Template Based Face Recognition using Real Images

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Abstract*:* **This paper proposes a face recognition algorithm based on histogram equalization methods. These methods allow standardizing the faces illumination reducing in such way the variations for further features extraction*;* Face recognition using Histogram equalization and eigenfaces are used to provide better results than the earlier techniques i.e. LDA and PCA. Results obtained with these techniques are more accurate and robust. ROC and results are compared at the end of the paper. Algorithm is tested and checks on the ORL database as well as images taken outside from the database. This is the first ever method which is being implemented and provide more perfectly matched results even on images taken outside from the database (ORL).**

Keywords – Robust, Histogram, Eigenfaces, Eigenvalues, ROC, Recognition, ORL, PCA, LDA

I. INTRODUCTION

Face recognition is a pattern recognition task performed specifically on faces. It can be described as classifying a face either "known" or "unknown", after comparing it with stored known individuals. It is also desirable to have a system that has the ability of learning to recognize unknown faces. Computational models of face recognition must address several difficult problems. This difficulty arises from the fact that faces must be represented in a way that best utilizes the available face information to distinguish a particular face from all other faces. Faces pose a particularly difficult problem in this respect because all faces are similar to one another in that they contain the same set of features such as eyes, nose, and mouth arranged in roughly the same manner.

Security is the one of the main concern in today's world. Whether it is the field of telecommunication, information, network, data security, airport or home security, national security or human security, there is various techniques for the security. Biometric is one of the modes of it. A biometrics is, "Automated methods of recognizing an individual based on their unique physical or behavioral characteristics." Face recognition is a task humans perform remarkably easily and successfully. This apparent simplicity was shown to be dangerously misleading as the automatic face recognition seems to be a problem that is still far from solved. In spite of more than 20 years of extensive research, large number of papers published in journals and conferences dedicated to this area, we still cannot claim that artificial systems can measure to human performance. Automatic face recognition is intricate primarily because of difficult imaging conditions (lighting and viewpoint changes induced by body movement) and because of various other effects like aging, facial expressions, occlusions etc. Researchers from computer vision, image analysis and processing, pattern recognition, machine learning and other areas are working jointly, motivated largely by a number of possible practical applications. A general statement of the face recognition problem (in computer vision) can be formulated as follows: Given still or video images of a scene, identify or verify one or more persons in the scene using a stored database of faces. Face recognition is one of the most active and widely used techniques [1, 2] because of its reliability and accuracy in the process of recognizing and verifying a person's identity. The need is becoming important since people are getting aware of security and privacy. For the Researchers Face Recognition is among the tedious work. It is all because the human face is very robust in nature; in fact, a person's face can change very much during short periods of time (from one day to another) and because of long periods of time (a difference of months or years). One problem of face recognition is the fact that different faces could seem very similar;

therefore, a discrimination task is needed. On the other hand, when we analyze the same face, many characteristics may have changed. These changes might be because of changes in the different parameters. The parameters are: illumination, variability in facial expressions, the presence of accessories (glasses, beards, etc); poses, age, finally background. We can divide face recognition [4, 5] techniques into two big groups, the applications that required face identification and the ones that need face verification. The difference is that the first one uses a face to match with other one on a database; on the other hand, the verification technique tries to verify a human face from a given sample of that face.

Problems: Face recognition is one of the few biometric methods that possess the merits of both high accuracy and low intrusiveness. It has the accuracy of a physiological approach without being intrusive. For this reason, since the early 70's, face recognition has drawn the attention of researchers in fields from security, psychology, and image processing, to computer vision. Numerous algorithms have been proposed for face recognition; while network security and access control are it most widely discussed applications, face recognition has also proven useful in other multimedia information processing areas.

Face recognition techniques [3] can be used to browse video database to find out shots of particular people. Also for face images with a compact parameterized facial model for low-bandwidth communication applications such as videophone and teleconferencing. Recently, as the technology has matured, commercial products have appeared on the market. Despite the commercial success of those face recognition products, a few research issues remain to be explored.

1.1 Face recognition: - Human face recognition and machine face recognition

Human face recognition: When building artificial face recognition systems, scientists try to understand the architecture of human face recognition system. Focusing on the methodology of human face recognition system may be useful to understand the basic system. However, the human face recognition system utilizes more than that of the machine recognition system which is just 2-D data. The human face recognition system uses some data obtained from some or all of the senses; visual, auditory, tactile, etc. All these data is used either individually or collectively for storage and remembering of faces. In many cases, the surroundings also play an important role in human face recognition system. It is hard for a machine recognition system to handle so much data and their combinations. However, it is also hard for a human to remember many faces due to storage limitations. A key potential advantage of a machine system is its memory capacity(V. Bruce et. al. 1999) [21], whereas for a human face recognition system the important feature is its parallel processing capacity. The issue “which features humans use for face recognition” has been studied and it has been argued that both global and local features are used for face recognition. It is harder for humans to recognize faces which they consider as neither “attractive” nor “unattractive”.

