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Criminal Face Identification

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Abstract - *Face Recognition/Identification has been a fast thriving, challenging and interesting domain in real time applications. A large number of face recognition algorithms have been developed in the recent decades. It has diverse application areas like surveillance, security, entertainment etc. The software on face identification is useful in airports, banks, offices, educational institutions for screening the people who are entering and exiting these places. Most of the Countries like Germany, Australia, etc use this technology [1]. Authorities have placed booths for face identification at borders and customs for automating the control system for passport verification and this becomes an important achievement in the context of ongoing covid-19 pandemic. Human face is a dynamic object that has a large degree of variability in its appearance as facial features of every individual are different, and this makes face recognition a challenging and ready to improve problem in the computer vision field. As in the face recognition/identification field, accuracy and speed both play an important role as well as it is the main issue. The goal of this paper is to evaluate different techniques of face recognition and provide a better solution for image and video-based face detection with greater accuracy, better response time and a step forward in betterment of society and protection of the society.*

Key Words: Face, Recognition, algorithms, identification, image, software.

1.INTRODUCTION

Over the years, a lot of security measures have been developed that help in holding confidential data secured and restricting the chances of a security breach. Face recognition, which is one of the few biometric methods that acquire the merits of both high accuracy and low intrusiveness, it is a computer program that engages a person's face to automatically identify and verify the person from a digital image or a video frame from a video source [2, 3 4]. It equates the selected facial features from the image and a face database, or it can also be a hardware which is designed to authenticate a person. This technology is a commonly used biometrics system for authorization, authentication, verification and identification. A lot of companies have been adopting face recognition in their security cameras, access controls and many more. Facebook has been using face recognition in their website for creating a digital profile for the people using their website. In developed countries, the law enforcement creates a face database to be used with their face recognition system to compare any suspect with the database. On other hand, in Malaysia, thumbprint identification is used to identify any suspect for the case. However, because of infinite knowledge through internet usage, most criminals are informed of thumbprint identification. Therefore, they become charier of leaving a thumbprint by wearing gloves except for unpremeditated crimes.[5] A criminal record or any record consists of available distinct knowledge about an individual, it also consists of a photograph of the same. For identification of any criminal, we need to have knowledge regarding the person, which are given by witnesses. Identification can be done by using various modes like fingerprint scanning, DNA tests, etc [1]. Our paper focuses on the Face Identification method to extract information from the image of the individual and use it as a means of identification rather than any other identification method. A face identification system will access the available database which consist of photographs and then compare those to the ones which it has captured or in real-time to find a match only if the match exists. For every image, this can be done by measuring the width, height of the face, also the value of the eye colour by using various ratios, different formulas that can be used for identification of the face as well as it will help in finding the approx. age, gender, etc. also. The software will work in two phases. First is called face detection and the other is Comparison. Face detection is the ability of a machine (computer) to independently identify and extract the features of a face in an image or video. The other phase of the process consists of creating a print like fingerprint, but it is of the image and then compares that imager print with available database accurately [2]. This System is used for pinpointing the criminals in spite of its location until he/she is captured by any cameras and aid government authority for further investigations. Also, we are storing these images of the criminals as a keep safe in our database along with the personal details and we are also hell bent to keep this database at other different locations so if one gets corrupted or hacked, we can use the others which are stored at locations know to only some individuals around the world. This project intends to identify the criminal based on the existing record of the same and creating a new record if no previous record existed.

2. LITERATURE REVIEW

The main purpose of research on computer vision is to develop an automated face identification system which canequally and will surpass human performance in future. This problem has been studied for the past two decades.

The approaches that had been used so far can divided into two categories that is:

1) Model Based 2) Appearance Based

The model based one attempts to find and mark the geometrical parameters by measuring the facial parts and the appearance based on the intensity- based parameters such as eigen coefficient for recording the face. Because of the changes in lighting, expression, etc. conditions the face of the human can be altered considerably [6].

The Face identification system is not a new field, as an early prototype which uses feature-based approach was developed over a 100 years ago by Alphonse Bertillon, as he developed a system of measurement of the physical aspects of the criminals using which they can identify them. He takes photographs of separate aspects of the face like nose, eyes, chin, forehead, different profiles etc. of the criminal and stores them in his "database." But this database was examined by humans not by computers, but still, it uses the same biometric approach that the modern recognizing system uses.

These approaches are being used in object detection systems which also use computer vision for detection of any object and based on its feature specifying it as a plant, ball, table, etc.

