# A Comparative Analysis of Face Recognition Methods Using Neural Networks , Fuzzy & Neuro-Fuzzy System

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**Abstract -** Face recognition is one form of biometric identification which has become an important way of recognizing person in a real time system. It gained importance due to its applications in many security related areas such as at airport terminals , authentication . Recognition is a method of identifying a person in still image or in video . From literature we can come across different traditional methods . New research of recognition in this area in recent years is focussed towards using neural network methods. Moving a step ahead in research in this area is application of Fuzzy system . In this comparative study our focus was on neural networks , fuzzy system and neuro-Fuzzy system**.**

**Keywords :** Neural networks , face recognition, fuzzy system ,Neuro-fuzzy .

## I Introduction

Face is a physical characteristic that a person posses to identify him/her self automatically. Face recognition is a process of identifying an image by matching with the images in the database. Face Detection is the process of claiming a person as an authorized user. Its a type of one – to –one matching. Facial images may be represented as a 2D or 3D. The 3D facial images are able to identify pose variations , has no effect due lightening. The main challenges one has to encounter in face recognizing are due to facial expressions , rotation effects , noise and distortion. Some times recognition is complex due to ***interclass*** and ***intra class*** similarities. In the first type two persons may appear to be similar such as twins where as in the second case same person but change in pose , facial expression aging effects appears to be of different. Face recognition can be done in four different ways. Using ***Knowledge Based Approach*** **[1] ,[2], [3], [4]** we encode faces based on rules. In ***Feature Invariant*** method we identify the facial features that doesn't change due to expressions , pose , illumination etc. Hand coded templates are stored and then used for face detection in ***Template Matching*** which is the simplest of all methods . The images are trained using different learning methods of neural networks , PCA , SVM in ***Appearance Based Method.*** Most of the research in face recognition in the recent years are based on the last method. From [2] the steps in face recognition are acquiring the face image , pre-processing is done to remove any noise in the image. Later two sets of data are selected , one for training and one for testing the new Image . The performance of any face recognition system is determined by the parameters False Acceptance Rate(FAR) – number of times a unauthorized users are accepted , False Rejection Rate (FRR) – number of times an authorized user has been rejected , Equal Error rate(EER)- FAR and FRR equals , Time to verify , Time taken to capture .

In this study Section II consists of Face recognition methods using Neural Networks , Section III focuses on Fuzzy System . Section IV describes a combination of both approaches Nuero-Fuzzy for face detection. In section V a comparative analysis is made on the two approaches that is neural networks and fuzzy system based on parameters. Section VI we conclude on the Neuro-Fuzzy system

## II Face recognition Using Neural Networks

### A Back Propagation (BP)

From [4] a general back propagation network is used for face recognition . The author has proposed two algorithms for feature extraction i)View Based ii)Biometric based . using a component based detector (CBD) the features of the face are extracted by selecting the sub images and calculating the biometric distance. The components that are selected in the face image are eyes , nose and mouth . From the sub image seven distance biometrics are calculated and normalized in terms of gray levels raging between the values 0 to 1. The resulting values is used as input to the classifier . BP uses both forward and reverse evaluation [5] to train the network and adjusting weights. The resulting training set is named as primary and secondary classifiers . During recognition if the face image doesn't matches with the primary then it matches with the secondary classifier.

### B. Self Organizing Maps(SOM)

SOM is a unsupervised learning method in neural networks which is mostly used a clustering algorithm. Maps the input space from higher dimension to low dimension. This algorithms follows the competitive learning method where the neurons compete with one another and the winning neuron is termed as the "Best Matching Unit(BMU) " which is very close to the input vector. At the end of the training phase the neurons are clustered base don the input space forming a Lattice. From [6] SOM is used to classify the face images even when their is change in facial expression. Here the author has proposed four SOM classifiers. The first SOM classifier (C1) applies to all neurons prior to testing phase. In this method their is no weight updating hence the neurons can be a winner or may be rejected or labelled a s unknown . In the second SOM classifier (C2) the class centroids are chosen for labelling as they are known before training. In this method neuron belongs to only one class. In the third SOM Classifier (C3) which is a form of supervised SOM the input vectors are classified as pattern vector and class vector. The class vectors are of unit length whose value is to "1' the others are set to "0". In the last method SOM Classifier (C4) for each classes assigned one SOM.

In the testing phase winning neuron is one among all of the SOM. In [7] the author presents a form of SOM that is used for facial skin segmentation recognition after plastic surgery. The different color spaces in Image processing are RGB , CMY , HIS , YIQ , IHLS . In this method [7] the given input face image which is normally based on RGB values are converted to IHLS . This color space method is used to improve color saturation and brightness of an image . The resulting images is processed by SOM in two stages . After conversion to IHLS the SOM starts with some random initial values for weight adjustments. The 256 neurons (16*16 colors ) in the input space are reduced to 5 neurons after the second stage of the SOM. Then the resulting images is post processed to obtained facial segmentation.

## III Face Recognition Using Fuzzy Method

Any image is converted into a set of integer values called "pixels". Face detection using fuzzy method can be done using two steps[8]. They are skin detection and edge detection. In the first step the given image values which is in the form of RGB values are converted to YCbCr values. Since RGB has different brightness values for Red , Green and Blue to overcome this YCbCr method is adopted. The Y component is the sum of R,G and B values , CB is obtained using B-Y , Cr is obtained using R-Y. The Cb ,Cr values are used to identify if a pixel belongs to skin part or not. In the second step Fuzzy rules are applied to detect the edges of the face. A set of four pixels are chosen from a 2x2 widow size and sixteen inference rules are proposed to detect edges of the face[8]. An edge is present when their is a large difference between intensities of adjacent pixels.