Machine face recognition: Although studies on human face recognition were expected to be a reference on machine recognition of faces, research on machine recognition of faces has developed independent of studies on human face recognition. During 1970’s, typical pattern classification techniques, which use measurements between features in faces or face profiles, were used [20]. During the 1980’s, work on face recognition remained nearly stable. Since the early 1990’s, research interest on machine recognition of faces has grown tremendously. The basic question relevant for face classification is that; what form the structural code (for encoding the face) should take to achieve face recognition. Two major approaches are used for machine identification of human faces; geometrical local feature based methods, and holistic template matching based systems. Also, combinations of these two methods, namely hybrid methods, are used. The first approach, the geometrical local feature based one, extracts and measures discrete local features (such as eye, nose, mouth, hair, etc.) for retrieving and identifying faces. Then, standard statistical pattern recognition techniques and or neural network approaches are employed for matching faces using these measurements [22]. One of the well known geometrical-local feature based methods is the Elastic Bunch Graph Matching (EBGM) technique. The other approach, the holistic one, conceptually related to template matching, attempts to identify faces using global representations [19]. Holistic methods approach the face image as a whole and try to extract features from the whole face region. In this approach, as in the previous approach, the pattern classifiers are applied to classify the image after extracting the features. One of the methods to extract features in a holistic system is applying statistical methods such as Principal Component Analysis (PCA) to the whole image. PCA can also be applied to a face image locally; in that case the approach is not holistic. Whichever method is used, the most important problem in face recognition is the curse of dimensionality problem. Appropriate methods should be applied to reduce the dimension of the studied space. Working on higher dimension causes over fitting where the system starts to memorize. Also, computational complexity would be an important problem when working on large databases.

1.2 Statistical Approaches

Statistical methods include template matching based systems where the training and test images are matched by measuring the correlation between them. Moreover, statistical methods include the projection based methods such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), etc. In fact, projection based systems came out due to the shortcomings of the straightforward template matching based approaches; that is, trying to carry out the required classification task in a space of extremely high dimensionality.

- *Template Matching:* Brunelli and Poggio [23] suggest that the optimal strategy for face recognition is holistic and corresponds to template matching. In their study, they compared a geometric feature based technique with a template matching based system. In the simplest form of template matching, the image (as 2-D intensity values) is compared with a single template representing the whole face using a distance metric. Although recognition by matching raw images has been successful under limited circumstances, it suffers from the usual shortcomings of straightforward correlation-based approaches, such as sensitivity to face orientation, size, variable lighting conditions, and noise. The reason for this vulnerability of direct matching methods lies in their attempt to carry out the required classification in a space of extremely high dimensionality. In order to overcome the curse of dimensionality, the connectionist equivalent of data compression methods is employed first. However, it has been successfully argued that the resulting feature dimensions do not necessarily retain the structure needed for classification, and that more general and powerful methods for feature extraction such as projection based systems are required. The basic idea behind projection based systems is to construct low dimensional projections of a high dimensional point cloud, by maximizing an objective function such as the deviation from normality.

1.2.1 Some approaches by PCA**:**

- PCA and Image Compression: In their study Moghaddam and Pentland [24] used the Eigenface Method for image coding of human faces for potential applications such as video telephony, database image compression and face recognition.
- Face Detection and Recognition Using PCA: Lee et al. [25] proposed a method using PCA which detects the head of an individual in a complex background and then recognize the person by comparing the characteristics of the face to those of known individuals.
- PCA Performance on Large Databases: Lee et al. [26] proposed a method for generalizing the representational capacity of available face database.
- PCA & Video: In a study by Crowley and Schwerdt [27], PCA is used for coding and compression for video streams of talking heads. They suggest that a typical video sequence of a talking head can often be coded in less than 16 dimensions.