Point to be noted is that face recognition is different than face detection:

● **Face Detection**: the main purpose in this is to find the face i.e. Its location and size in a photograph and extract the same to be used in the recognition algorithm.

● **Face Recognition**: with the already extracted information which is also cropped, resized, and mostly converted to grayscale, this algorithm is accountable for finding the traits which can appropriately describe the image.

The face recognition application can be operated in two modes:

● **Verification or corroboration of the facial image:** This estimates the input image with the facial image associated with the user who is requiring the corroboration. This is stated as 1x1 comparison [6].

● **Identification or Recognition of face**: it compares the input image with the preloaded images in the database and aims to find the matching user. It is a 1xN comparison.

2.1 ALGORITHM

There are many different types of face algorithm that exists,like [4]:

● Eigenface (1991)

● Fisherface (1997)

● Scale Invariant Feature Transform (SIFT) (1999)

● Speed Up Robust Feature Transform (SURF)

● Local Binary Pattern Histograms (LBPH)

● Etc,

Each of the above-mentioned algorithms uses different approaches to extract the information from the image and for performing the matching with the input image. However, methods used by Eigenface and Fisherfaces are mostly the same and the same is also true for SIFT and Surf methods [7].

● **Eigenface and Fisherfaces**: Eigenface uses PCA (Principal Component Analysis) that is a dimensionality-reduction method which reduces the dimensions of the large dataset of images, by converting large set of variables into smaller ones

but it still contains most of the info of the large dataset[8], whereas Fisherfaces uses FLD (Fisher Linear Discriminant) whose working is mostly same as Eigenface, but it works better for the classification of different aspects of the image or object[8].

● **SIFT and SURF**: These methods extract the local feature points of the eyes and then classify the invariant key points in the image of the eyes and then indicate these points, create a local pattern around these points, and use them for identification. In this the KNN-Algo (K-nearest neighbor algorithm) is used for the classification purpose [9]. But for our system we are using the LBPH algorithm as we have found it to be much more efficient and has a large scope of improvement which can be done as it is easy too.

● **LBPH (Local Binary Pattern Histogram):** The LBP (local binary Pattern) is a simple but also very efficient texture operator as it labels the pixels of the photograph by thresholding the neighbor places of each pixel and regards the output result as a binary number [10]. This algorithm was first stated in 1994 and till now it is recognized as the best and most powerful feature for texture classification. And further it is found that when this algorithm in combination with HOG (Histogram of Oriented Gradients) descriptor is used, its performance to detect the similarities improves for some datasets. But using the combination of LBP and histogram we can represent the image of the face by a simple data vector.

2.2 METHODOLOGY

Steps are as followed:

1. Parameters: this algorithm uses four parameters:

a. **Radius**: radius is used to construct the local binary pattern in circular form and to represent radius around the central pixel. It is set to 1.

b. **Neighbor**: it is the cluster of points that constructs the circular binary pattern. Point to note- the more sample points we include the more the computational cost increases.

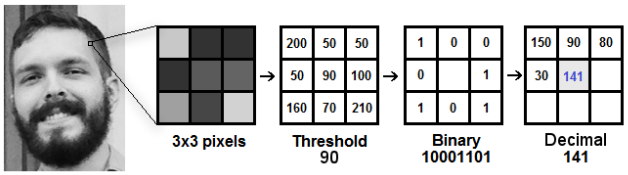
c. **Grid X**: the number of cells in the horizontal direction. More cells mean more finer the grid, and higher the dimensionality of the output feature vector.

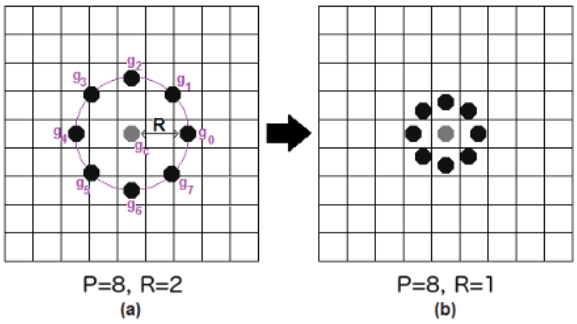
d. **Grid Y**: the number of cells in vertical direction.

