International Journal of Computer Applications Technology and Research
Volume 6–Issue 4, 183-189, 2017, ISSN:-2319–8656

An Approach to Face Recognition Using Feed Forward Neural Network

Sajetha T
Dept. of CSE, UVCE,
Bangalore University,
Bangalore, India

Samyama Gunjal G H
Dept. of CSE, UVCE,
Bangalore University,
Bangalore, India

Abstract: Many approaches have been proposed for face recognition but there are major constraints like illumination, lightning, pose etc., when taken into consideration, results in poor recognition rate. We propose a method to improve the recognition rate of the face recognition system which uses various methods like homogeneity, energy, covariance, contrast, asymmetry, correlation, mean, standard deviation, entropy, kurtosis to extract the facial features for a better recognition rate. Also the extracted features are trained and it is associated with a feed forward back propagation neural network used for classification to render better results.

Keywords: Face recognition, Neural network, Features extraction.

I. INTRODUCTION

Face recognition is an active research area in last 30 years. Criminal immigrant detection, Passport authentication, participant identification, system access control, enterprise security, scanning criminal persons, telecommunication are some of the applications of face recognition system [1]. Although there is remarkable progress in the face recognition system, it remains a challenging problem, mainly because of the complexities involved in variations in illumination, where because of different light conditions the face may appear differently. This leads in the misclassification of the input face images. Another problem is posing, where the face recognition system becomes unable to recognize the different poses of the same person. The different poses may include face images with smiling, not smiling, wearing glasses or without glasses and so on. Therefore it becomes necessary to develop an efficient face recognition system.

The approaches for face recognition system can be dealt as analytical and holistic approaches. For analytical approaches, the face outline forms a feature vector which represents a face [2].

Holistic method uses the whole face information. *Principal Component Analysis* (PCA) is a well known holistic method which uses eigenface for face recognition [3]. PCA can achieve the minimum error but it has limitations where it is hard to decide suitable thresholds automatically and to decide upon on how many eigenvectors are required to recover an original face. *Linear Discriminant Analysis* (LDA) is another holistic method which is applied for the fisher face methods. It lags behind where it needs large training sample sets for good generalization. PCA is normally adopted to reduce the feature dimension before LDA can be applied. In the proposed method, we are detecting various features of face like homogeneity, energy, variance, contrast, asymmetry, correlation, mean, standard deviation, entropy, kurtosis each of these features has its own characteristics and overall gives better recognition rate

II. ORGANIZATION OF PAPER

The paper is organized as follows. Section I deals with the brief description of basics of face recognition system, its advantages, why the face recognition system is required. Section III deals with reviews of background of face recognition system followed by the description of early and some new techniques of face recognition system. Section IV deals with proposed method. Section V deals with the simulation and results of the proposed work with classification using feed forward back propagation neural network. Section VI gives the conclusion.

III. RELATED WORK

The face recognition methods are divided into template based method and geometry based methods. Template matching method uses the whole face information.

R. Brunelli and T. Poggio developed the template based method [4], where an array with intensity values is used to represent the image and compared using Euclidean distance.

Sirovich and Penev used PCA method to obtain reduced dimensions of the human faces [6]. PCA is one of the statistical approaches used for the compression of data [5] and is also known as eigenface method. This method was considered robust and produced a good recognition rate on various database. However, PCA lags behind if the parameter range exceeds. It also removes the relationships between neighborhood pixels.

The Linear Discriminant Analysis or the fisher face method is another statistical approach which is considered as better than eigenface method in classifying

face images better than the eigenface method. It uses interclass and intraclass relationships to classify face images. It is robust against noise, occlusion, and illumination [12].

Independent Component Analysis (ICA) is a new statistical technique which extracts independent variables [7]. The technique of ICA is originated from signal processing. However, the training is considered slow and computational cost is high.

Geometry feature based methods were mainly focused on finding the angles, size, and distance between eyes, nose, ears, head outline and mouth. Wavelets is a technique used in the geometry method to decompose complex signals into basis functions, this is similar to Fourier decomposition. For several computer vision applications Gabor filters are used [8].

