NEURAL NETWORK ALGORITHMS FOR FACE RECOGNITION

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***Abstract*: Computer vision and its applications have become important in today's life. Therefore, research in the field of face and object recognition is increasingly important for both researchers and practitioners. Smart devices such as smartphones now have high processing power, storage capacity and high-resolution cameras. In addition, connection bandwidth and interaction speed have a significant impact on the popularity of mobile object detection applications. These developments, along with advances in computer vision algorithms, brought object recognition from the desktop environment to the mobile world. The purpose of this research paper is to demonstrate the effectiveness and accuracy of existing open-source facial recognition algorithms in real-world environments. It uses the following popular open-source efficiency evaluation algorithms: Local Binary Pattern (LBP), Gabor Filter, PCA Eigenfaces. The results of this study will help practitioners make algorithm selection decisions and help researchers decide how to further improve the accuracy of current algorithms.**

1. INTRODUCTION

Face recognition is the problem of identifying and verifying people in a photo based on their face and is quite important in our daily life today. It is an important task for applications such as security systems , attendance applications etc. A normal human being can distinguish an individual face from others depending on a number of things/factors, while until recently it remained a challenging problem in computer vision for decades. Creating such a system is quite difficult because faces are: complex, multidimensional visual stimuli. In recent years, many researchers have tried face recognition systems developed inter-feature spaces and neural network techniques. The article discusses algorithms that can be used for facial recognition.

In this paper, we will discuss about the list of algorithms that can be used for face recognition, its merits and demerits and finally a conclusion that suggests the best algorithm that can be used for face recognition out of the discussed algorithms.

2.FACE RECOGNITION ALGORITHMS

This paper discusses about the following possible algorithms for facial recognition

- Local Binary Pattern(LBP)
- Gabor Filter
- PCA Eigenfaces

2.1 *LOCAL BINARY PATTERN (LBP)*

Local Binary Pattern (LBP) is a very efficient and simple texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the binary number as a result. Due to its computational simplicity and high discriminative power, LBP texture operator has become a significant approach in various applications. Using the LBP combined with histograms we can represent the face images with a simple data vector.[1]

2.1.1 WORKING OF LPBH

LBPH algorithm typically makes use of 4 parameters:

- ***Radius:*** It is distance of a circular local binary pattern from the perimeter to the centre of pixel, and usually takes a value of 1.
- ***Neighbors:*** Number of data points in a circular local binary pattern. Usually a value of 8 is taken
- ***Grid X:*** The number of cells in the horizontal plane is usually 8.
- ***Grid Y:*** The number of cells in the vertical plane is usually a value of 8. [1]

Given the above parameters, LBPH works as follows;
A dataset is created by taking pictures that are stored or through the camera, then providing a unique identifier on the picture and adding the pictures to the database and It is appreciated to collect many samples from one single individual. A certain part of the

dataset is used for training the algorithm and the rest is used for testing. Then, using the concept of a circular neighborhood (which occupies non-integer pixel points around a selected region), the number of occurrences of LBP codes in the image is combined into a histogram. The classification is then performed by calculating the basic similarities of the compared histograms. This histogram contains a description of an individual at three different levels: at the pixel level, the labels are combined in a small area to form a regional level, the regional histograms are combined to form a general description of the person.

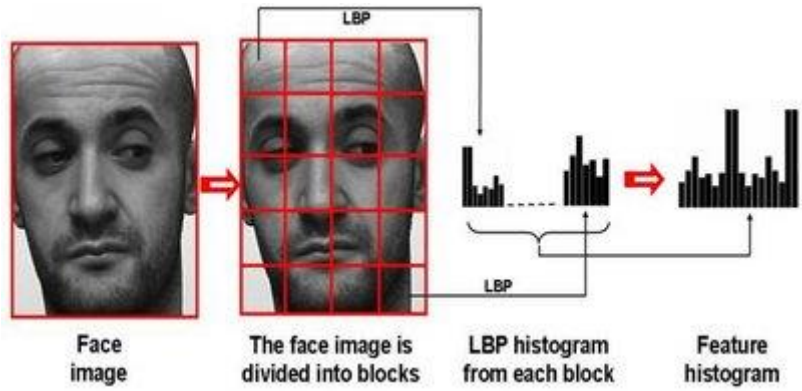

Fig 1: Face description with local binary patterns.