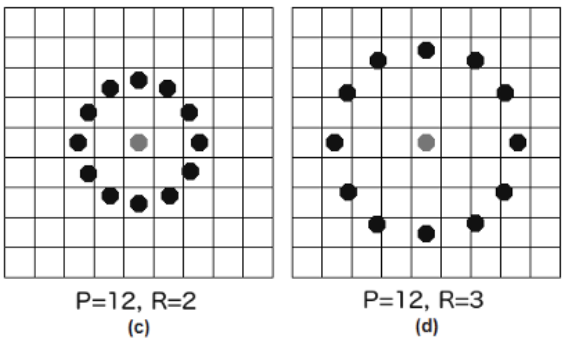
2. Training: Firstly, we need to train the algorithm. And to do so, we need some training dataset that comprises the facial image of the person we want to recognize, and, in our case, we need the image of the criminal. And we also need to set an ID or some type of number for each image.

3. Applying the LBP: The first step in computation of the algo is to construct a swift image which describes the native image in a well manner, by playing up the facial features, and for doing all this the LBHP uses the concept of a sliding window, which mostly depends on the radius and neighbour parameter.

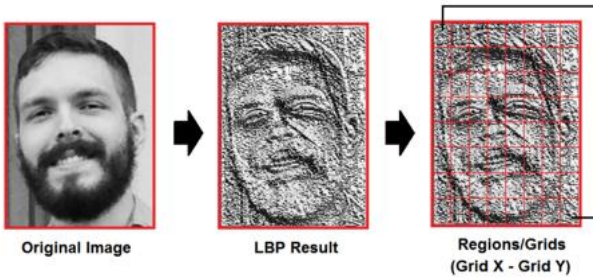
For example-

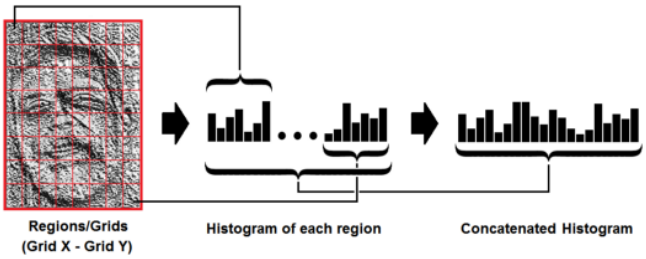






4. Histograms extraction: By using the image which was generated in the previous step, we use the parameters of Grid X and Y for dividing the image into multiple grids like the below given image:





5. At last, performing the recognition of face: Since the algorithm has already been trained in the previous steps. Every distinguished histogram that is created is used in the representation of each image from the training dataset. Similarly for every new image we perform the same steps.

- For finding the data of the criminal we just need to compare the input image with the histogram of every image and the which is closest is given as output.

- There are various approaches to calculate the distance between the histograms, like- Euclidean distance, cosine similarities, Manhattan distance, absolute value, chi-square, etc.

Euclidean distance:

$$d(x,\ y)\ = \sqrt{\sum_{i=1}^{n}(y_i - x_i)^2}$$

Cosine similarity:

$$\text{cosine}(\mathbf{v},\mathbf{w}) = \frac{\mathbf{v}\cdot\mathbf{w}}{|\mathbf{v}||\mathbf{w}|} = \frac{\sum_{i=1}^{N} v_i w_i}{\sqrt{\sum_{i=1}^{N} v_i^2}\sqrt{\sum_{i=1}^{N} w_i^2}}$$

Manhattan distance:

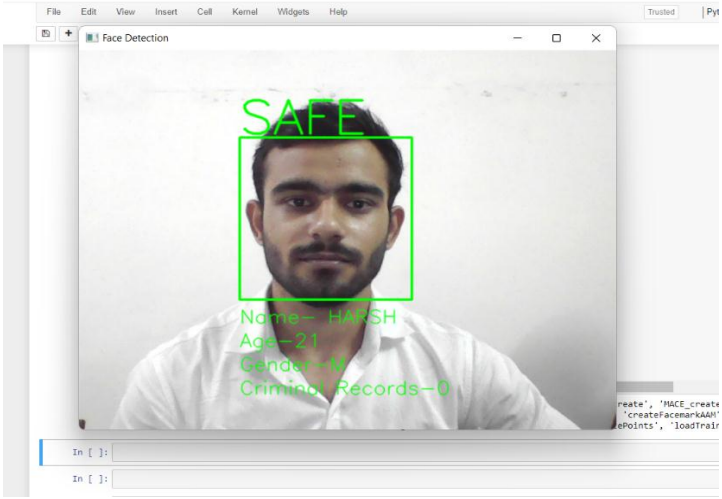
$$Distance\ = \sum_{i=1}^{n}|p_i - q_i|$$