IV. PROPOSED METHOD

The proposed method uses a well known face database, ORL database from the AT&T laboratories, Cambridge [9]. The architecture of the proposed system is as shown in Fig 1. A typical face recognition system has pre-processing, feature extraction and classification steps. In the proposed method pre-processing is done where the images are converted to matrix form, Feature extraction is done using homogeneity, energy, covariance, contrast, asymmetry, mean, entropy, kurtosis, standard deviation, and covariance. The classification is carried out using feed forward neural network.

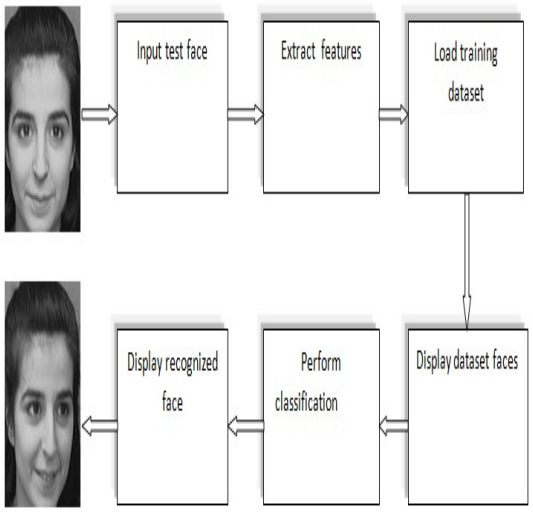

Fig 1: Architecture of proposed face recognition system

A. Pre-processing Stage

The first phase of face recognition system would be collecting the face images. The images may contain unnecessary factors like noise, blurriness, improper illumination effects, distortions etc.

Pre-processing of images is used to enhance the image features which might be important for further processing, it optimize the images to get the satisfactory results on output.

Several pre-processing methods like enhancing brightness of the images, smoothing of images to reduce noise, contrast enhancement, edge enhancement, normalizing intensity of image pixels, removing image reflections, histogram equalization which distributes the brightness levels normally can be applied to the selected input images. In the proposed method images are collected from the ORL database. It is transformed into matrix form in order to ease the operation.

B. Feature Extraction Factors

- **Homogeneity** is used to see the similarity of the pixels, to check the uniformity of the pixels.
- **Energy** is defined as a factor that would capture the desired solution and perform gradient-descent to compute its lowest value, resulting in a solution for the image segmentation.
- **Covariance** is a measure of how much the two pixels change together, the greater values of one pixel mainly correspond with the greater values of the other pixel, and the same holds for the smaller values, i.e., the pixels tend to show similar behavior, the covariance is positive, in the opposite case, when the greater values of one pixel mainly correspond to the smaller values of the other, i.e., the pixels tend to show opposite behavior, the covariance is negative. The covariance shows the linear relationship between the pixels.
- The **Contrast** function enhances the contrast of an image. It defines the intensity of the image; image may have high intensity or the low intensity.
- The **Asymmetry** is without symmetry means, it is the analysis of the abnormal distribution of the pixels in the specified window. It means that there are no mirror images in a composition. It involves the measure of the asymmetry of the data. If asymmetry is negative then the data are spread more to the left of the mean. If it is negative the data are spread more to the right. The asymmetry of the normal distribution is zero.

[1] The **Correlation** defines how much the pixels are closely related to each other. Properties of correlation are:

- Single objects usually have a higher correlation value within them than between adjacent objects.
- Pixels are usually more highly correlated with pixels nearby than with more distant pixels. Smaller window sizes will usually have a higher correlation value than larger windows.
- Correlation is calculated for successively larger window sizes, the size at which the Correlation value declines may be taken as the size of definable objects within an image, which works only if all objects in the image are of same size.

- Correlation uses a different approach in calculation than the other texture measures mentioned above. As a result, it provides different information and can often be used in combination with other texture measures.
- If all the pixels have identical values, then the variances are zero and the correlation equation would give an undefined result.
- If the variance is zero, then the equation is not used, and the correlation is set to 1, to reflect identical pixels.