- Bayesian PCA: Another method, which is also studied throughout this paper, is the Bayesian PCA method suggested by Moghaddam et al. [28], [29], [30], [31], [32], [33], [34], [35]. By this system, the Eigenface Method based on simple subspace-restricted norms is extended to use a probabilistic measure of similarity. Also, another difference from the standard Eigenface approach is that this method uses the image differences in the training and test stages. The difference of each image belonging to the same individual with each other is fed into the system as intrapersonal difference, and the difference of one image with an image from different class is fed into the system as extra personal difference. Finally, when a test image comes, it is subtracted from each image in the database and each difference is fed into the system. For the biggest similarity (i.e. smallest difference) with one of the training images, the test image is decided to be in that class. The mathematical theory is mainly studied in [43] Also, in [36] Moghaddam introduced his study on several techniques; Principal Component Analysis (PCA), Independent Component Analysis (ICA), and nonlinear Kernel PCA (KPCA). He examined and tested these systems using the FERET database. He argued that the experimental results demonstrate the simplicity, computational economy and performance superiority of the Bayesian PCA method over other methods. Finally, Liu and Wechsler [37], [38] worked on Bayesian approach to face recognition.
- PCA and Gabor Filters: Chung et al. [37] suggested the use of PCA and Gabor Filters together. Their method consists of two parts: In the first part, Gabor Filters are used to extract facial features from the original image on predefined fiducially points. In the second part, PCA is used to classify the facial features optimally. They suggest the use of combining these two methods in order to overcome the shortcomings of PCA. They argue that, when raw images are used as a matrix of PCA, the eigenspace cannot reflect the correlation of facial feature well, as original face images have deformation due to in-plane, in-depth rotation and illumination and contrast variation. Also they argue that, they have overcome these problems using Gabor Filters in extracting facial features.

Feature Based PCA: Cagnoni and Poggi [40] suggested a feature-based approach instead of a holistic approach to face recognition. They applied the eigenface method to sub-images (eye, nose, and mouth). They also applied a rotation correction to the faces in order to obtain better results.

- A feature based approach using PCA vs. ICA*:* Guan and Szu compared the performance of PCA and ICA on face images. They argue that, ICA encodes face images with statistically independent variables, which are not necessarily associated with the orthogonal axes, while PCA is always associated with orthogonal eigenvectors. While PCA seeks directions in feature space that best represent the data in a sum-squared error sense, ICA seeks directions that are most independent from each other [39]. They also argue that, both these pixel-based algorithms have the major drawback that they weight the whole face equally and therefore lack the local geometry information.

PCA applied on local features.

-A feature based approach using PCA, Bayesian Classifier, and HMMs: Martinez [39] proposed a different approach based on identifying frontal faces. Their approach divides a face image into n different regions, analyzes each region with PCA, and then uses a Bayesian approach to find the best possible global match between a probe and database image. The relationship between the n parts is modeled by using Hidden Markov Models (HMMs).*3*

1.3 Histogram Method for Face Detection

As per [18], RGB color space is commonly used in image processing because of its basic synpaper property and direct application in image display. According to the requirements of different image processing tasks, RGB color space is often transformed to other color spaces. From a visual perception's point of view, hue, saturation and value are often employed to manipulate color, such as de-saturation or change of color fullness. When the color is quantized to a limit number of representative colors, one will have to deal with two problems. The first is how to best match the distance [23], [24] of data representation to human perception. It is desirable that numerical color distance is proportional to perceptual difference. The second problem is how to best quantize the colors such that the reproductions from these quantized colors is the most faithful to the original. In this work, we adopt a perceptually meaningful color space, the HMMD color space, and used a carefully worked out quantization scheme of the MPEG-7 standard

II. PROPOSED ALGORITHM

Recognizing objects from large image databases, histogram based methods have proved simplicity and usefulness in last decade. Initially, this idea was based on color histograms .This algorithm presents the first part of our proposed technique named as “Histogram processed Face Recognition” as compared to detection use in [18]

Histogram techniques are well designed for face detection[17] as shown above .But in our case we apply histogram calculation for face recognition .The algorithm given below worked for face recognition with success rate of 95%.For training, grayscale images with 256 gray levels are used. Firstly, frequency of every gray-level is computed and stored in vectors for further processing. Secondly, mean of consecutive nine frequencies from the stored vectors is calculated and are stored in another vectors for later use in testing phase.

This mean vector is used for calculating the absolute differences among the mean of trained images and the test image. Finally the minimum difference found identifies the matched class with test image. Recognition accuracy is of 95 in our case.

Algorithm

1. Step 1: Take input image I
2. Step 2.Test the gray level ,For I1=1: N %where N is number of Images
3. Step3: Compute frequency ,For I2=1: N
4. Step 4: Make frequency vector,ForI3=1:M %where M is the dimension of frequency vector and taken as M=9
5. Step5: Calculate mean or mean difference M_d, M_d=Trained image –Test image
   If M_d= 0 then , Matched
6. Got to Step 7 ,Else
7. %Again check for the next image
8. Go to step 4
9. End if
10. End for &Go-to step 3
11. End for & go-to step 2
12. End for& got to step 6

13. Step 6: Print Not Matched & Stop
14. Step 7: Show the Mapped Output in GUI & Stop

On the basis of such considerations, the algorithm uses a different color image multiplied by the weighting coefficients of different ways to solve the visual distortion, and by embedding the watermark, wavelet coefficients of many ways, enhance the robustness of the watermark.

