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Performance Parameter Analysis of Face Recognition Based On Fuzzy C-Means Clustering, Shape and Corner Detection

Minj Salen Kujur[1], Prof. Prashant Jain[2]
Department of Electronics & Communication Engineering college Jabalpur

Abstract
The aim of this research is to solve face recognition problem in area of biometric by using CSC hybrid method. In our work first we make the cluster of face key points and parallely apply shape and corner method for detection boundary of face and the corner of face objects. Our work is performing both face identification and recognition on large face database. It is better than other previous work because our FAR, FRR and EER less than. Also we calculate the recognition time in our work.
Keywords- Face Recognition, Clustering, Shape Descriptor, Corner Detection, RGB Image, Image Processing, Color Model, Binary Image, 4-Connected Component.

I. Introduction

Image of outdoor scenes are Now a day's face recognition is play very crucial role in recent technology like mostly companies are adopting the biometric identification for login but when images are degraded than the performance of our system is reduced. This study gives some idea about steps by steps face recognition algorithm how face is recognized but when quality of an image is degrade due to some noise or any external reason than matching process will not give accurate result for this reason we adopt some restoration and enhancement techniques like retinex theory for degrade image to improve quality for better performance in next part of my work.

Pattern recognition is the scientific discipline whose goal is the classification of *objects* into a number of categories or classes [1]. Depending on the application, these objects can be images or signal waveforms or any type of measurements that need to be classified. We will refer to these objects using the generic term *patterns*. Pattern recognition has a long history, but before the 1960s it was mostly the output of theoretical research in the area of statistics [6].

We have studied a face recognition system using the Principal Component Analysis (PCA) algorithm with Euclidean distance as a classifier and secondly Linear Discriminates Analysis (LDA) with Euclidean distance as a classifier. Face recognition systems try to find the identity of a given face image according to their memory. The memory of a face recognizer is generally simulated by a training set. Independent Component Analysis (ICA) is similar to PCA except that the distribution of the components is designed to be non-Gaussian. Maximizing non-Gaussianity promotes statistical independence.

The problem of face recognition can be stated as follows: Given still images or video of a scene, identifying one or more persons in the scene by using a stored database of faces [3]. The problem is mainly a classification problem. Training the face recognition system with images from the known individuals and classifying the newly coming test images into one of the classes is the main aspect of the face recognition systems.

II. Face Recognition

The face plays a major role in our social intercourse in conveying identity and emotion. Face Recognition (FR) [1,3] is a challenging task and has been one of the most successful applications of image analysis and understanding in many fields such as computer vision, pattern recognition. Image-based face recognition techniques can be divided into two groups according to the face representation which they use, which being the appearance-based approach and the feature-based approach, among which the appearance-based is more popular, that use holistic texture features [2,7]. With automatic face recognition there are many applications in human computer interaction, biometrics and security, etc. Over the decades, many computer systems that can recognize faces have been developed, some of which have been in commercial use. Generally, appearance-based face recognition techniques are finished with image matching in the space of compressed image. If image matching done in the original space, it will result in the curse of dimensionality in addition to the problems of large computational complexity and memory Face recognition has received considerable interest as a widely accepted biometric, because of the ease of collecting samples of a person, with or without subject's intension . Face recognition [10,11] refers to an automated or semi automated process of matching facial images. This type of technology constitutes a wide group of technologies which all work with face but use different Scanning techniques.

Most common by far is 2D face recognition which is easier and less expensive compared to the other approaches.
There are four steps in face recognition process as shown in flow chart:

1. Acquiring a sample: In a complete, full implemented biometric system, a sensor takes an observation. The sensor might be a camera and the observation is a snapshot picture. In our system, a sensor will be ignored, and a 2D face picture [8, 11] "observation" will supplied manually.

2. Extracting Features: For this step, the relevant data is extracted from the predefined captured sample. This is can be done by the use of software where many algorithms are available. The outcome of this step is a biometric template which is a reduced set of data that represents the unique features of the enrolled user's face.

