A Study on Various Techniques for Face Recognition

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Abstract: ***Face recognition is a process of one to many matching. In these particular phenomena, the user matches one person identity with several database images. Various approaches have been used for the purpose of face recognition. These approaches use different features for face recognition purpose. The feature considered for face recognition are shape, distance between two traits of face, texture features for face. Texture features are particularly susceptible to the resolution of images, when the resolution changes the calculated textures are not accurate. Texture features computed for low resolution face images does not provide better feature information. So, there is a big issue in face recognition for low resolution images. EULBP (Equalized Uniform Local binary Pattern) has been implemented for the problem of low resolution but it does not provide better results up to an extent. In this paper, research is done to improve the accuracy for the low resolution images. By analysing various approaches for face recognition there is need to develop a new approach which can provide better results using texture features for blurred images.***

Keywords: Biometric, Face Recognition, LBP, EULBP, PCA, 2DPCA, MDS

1. Introduction

Biometrics refers to metrics related to human characteristics Biometrics authentication (or realistic authentication) is used in computer science as a form of identification and access control. It is also used to identify individuals in groups that are under surveillance.

Biometric identifiers are the distinctive, measurable characteristics used to label and describe individuals. Biometric identifiers are often categorized as physiological versus behavioral characteristics. Physiological characteristics are related to the shape of the body. Examples include, but are not limited to fingerprint, palm veins, face recognition, DNA, palm print, hand geometry, iris recognition, retina and odor /scent. Behavioral characteristics are related to the pattern of behavior of a person, including but not limited to typing rhythm, gait, and voice. Some researchers have coined the term behavior metrics to describe the latter class of biometrics.

A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database. Depending on the application context, a biometric system may operate either in verification mode or identification mode. In the verification mode, the system validates a person's identity by comparing the captured biometric data with her own biometric template(s) stored in the system database. In such a system, an individual who desires to be recognized claims an identity, usually via a personal identification number (PIN), a user name, or a Smart card and the system conduct a one-to-one comparison to determine whether the claim is true or not.

Identity verification is typically used for positive recognition, where the aim is to prevent multiple people from using the same identity.

In the identification mode, the system recognizes an individual by searching the templates of all the users in the database for a match. Therefore, the system conducts a one-to-many comparison to establish an individual's identity without the subject having to claim an identity. Identification is a critical component in negative recognition applications where the system establishes whether the person is who she (implicitly or explicitly) denies to be. The purpose of negative recognition is to prevent a single person from using multiple identities.

2. Approaches Used in Face Recognition

Local Binary Patterns (LBP): Within LBP-based algorithms, most of the face recognition algorithms using LBP follow the approach.

$$LBP_{p,r} = \sum_{n=0}^{p-1} s(x_{r,n} - x_{0,0})2^n, \quad s(x) = \begin{cases} 1, x \geq 0 \\ 0, x < 0 \end{cases}$$

Two extensions of the original operator were made. The first defined LBPs for neighborhoods of different sizes, thus making it possible to handle textures at different scales. Using circular neighborhoods and bilinear interpolating the pixel values allow any radius and number of pixels in the neighborhood. In this extension, P sampling points on a circle of radius of R, are shown to form a (P, R). The second defined the so-called uniform patterns: an LBP is uniform if it contains at most one 0-1 and one 1-0 transition when viewed as a circular bit string. For example, 00000000, 00011110 and 10000011 are uniform patterns. Uniformity is important because it characterizes the Pieces that include primitive structural information such as edges and corners

PCA Principal Component analysis (PCA) was invented in 1901 by Karl Pearson. PCA is a variable reduction procedure and useful when obtained data have some redundancy. This will result into reduction of variables into smaller number of variables which are called Principal Components which will account for the most of the variance in the observed variable. Problems arise when we wish to perform recognition in a high-dimensional space. Goal of PCA is to reduce the dimensionality of the data by retaining as much as variation possible in our original data set. On the other hand dimensionality reduction implies information loss. The best low-dimensional space can be determined by best principal components.

Below is the general form for the formula to compute scores on the first component extracted (created) in a principal component analysis

$$C_1 = b_{11}(X_1) + b_{12}(X_2) + \ldots b_{1p}(X_p)$$

Where C1 = the subject's score on principal component
b1p = the regression coefficient (or weight) for observed variable p, as used in creating principal component
Xp = the subject's score on observed variable p.

2DPCA: a new PCA approach called 2DPCA is developed for image feature extraction. As opposed to conventional PCA, 2DPCA is based on 2D matrices rather than 1D vector.

Let X denotes an n-dimensional unitary column vector. Our idea is to project image A, an m*n random matrix, onto X by the following linear transformation

$$Y = AX:$$

Thus, we obtain an m-dimensional projected vector Y, which is called the projected feature vector of image A. How do we determine a good projection vector X? In fact, the total scatter of the projected samples can be introduced to measure the discriminatory power of the projection vector X. The total scatter of the projected samples can be characterized by the trace of the covariance matrix of the projected feature vectors. From this point of view, we adopt the following criterion:

$$J(X) = tr(Sx)$$

Where Sx denotes the covariance matrix of the projected feature vectors of the training samples and tr(Sx) denotes the trace of Sx. The physical significance of maximizing the criterion is to find a projection direction X, onto which all samples are projected, so that the total scatter of the resulting projected samples is maximized. The covariance matrix Sx can be denoted by

$$\mathbf{S}_x = E(\mathbf{Y} - E\mathbf{Y})(\mathbf{Y} - E\mathbf{Y})^T = E[\mathbf{AX} - E(\mathbf{AX})][\mathbf{AX} - E(\mathbf{AX})]^T$$
$$= E[(\mathbf{A} - E\mathbf{A})\mathbf{X}][(\mathbf{A} - E\mathbf{A})\mathbf{X}]^T.$$

Multidimensional scaling (MDS): Multidimensional scaling (MDS) is a means of visualizing the level of similarity of individual cases of a dataset. It is concerned with set of coordination methods which are performed in information visualization process that is used to display the information contained in distance matrix.