[2] **Mean** returns the mean of image. It finds out the mean of the row pixels, the mean of the column pixels and the mean together with row and column pixels returning mean of the image.

[3] **Standard deviation** returns deviation between images. It computes the standard deviation of each row and column of the input.

[4] **Entropy** measures the randomness of the pixels, which is used to characterize the texture of the input image [11].

[5] **Kurtosis** describes the peakness of image, frequency distribution of the pixels. If the distribution is normal then the kurtosis has *zero* value. If the kurtosis value is positive its peak distribution will be sharper. Conversely, if kurtosis has negative value lesser the peak distribution will be. The extracted features from test and training images are classified using feed forward neural network.

C. Feature Extraction

In various applications feature extraction is a process of dimensionality reduction, which is required if the input data to be processed is too large and redundant, then the input data is transformed into a reduced dimension set of features, which are also called as features vectors.

In the proposed method the features of the face are extracted and fed as input to the neural network for the further process. Extraction of the relevant information is necessary for the proper recognition to be made.

Rather than working with the entire image it is simple to analyze the relevant extracted features. In the proposed method the features like Homogeneity, Energy, Covariance, Contrast, Asymmetry, Correlation, Mean, Standard Deviation, Entropy, and Kurtosis. The following equations are used to extract the particular features [10].

Features	Expression
Homogeneity	$H=\sum_{i,j}\frac{p(i,j)}{1+\lvert i-j\rvert}$
Energy Range = [0 1] Energy is 1 for a constant image.	$E=\sum_{i,j}p(i,j)^2$ p (i, j) is the pixel value at the point (i, j)
Covariance	$Var=\sqrt{SD}$
Contrast Is 0 for a constant image	$C=\sum_{i,j}\lvert i-j\rvert^2\,p(i,j)$
Asymmetry	$A=\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(\frac{p(i,j-\mu)}{\sigma}\right)^3$ p (i, j) is the pixel value at point *(i,j),* μ and σ are the mean and standard deviation respectively.
Correlation **1** if the image is positively correlated **-1** if the image in negatively correlated	$Corr=\sum_{i,j}\frac{(i-\mu_i)(j-\mu_j)\,p(i,j)}{\sigma_i\sigma_j}$ p_i and p_j, the partial probability density functions.
Mean	$\mu=\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}p(i,j)$ p (i, j) is the pixel value at point (i, j) of an image of size mXn.
Standard Deviation (SD)	$\sigma=\sqrt{\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}(p(i,j)-\mu)^2}$
Entropy	$Ent=-\sum_{k=0}^{L-1}pr_k(\log_2 pr_k)$ pr_k is the k^{th} grey level probability, L total number of grey levels.
Kurtosis	$K=\left\{\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left[\frac{p(i,j)-\mu}{\sigma}\right]^4\right\}-3$ p (i, j) is the pixel value at point (i, j), For normal distribution -3 becomes zero.

D. Neural network

The Feed Forward Back propagation neural network is a technique with the network structure, having series of layers, where the inputs flows forward in the network. The network is a collection of nodes connected together. Nodes represent neurons and arrows represent links between them. Input layer has input nodes which simply pass values to the processing nodes. The activity of hidden layer is hidden. The output layer is expected to give the output.

Back propagation neural network works in two phases. Feed forward and feed backward. Network without cycles are called a feed-forward networks, where the inputs flows only forward. In the feed backward network, weights can be used, if the expected output doesn't come then the weights can be changed in such a way that it will achieve expected output.

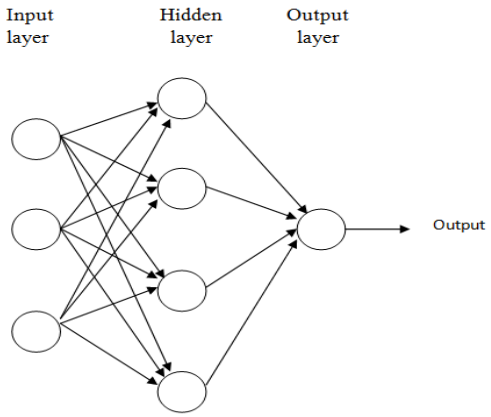

Fig 2: Feed Forward Back propagation neural network

In the proposed method feed forward neural network is used. The features extracted for the face is fed as an input to the neural network. It propagates forward and gives the expected result, which is in this case recognizing the input face. The features obtained for input face is compared with the features of the training dataset faces. The network is trained with the training dataset images. The feed forward back propagation neural network is as shown in Fig 2.