3. Comparison Templates: This depends on the application at hand. For identification purposes, this step will be a comparison between a given picture for the subject and all the biometric templates stored on a database. For verification, the biometric template of the claimed identity will be retrieved (either from a database or a storage medium presented by the subject) and this will be compared to a given picture.

4. Declaring a Match: The face recognition system will return a candidate match list of potential matches. In this case, the intervention of a human operator will be required in order to select the best fit from the candidate list. An illustrative analogy is that of a walk-through metal detector, where if a person causes the detector to beep, a human operator steps in and checks the person manually or with a hand-held detector.

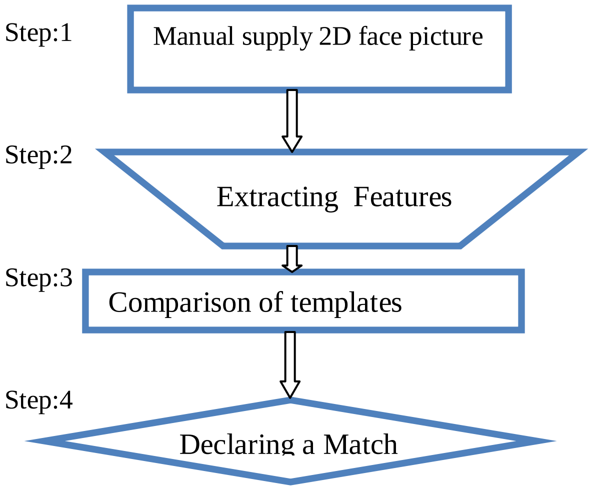

Fig. 1. Flow chart of the face detection

III. previous Work

A. Facial-Image Acquisition

In our research, original images were obtained using a charge coupled devices (CCD) camera with image dimensions of 384 $\times$ 243 pixels encoded using 256 gray-scale levels.

In image acquisition, the subject sits 2.5 m away from a CCD camera. On each site of the camera, two 200-W lamps are placed at $30_{\circ}$ angles to the camera horizontally. The original images are shown in Fig. 2.

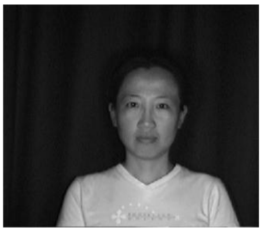

Fig. 2. Original face image.

B. Lighting Compensation

We adjusted the locations of the lamps to change the lighting conditions. The total energy of an image is the sum of the squares of the intensity values. The average energy of all the face images in the database is calculated. Then, each face image is normalized to have energy equal to the average energy

$$\text{Energy} = \sum (\text{Intensity})_2. \quad (1)$$

C. Facial-Region Extraction

We adopt the face-detection method presented in the method of detecting and extracting the facial features in a gray-scale image is divided into two stages. First, the possible human eye regions are detected by testing all the valley regions in an image. A pair of eye candidates is selected by means of the genetic algorithm to form a possible face candidate. In our method, a square block is used to represent the detected face region. 3 shows an example of a selected face region based on the location of an eye pair. The relationships between the eye pair and the face size are defined as follows:

$$h_{\text{face}} = 1.8 d_{\text{eye}}$$
$$h_{\text{eye}} = \frac{1}{5} h_{\text{face}}$$
$$w_{\text{eye}} = 0.225 h_{\text{face}}.$$

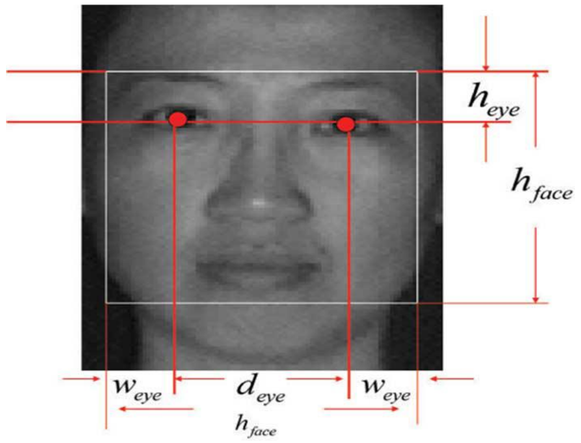

Fig. 3. Geometry of our head model.