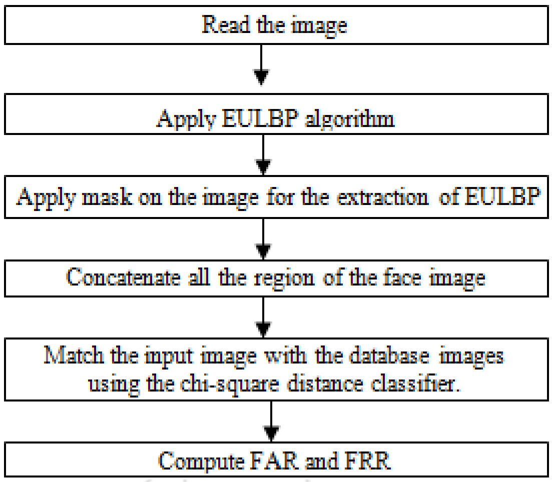
MDS Algorithm

1) Initial state (random or classical MDS).
2) Calculation of the Euclidean distances between the elements.
3) Comparison between the Euclidean distances and the original distances using STRESS function.
4) Adjustments

$$STRESS = \sum_{i<j} (d_{ij} - D_{ij})^2$$

EULBP: This approach has been used in number of different applications that includes tasks related to face detection, face recognition, demographic classification and facial expression analysis. In addition to LBP, EULBP is one of extension of this approach. In EULBP, dimensions of histograms are reduced by doubling one- dimensional pattern. It takes the effect of central pixels that improves the discrimination ability. LTP is other type of LBP which is more resistant to noise. In LTP, ternary code is developed and they are divided into upper binary and lower binary pattern. LTP include pre-processing, thresholding, local histograms.

3. Proposed Work



Various steps followed for face recognition process.

Phase 1

In this phase different database images have to be normalized and features have to be extracted from these images and stored. These features computed by using local ternary approach can be classified in texture features for further processing.

Phase 2

In this phase the low resolution query image is taken as input and the resolution enhancement approach have to be implemented using different enhancement approaches. These approaches enhance resolution quality of query image and features for that image have to be extracted.

Phase 3

In this phase similarity between different database features and query image feature on the basis of similarity constraint is computed. The minimum distance with a particular image is the maximum matched image from database images with query image. After this process different query images have to be utilized and matched with database. This provides performance analysis on the basis of different parameters i.e. FAR, FRR and accuracy.

4. Parameters Used

In order for us to determine the accuracy of any biometric system, we have to measure the error rates. There are two key error rates in biometrics, false acceptance rate (FAR) and false rejection rate (FRR).The FAR is a measurement of how many impostor users are falsely accepted into the system as “genuine” users. The FRR is a measurement of how many genuine users are falsely rejected by the system as “impostors”

FAR (False Acceptance Rate): The False Acceptance Rate (FAR) is the frequency that a non-authorized person is accepted as authorized and is calculated as follows

$$FAR=\frac{N_{fs}}{N_f}$$

Nfs = Number of successful fraud attempts against a person
Nf = Total Number of fraud attempts against a person

The false acceptance rate, or FAR, is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. FAR only provides half the information. When selecting a biometric solution, we need to find out what the False Rejection Rate (FRR).

FRR: The False Rejection Rate (FRR) is the frequency that an authorized signature is rejected and is calculated as follows:

$$FRR=\frac{N_{qr}}{N_{fq}}$$

Nqr = Number of rejected verification attempts for a qualified person
Nq = Total Number of verification attempts for a qualified person

The features of dynamic signature are subject to statistical fluctuations. Therefore, the recognition systems are designed with a built-in acceptance threshold. If it is high FAR decreases and FRR increases. The false rejection rate, or FRR, is the measure of the likelihood that the biometric security system will incorrectly reject an access attempt by an authorized user. So when a biometric solution provider claims to have a very low FAR, it is very important to find out what is the FRR at this 'low' FAR. Then depending upon the application one needs to evaluate whether the FAR & FRR ratio is acceptable for the application. In a practical scenario a low FAR & a high FRR would ensure that any unauthorized person will not be allowed access. It would also mean that the authorized people will have to put their finger on the device several times before they are allowed access.

5. Conclusion

Face recognition process comprises of various steps that has to be performed for the process of face verification. In this features of all the database images have to be computed on the basis of different algorithms. These features have to be matched with the data base images features which compute distance between different query image feature and database image feature. Different distance classifier has been utilized for calculation of distance between features. In our proposed work, for the solution of low resolution EULBP can be implemented.

Accurarcy=[100-(Mis-match Images/Total test images*100)]

Accuracy				
APPROACHES	EULBP	DCT	DWT	DCT+DWT
112*92	85%	90%	91.25%	93.12%
64*64	90%	91.25%	92.50%	92.50%
32*32	85.62%	90%	88.70%	90.62%

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