The advantage of using neural network in classification stage is, there is no need to train the network with known inputs repeatedly. Once it is trained it is expected to work efficiently to analyze the data, and is easy to maintain.

V. SIMULATION AND RESULTS

In the proposed method 8 selected face images of different individuals from the ORL database are considered and training data consists of 40 images, each individual with 5 different facial expressions like open/close eyes, smiling or not smiling, glasses or no glasses. The sample dataset is as shown in Fig 4. The test faces are shown in Fig 3. For some faces, the images were taken at different times, varying the lighting. The system has been simulated in MATLAB.

Fig 3: Test data

Fig 4: Sample data set consisting each person image with different facial expression

Any face image among 8 different individuals is given as input to the face recognition system. The training data set is loaded and features are extracted for the training data set. With the extracted features classification is carried out using back propagation neural network. Then a decision is made upon recognizing the face. The test data with recognized face is as shown in Fig 5.

Fig 5: Test face and recognized face

The values obtained for all the features mentioned for the input face is given in Table 1.

TABLE I: THE FEATURE VALUES OBTAINED

Features	Values
Homogeneity (H)	0.2624
Energy (E)	3.8950
Covariance (Var)	3.5248
Contrast (C)	6.9221
Asymmetry (A)	0.2327
Correlation (Corr)	6.9662
Mean (μ)	0.3252
Standard deviation (σ)	131.98
Entropy (Ent)	-693.7
Kurtosis (K)	432051

VI. CONCLUSION

For any face recognition system feature extraction is an important step. If features are not extracted properly recognition becomes difficult. The proposed face recognition system has high recognition rate as it calculates various features like homogeneity, energy, correlation, covariance, mean, standard deviation, kurtosis, asymmetry, contrast, entropy.

Extracted features increase the robustness of the face recognition system. It is found that the recognition rate for the selected database followed by neural network gives high recognition rate and eliminates the variations due to pose.

REFERENCES

[1]. D. Osten, H.M.Carin, M.R.Arneson and B.L.Blan, "Biometric personal authentication system", U.S. Patent #571, 9950, Feb 1998.

[2]. Kin- Man Lam and Hong Yan,"An Analytic – to – Holistic Approach for Face Recognition Based on a Single Frontal View", IEEE Trans., on Pattern Analysis and Machine Intelligence, Vol.20, no. 7, July 1998.

[3]. K.I. Diamantaras and S.Y.Kung,"Principal Component Neural Network:Theory and Applications", John Wiley & Sons,Inc., 1996.

[4]. R. Brunelli, T. Poggio, "Face recognition: Features versus templates", IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 15(10), pp.1042-1052, 1998.

[5]. M.Turk and A.Pentland," Eigenfaces for recognition", J.Cognitive Neuroscience, vol.3, 71-86., 1991.

[6]. Sirovich, L, Penev, P.S., "The global dimensionality of face space", 4th IEEE International conference, 2000.

[7]. A. Hyvaerinen, E. Oja.," A fast fixed-point algorithm for independent component analysis", MIT Press, Neural Computation, vol. 9, pp.1483-1492, 1997.

[8]. Rahman , M.T, Bhuiyan, M.A, " Face Recognition using Gabor Filters", 11th International Conference, 24-27, Dec 2008.

[9].http://www.uk.research.att.com/facedatabase.html.

[10]. http://www.mathworks.in.

[11]. Fattah,S.A, "Spatial Domain Entropy based local feature extraction scheme for face recognition", 7th International Conference, 24-27, Dec 2012.

[12]. Shuiwang Ji, Jieping Ye, "A Unified framework for generalized linear Discriminant Analysis", IEEE International conference on Computer vision and Pattern Recognition, 2008.