Then, the symmetrical measure of the face is calculated. The nose centerline (the perpendicular bisector of the line linking the two eyes) in each facial image is calculated. The difference between the left half and right half from the nose centerline of a face region should be small due to its symmetry. the symmetrical measure is less than a threshold value, the face candidate will be selected for further verification.

After measuring the symmetry of a face candidate, the existences of the different facial features are also verified. The positions of the facial features are verified by analyzing the projection of the face candidate region. The facial feature regions will exhibit a low value on the projection. A face region is divided into three parts, each of which contains the respective facial features. The y-projection is the average of gray-level intensities along each row of pixels in a window. In order to reduce the effect of the background in a face region, only the white windows, as shown in Fig. 4, are considered in computing the projections. The top window should contain the eyebrows and the eyes, the middle window should contain the nose, and the bottom window should contain the mouth. When a face candidate satisfies the aforementioned constraints, it will be extracted as a face region. The extracted face image is shown in Fig. 5.

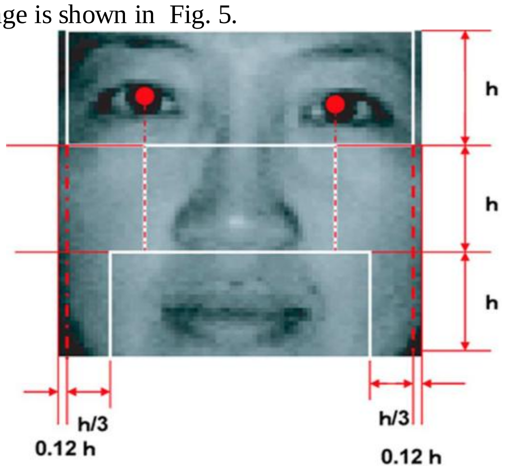

Fig. 4. Windows for facial feature extraction.


Fig. 5. Extracted face image.

D. Principal Component Analysis (PCA)

Let a pattern Z_i be a two-dimensional (2-D) $m\times m$ array of intensity values. A pattern may also be considered as a vector of dimension m^2. Denote the database of n patterns by $Z=(Z_1 Z_2 \ldots Z_n)\in\Re^{m^2\times n}$. Define the covariance matrix as follows [4].