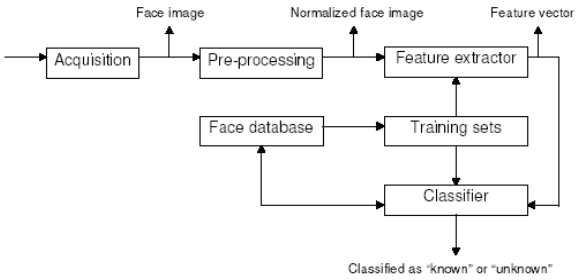
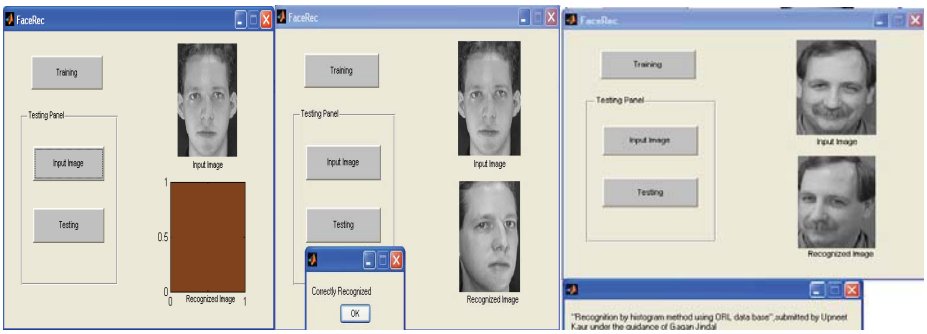


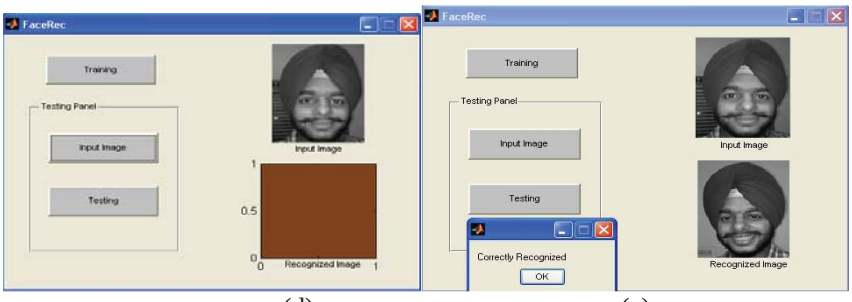
Figure 1. Outline of a typical Face Recognised System

III. Experiment and Result

Initially training of nine databases is done and Reserve one for testing. The base work is done in Matlab .The training module is as given below in figure 4.1.Dimension are taken 92*112 for each image in the database as well as in the testing database



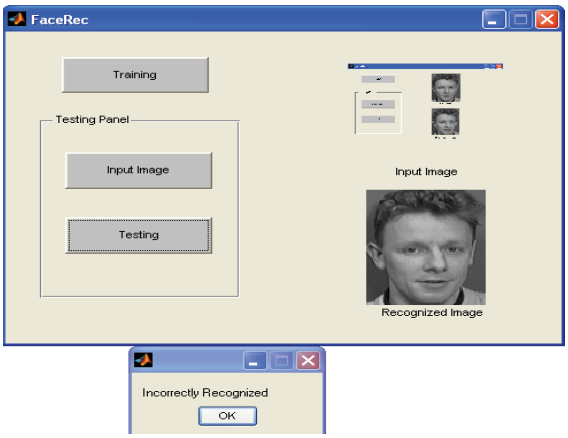
(a) (b) (c)



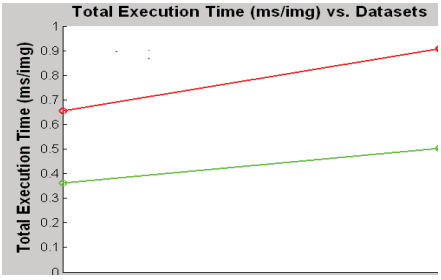
(d) (e)

Figure2 (a) Input image using ORL database (b) Image correctly recognized after testing (c) Image with tilted face is recognized (d) Image from different database (e) Robust image

In those cases where more than one images are tested like in case of a neural network, it do not provide us with the accurate results besides gives a incorrectly recognized image message.



Sr.No	No. of Training image	Number of test database	Success rate	Result
1	9	1	100%	Matched
2	5	5	100%	Matched
3	4	6	70%	Lesser Efficient
4	9	Outside from database	100%	Matched



Red lines indicates PCA and Green is for LDA

Figure3 ROC of LDA and PCA

IV.CONCLUSION

In this paper, we achieved our purpose in developing a system in which faces recognition has been made more accurate and robust using histograms instead in case of using PCA and LDA technique . Hence we conclude that results obtained from the histogram equilisation and eigenvaalues retrieves better results that other techniques. Roc and result verify that the face recognition is more accurate and robust and even if we take a picture outside the database results are shown more clearer .In futue work can be done on the neural network in which more than one image can be accurately recognized

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