2.2 *GABOR FILTER*

A Gabor filter is a linear filter used for texture analysis, which basically means that it analyzes whether there is any specific frequency content in an image in certain directions in a localized area around a point or area of analysis.
A set of Gabor filters with different frequencies and orientations can be useful for extracting useful features from an image. In the discrete domain, two-dimensional Gabor filters are given by

$$G_c[i,j] = Be^{-\frac{(i^2+j^2)}{2\sigma^2}} \cos(2\pi f(i\cos\theta + j\sin\theta))$$
$$G_s[i,j] = Ce^{-\frac{(i^2+j^2)}{2\sigma^2}} \sin(2\pi f(i\cos\theta + j\sin\theta))$$

where *B* and *C* are normalizing factors to be determined.

2-D Gabor filters have rich applications in image processing, especially in feature extraction for segmentation and texture analysis.

2.2.1 WORKING OF GABOR FILTER IN FACE RECOGNITION

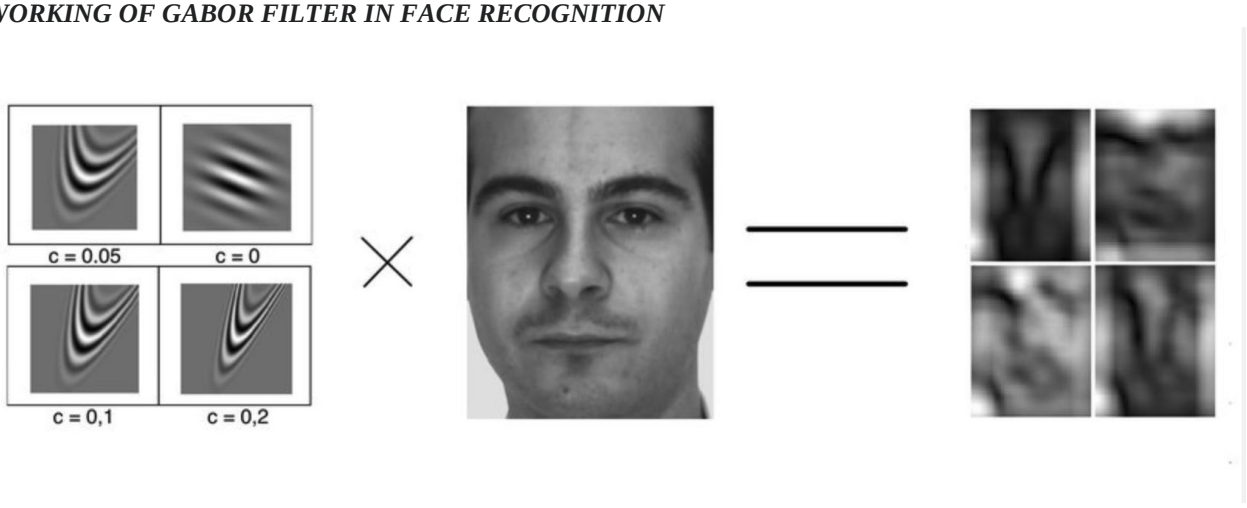

Fig 2: Working of Gabor Filter

A Gabor filter is used to capture facial features aligned at certain angles. Together with them, a feature selection algorithm based on Binary Particle Swarm Optimization is used to search the feature space for an optimal subset of features. Using the Gabor filter, the original face images will be converted to grayscale and further some contrast and lighting adjustment operations are performed on it . All face images will be processed with the same contrast and lighting . We try to obtain some feature vectors that provide an optimal characterization of the visual content of face images. For this reason, we chose two-dimensional Gabor filtering, a widely used image processing tool, for feature extraction.

Various metrics can be applied to these feature vectors. Since the size of each vector depends on the size of the corresponding face image, a resizing procedure must be performed on the compared face pictures, first.

Then some known metrics like Euclidean distance could be used. Using the squared Euclidean metric, we calculate the distance between this facial feature vectors. The next phase of the face identification process consists of feature vector classification. We propose a supervised classification technique for these 3D feature vectors based on a Gabor filter. In this case, popular supervised classifiers can be used, including the minimum distance classifier and the K-Nearest Neighbor (K-NN) classifier and a extended version of the minimum distance classifier called the minimum average distance classifier is developed. [8] Here the filters are connected orthogonally and constructed as a combination of multiple original filters in such a way that they are able to accept the same recognition rates.