$$\Gamma = \frac{1}{n}\sum_{i=1}^{n}(Z_i-\bar{Z})(Z_i-\bar{Z})^T = \phi\phi^T$$

Proposed Work

We present the model of the our work is given below

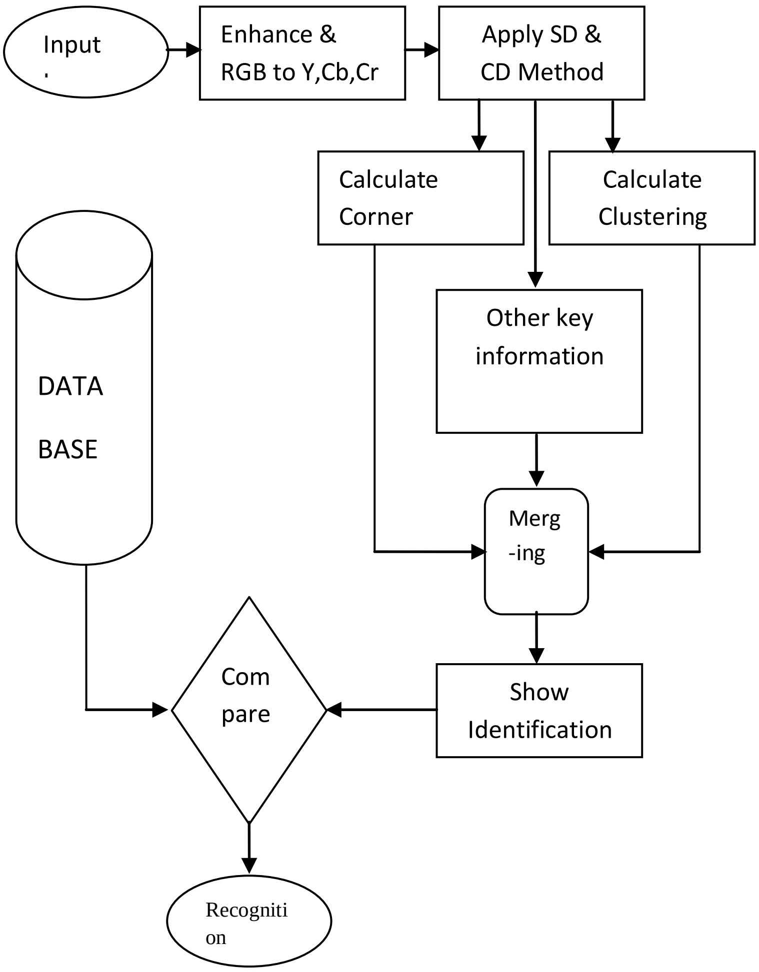

Fig.6. Block diagram of proposed method

Algorithm

Step1. We take query image.

Step2. Image enhancement (Filtering)

Step3. Convert into Y, Cb, Cr model.

Step4. By this process (step 3), we get three picture of this query image (luminance, chrome blue & chrome red)

Step5. Then we apply shape discripter on luminance image.

Step6. Now we apply colour discripter on Cb(chrome blue) &Cr.

Step7. Merging of result no.5&6 steps.

Step7. By step 7 we detect the face.

Step8. Now we save the detected shape in variables (For subsequent analysis) c o m p l e t e

Step9. Prepare predefind database of 40 image.

Step10. Now we apply step 2-9 on prepare database image.

Step11. Now we apply C-Means clustering on step 9& step 10 (parallely)

Step12. If no. of clusters, clusters position, cluster size are same then show recognition done and also show recognize person name.

Step13. Determine no. of detected & no. of non face.Image will be count & then calculate FAR,FRR & EER.

Shape

In the proposed methodology face feature extraction is implemented by using rectangle shape.

Applications of Corner Detectors

The use of interest points (and thus corner detectors) to find corresponding points across multiple images is a key step in many image processing and computer vision applications. Some of the most notable examples are:

· stereo matching
· image registration (of particular importance in medical imaging)
· stitching of panoramic photographs
· object detection/recognition
· motion tracking
· robot navigation

IV. FUZZY CLUSTERING

The “clusters” are functions that assign to each object a number between zero and one, which is called the membership of the object in the cluster. Objects which are similar to each other are identified by having high membership degrees in the same cluster. It is also assumed that the membership degrees are chosen so that their sum for each object is one therefore, uzzy clustering is also a partition of the set of objects. The most widely used fuzzy clustering algorithm is the FCM algorithm.

FCM

FCM is a data clustering algorithm in which each data point is associated with a cluster through a membership degree. This technique divides a collection N of data points into r_c fuzzy groups and finds a cluster center in each group such that a cost function of a dissimilarity measure is minimized. The algorithm employs fuzzy partitioning such that a given data point can belong to several groups with a degree specified by member membership grades between 0 and 1. A fuzzy r_c –partition of input feature vector$X = \{x1, x2, \dots\dots\dots\dots\dots xN\}$ is represented by a matrix$U = [\mu_{ik}]$, and X is an N -element set of t-dimensional vectors, each representing a 32-dimensional vector. The entries satisfy the following constraints:

