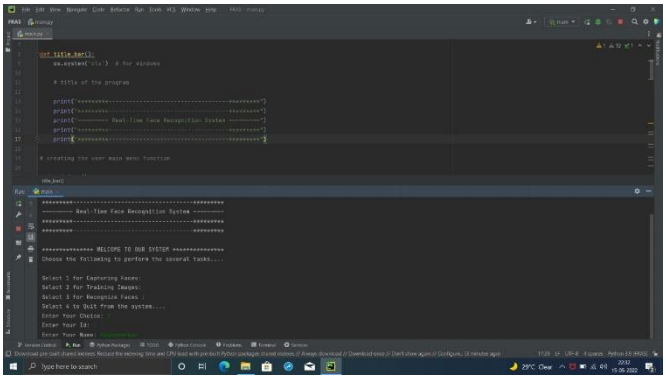


Fig: 1.1

In Figure 1.1 it was shown that one id and name of a person is taken as input. This particular process is done in face image capturing process. Here, one id and name of that person is taken as input and after that webcam automatically starts capturing pictures of face as shown in fig 1.2 below.

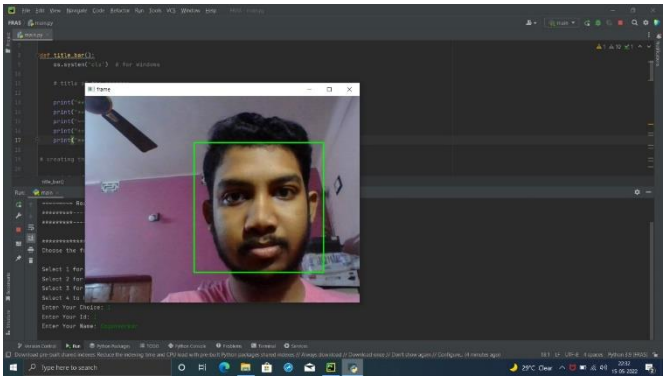


Fig: 1.2. Capturing images after giving id and name of that particular person

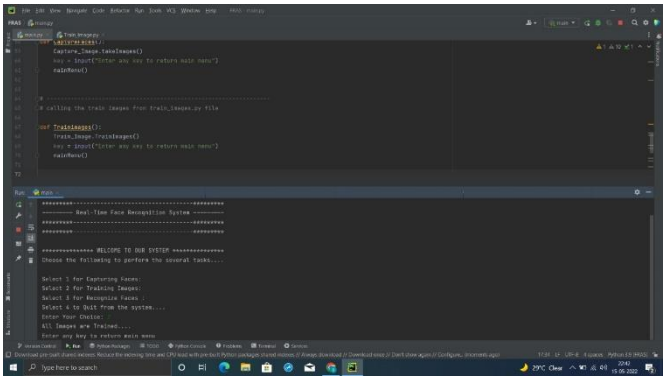


Fig: 1.3. Training of the captured images

Figure 1.3 shows us that after successfully capturing images of a particular person our system trained that captured images for future recognition purpose. After the competition of the training of captured images the name and the given id gets stored in a separate file as shown in figure 1.4 which is used in recognition process.

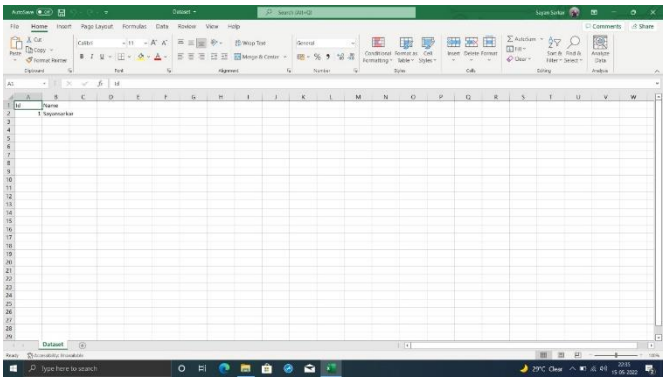


Fig: 1.4. Name and ID of that particular person is stored in a separate file for recognition process.

VI. RESULTS AND DISCUSSION

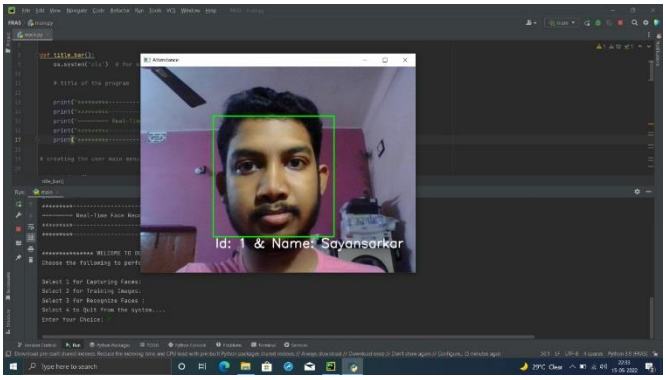


Fig: 1.5. Recognition of Known face

After capturing images and training of those images two types of output generates. One for known person and the other for Unknown person. During Recognition if the person's face completely matches with the database with 100 percent accuracy then the stored id and the name of that person will visible on the screen.

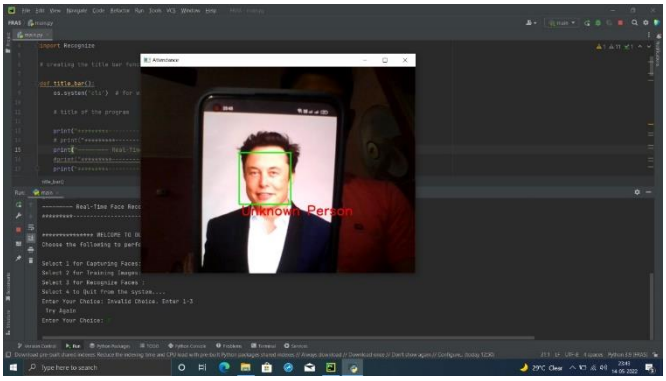


Fig: 1.6. Shows Recognition of a Unknown face

If the face doesn't match with the database then our system will declare that person as unknown person. This high accuracy of our proposed system makes it more secure.

In this study, we have implemented a Real Time Face Recognition System using OpenCV and Python. It can be used as a security system also because of its high accuracy. It recognizes a person if and only if the face of that particular person matches with the database with 100 percent accuracy. This is Real-Time System which captures person's images live using webcam. In this project there is still some work remained to do. Our future work is to implement Iris Recognition in this system which will make this system more appropriate for security of some confidential data or recognition purpose too.

VII. REFERENCE

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