2.3 *PCA EIGENFACES ALGORITHM*

PCA (Principal Component Analysis) is a statistical approach used for reducing the number of variables in face recognition. In PCA, every image in the training set is represented as a linear combination of weighted eigenvectors called eigenfaces. These eigenvectors are obtained from the covariance matrix of a training image set.

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2.3.1 WORKING OF PCA EIGENFACES ALGORITHM

In PCA, each image in the training set is represented as a linear combination of weighted eigenvectors called eigenfaces. These eigenvectors are obtained from the covariance matrix of the training image set. The weights are found after selecting the set of most relevant eigenfaces. Recognition is performed by projecting a test image onto a subspace spanned by own faces, and then classification is performed by measuring the minimum Euclidean distance. The working of PCA Eigenface algorithm is represented in fig 3 [5].

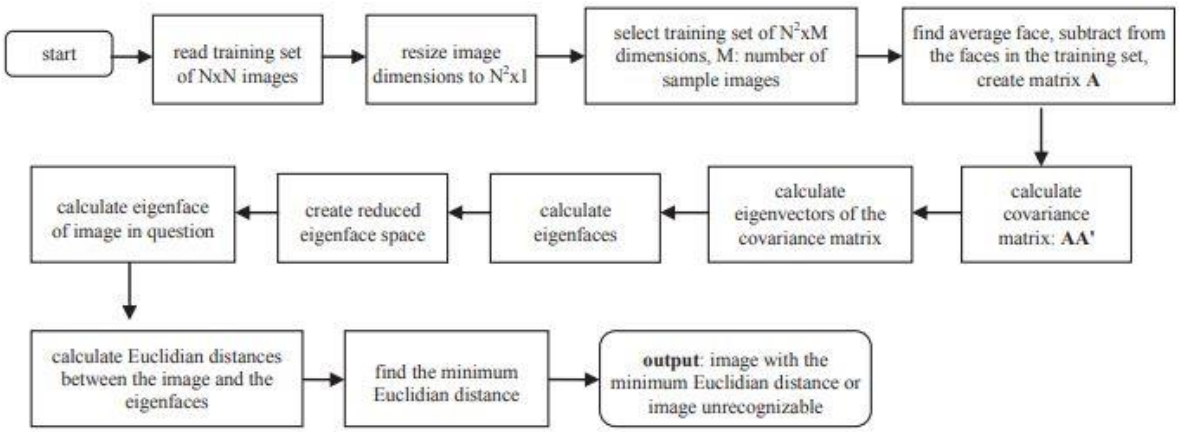

Fig 3: Working of PCA Eigenfaces Algorithm

3.MERITS AND DEMERITS

3.1 *Local Binary Pattern:*

Merits:

- Discriminative power is high
- Simplicity of computation
- Invariance to grayscale changes and good performance

Demerits:

- Not invariant to rotations

- The size of the features increases exponentially with the number of neighbors which leads to an increase of computational complexity in terms of time and space
- The structural information captured by it is meager..
- Only pixel difference is used, magnitude information ignored

3.2 *Gabor Filter*

Merits:

- A different "threshold" is chosen for each pixel.
- These pixel "thresholds" adjust over time.
- Objects are allowed to become part of the background without destroying the existing background model.
- Provides quick recovery.

Demerits:

- Gaussian initialization is important (median filtering).
- There are relatively many parameters and they should be chosen intelligently [8].
- The information contained in the Gabor Face Representation is redundant and affects the size of the image [8]
- Cannot deal with sudden, drastic changes in lighting.

3.3 *PCA Eigenfaces algorithm*

Merits:

- Recognition is easy and effective compared to other approaches
- No knowledge of the image required except id
- Data Compression is achieved by low dimensional subspace representation
- Easy to implement and computationally less expensive..

Demerits :

- Proper centered face is required for training/testing.
- Quite sensitive to scaling
- For proper working of algorithm front view is required
- The algorithm is sensitive to lightning, shadows and also the scale of face in the image .

CONCLUSION

In this paper, we compared three different algorithms using networks for face recognition along with merits and demerits. In the case of PCA , the Eigenfaces is used which is the simplest and it is holistic approach and whole face images are taken as a feature vector.While, the LBP method is a hybrid approach which makes use sum of local texture descriptors over the entire facial image as the feature vector, whereas for Gabor filter, it takes too high time for performing features due to its dimension of feature vector is very long.Based on these observations , the Local Binary Pattern (LBP) algorithm is more efficient than Principal Component Analysis (PCA) and Gabor Filter for face recognition of the scenarios to be implemented in real-time video

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