$$\mu_{ik} \epsilon [0,1], \quad 1 \leq i \leq r_c \quad 1 \leq i \leq N \tag{1}$$

$$\sum_{i=1}^{r_c} \mu_{ik} = 1, \quad 1 \leq i \leq N \tag{2}$$

$$0 < \sum_{k=1}^{N} \mu_{ik} \leq N, \quad 1 \leq i \leq r_c \tag{3}$$

$x_k (k = 1, \dots\dots\dots . N)$ represents the feature coordinate of the ith data. μ_{ik} is the membership degree o x_kf to cluster . A proper partition $U \, of \, X$ may be defined by the minimization of the following cost function:

$$J_m(U, C) = \sum_{k=1}^{N} \sum_{i=1}^{r_c} (\mu_{ik})^m \, d_{ik}^2 \tag{4}$$

where$m \in (1, \infty)$ is a weighting exponent, called a fuzzifier,that is chosen according to the case. When $m \to 1$, the process
converges to a generalized classical -means. When $m \to \infty$, all clusters tend towards the center of gravity of the whole data set. That is, the partition becomes fuzzier with increasing m .
$C = [c1, c2, \dots\dots\dots\dots . c_{r_c}]$ is the vector of the cluster centers, and d_{ik} is the distance between x_k and the ith cluster. Bezdek [18] proved that if $m \geq 1, d_{ik}^2 > 0$ and $1 \leq i \leq r_c$,than U and C minimize $J_m(U, C)$ only if their entries are computed as

$$\mu_{ik}^* = \frac{1}{\sum_{i=1}^{r_c} \left({d_{ik}}/{d_{jk}} \right)^{2/(m-1)}} \tag{5}$$

$$C_i^* = \frac{\sum_{k=1}^{N} (\mu_{ik})^m \, x_k}{\sum_{k=1}^{N} (\mu_{ik})^m}. \quad (6)$$

One of the major factors that influence the determination of appropriate clusters of points is the dissimilarity measure chosen for the problem. Indeed, the computation of the membership degree μ_{ik}^* depends on the definition of the distance measure d_{ik} , which is the inner product norm (quadratic norm).
The squared quadratic norm (distance) between a pattern vector x_k and the center c_i of the ith cluster is defined as

$$d_{ik}^2 = \| x_k - c_i \|_G^2 = (x_k - c_i)^T G (x_k - c_i) \quad (7)$$

where$G$ is any positive–definite matrix. The identity matrix is the simplest and most popular choice for G.

V. Algorithm of the Facial Images by FCM

The FCM algorithm consists of a series of iterations using (5) and (6). This algorithm converges to a local minimum point of $J_m(U, C)$. We use the FCM as follows to determine the cluster centers c_i and the membership matrix U .

Step 1) Initially, the membership matrix is constructed using random values between 0 and 1 such that constraints (1), (2), and (3) are satisfied.

Step 2) The membership function is computed as follows.
a) For each cluster i , the fuzzy cluster center c_i is computed using (6).
b) All cluster centers which are too close to each other are eliminated.
For each cluster i , the distanceD_{ik} is computed
As $D_{ik} = \| c_i - c_k \|$.
When $D_{ik} \leq ave_d, \mu_{kj} = 0$for j=1 to N ,
where ave_d is the average distance value.
c) For each cluster i , the distance d_{ik} is computed using (7)
d) The cost function using (4) is computed. Stop if its improvement over the previous iteration below a threshold.
e) A new using (4) is computed and Step 2) is repeated.

VI. Experimental Result

Below figure show the GUI of our work, that getting the face image for analysis. Next figure calculate the only face of the face image. After that we apply our methodology on this query image and finally archive the matching face image, name of image person, clustering on face image and diagram of FAR,FRR.