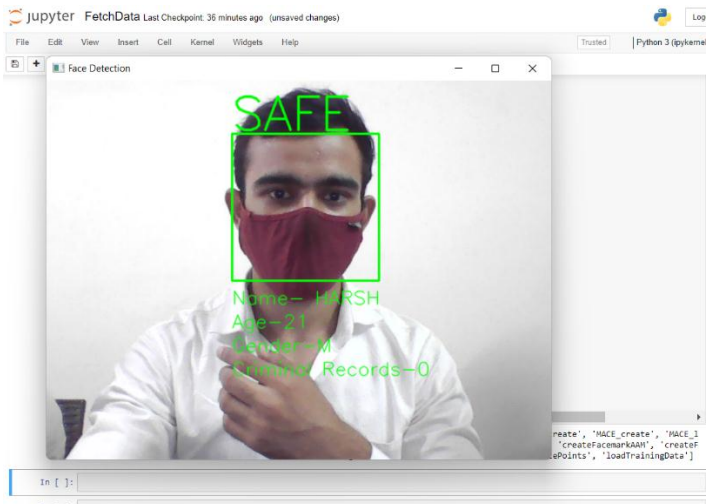
Chi-square:

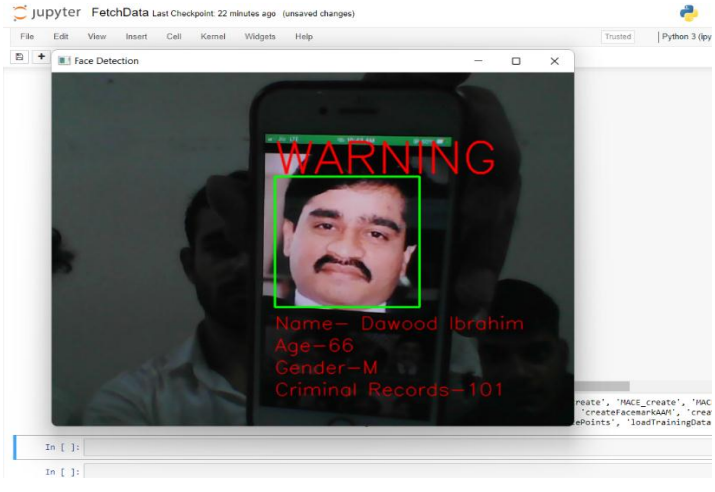
$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

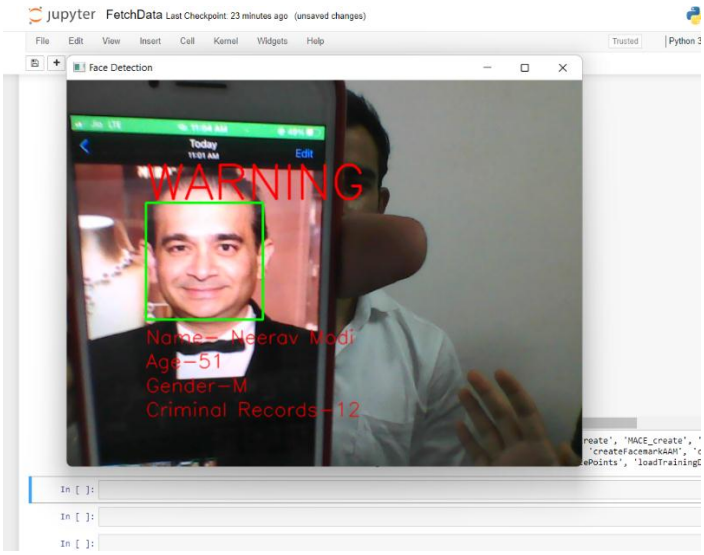
3. CONCLUSIONS

As a result, we have developed a system that is capable of identifying, detecting, verifying the face of a criminal and showing its information after retrieving it from the database. Below are some screenshots which were taken while testing and training the system.









In the above we are just trying to show the points or the parameters that the system is taking as a reference for making the histograms of the input image.

No matter how well trained there's always a scope of error in Face recognition programs. Recklessly relying on this model may turn out to be catastrophic for the Authorities. As the photographs are uploaded via the internet it makes the application severely crippled if there's no access to the internet. Deploying and integrating this system to its fullest potential requires massive funding and research. Despite getting or having such drawbacks. The more this system gets used, the more its database increases and the more useful it becomes along the line. Right now, face recognition programs are obviously far below what a human can do, but it's also obvious that machine learning is improving every day and is already much better in some tasks than what a human can do. Therefore, it's a plausible conclusion that facial recognition programs may someday surpass us.

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