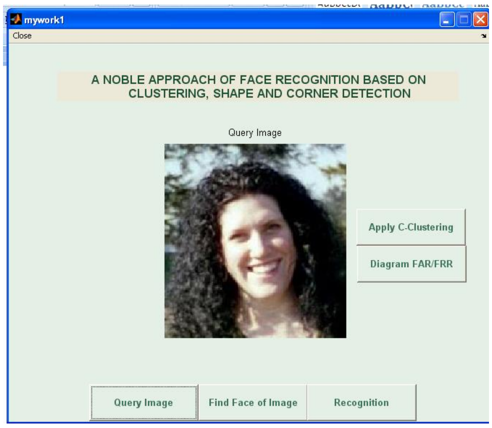

Fig.7 Query image of dataset

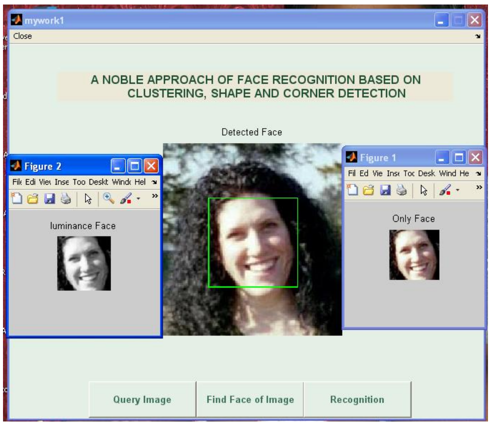

Fig.8. Find face of image with only face and luminance image

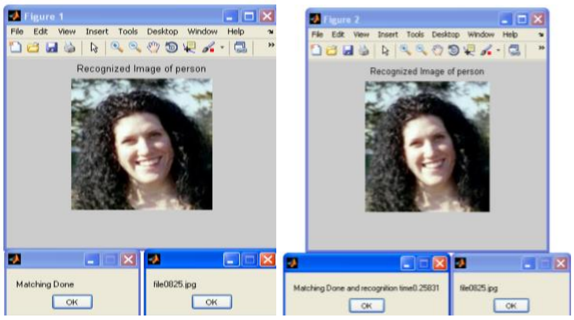

Fig.9. a)matching with person name. b)matching done and recognition time

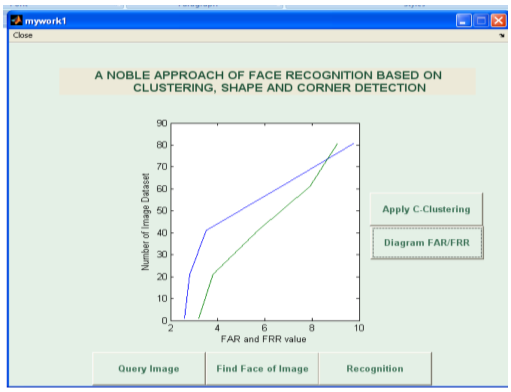

Fig.10. Graph of FAR and FRR

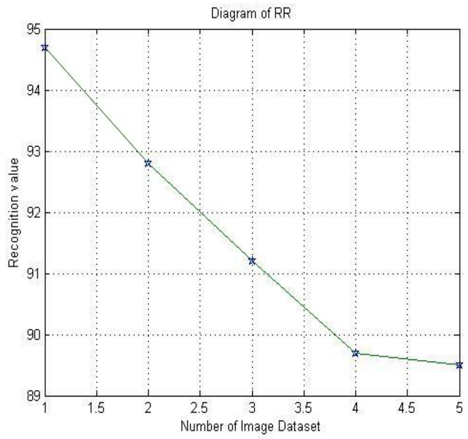

Fig.11. Graph of recognition rate

VII. Conclusion

In this paper, we have developed a hybrid method that is very effectively work on face image. It selects a face image then find the only face image and matching with respect to database. It reduces the deficiency of existing methods like PCA, correlation based etc. This hybrid method gives better result than all the other individual method. In this work we calculate FAR and FRR. In future we add some other concept like 2D cross correlation and moment invariants of face, with this approach and get a very good result for fingerprint matching.

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