In [9] fuzzy Retinex method was proposed for face image normalization. Initially the face and eye regions are detected using Adaboost algorithm . In the next step the image is normalized using Fuzzy Logic. Input to the fuzzy based normalization is the mean and standard deviation grey values of the facial image. Using the fuzzy Retinex method the global and local variations are overcome .Fuzzy membership function is derived for the input image. After normalization the face is recognized.

## IV Face Recognition Using Neuro-Fuzzy(NF) system

### A.BP and Fuzzy system

In [10] this method the input Facial image considered as image matrix . The rows that are identical are fed as input to the neural network. The number of input neurons are equal to the number of columns in data set matrix. The entire system is designed in two phases. First is the training phase and second is the recognition phase. In the first phase Back Propagation Neural Network is used for training the data sets. During training if their is any error it is feed back to adjust the weights. Once the network is converged the number of epoch and gradient is calculated. These two values are treated as input for Fuzzy Inference System (FIS) . Based on the accuracy of the fuzzy membership values face recognition is done.

### B. EigenFace and Neuro-Fuzzy System

In[11] this method Face features are extracted using Principal component Analysis(PCA) using Eigen faces. The PCA components are taken as input for the Neuro-Fuzzy System. Prior to this Fuzzification of PCA values are done. For each input and out put values two membership values High and Low are derived. These values are fed as input to the BP Neural Network for Training Purpose. The hidden layer of BP takes the High and Low values as input. In the next step Genetic algorithms are used for recognition purpose.

### C. Wavelet Gabor and Neuro-Fuzzy System

In [12] the author proposed a method of face detection using Wavelet Gabor for feature Extraction and NF system for face recognition. The features of the face is extracted by applying the Wavelet Gabor filter. NF is used to classify the input image. In this system BP is used for training purpose. The input layer is same as to that of the General BP but the hidden layer is fuzzification and rule antecedent layer . The out put is rule inference layer. In the backward phase error is determined and minimized.

## V Comparison Of Neural Networks and Fuzzy System

| Parameters | Neural Networks | Fuzzy System |
|---|---|---|
| **Knowledge Representation** | Implicit | Explicit |
| **Trainability** | Train itself by learning from data sets | No self Training , must be defined Explicitly |
| **Computational Algorithms** | Low level | Structured Frame work |
| **Initial Parameters** | Fixed well | Randomly Chosen |

## VI Conclusion

In this study we compared the three approaches for face recognition. Using only neural networks approach some times the network get trapped in local minima as to that of a back propagation Network. When we adopt only Fuzzy system for face recognition biometrics learning becomes an explicit function. In order to achieve a face recognition system that is fast and self adaptive base don the inputs extracted from the face image we can combine the two systems as Neuro-Fuzzy system From the above analysis we can say the output performance of face recognition is much better in Neuro-Fuzzy system when compared to the individual system

## VII REFERENCES


[1] Ming-Hsuan Yang , David J.Kriegman , Narendra Ahuja , "Dtecting Faces in Images: A survey" , IEEE Transaction on Pattern Analysis & Machine Intelligence Vol 24, No1 , January 2002.

[2] Mayank Agarwal , Nikunj Jain , Mr Manish Kumar and Himanshu Agarwal , " Face Recognition Using Eigen Faces and Artificial Neural Networks " International Journal of Computer Theory and Engineering , Vol 2 , No 4 , August 2010.

[3] Cha Zhang and Zhengyou Zhang , "A Survey of Recent Advances in Face Detection ", Tachincal Report , June 2010 , MSR-TR-2010-66.

[4] W.Zhao , R.Chellappa , P.J.Phillips and A.Rosenfeld ," Face recognition : A Literature Survey ", ACM computing surveys , Vol 35, No 4 , December 2003 , pp 399-458

[5] M.Samer Charifa , Ahmad Suliman and Marwan Bikdash, "Face recognition using Hybrid General Back propagation Neural Networks " , 2007 IEEE International Conference on Granular Computing .

[6] Isaque Q, Monterio , Samy D, Queiroz , Alex T Carneiro , Luis G. Souza and Guilherme A Barreto " Face Recognition Independent of Facial Expression Through SOM- Based Classifiers" , vi International Telecommunications Symposium (ITS2006) , September 3-6 , 2006 , Fortaleza –Ce Brazil.

[7] Mohamad Amin Bakshali , Mousa Shamsi , Amir Golzarfar , " Application of SOM network to study Facial Skin segmentation after Facial Surgery " 2012 IEEE Symposium on Industrial Electronics And Application (ISIEA2012) , September 23-26 2012 , Bandung , Indonesia.

[8] Rajandeep Kaur , Vijay Dhir , "Fuzzy Logic Based Novel Method of Face Detection " , International Journal Of Latest Research In Science & Technology , Vol 2, Issue 1 ,Page No 5558-566 , January-February (2013).

[9] Gi Pyo Nam and Kang Ryoung Park " New Fuzzy-based Retinex Method for illumination Normalization of Face Detection " ,International Journal Of Advanced Robotics System 2012 , Vol 9 ,103:2012

[10] Shwetha Mehta , Shailender Gupta , Bharat Bhushan and C.K.Nagpal , "Face Recognition Using Neuro-Fuzzy Inference System ", International Journal Of Signal Processing , Image Processing and Pattern Recognition , Vol 7 , No 1 (2014) , pp 331-344.

[11] Prashanth.R.S and Saritha.R , " Face Recognition in Eigen Domain With Neuro-Optimization " , International Journal Of Image Processing and Vision Science Vol 1, Issue -2 , 2012.

[12] Raidah Salim ," Neuro Fuzzy Network and Wavelet Gabor For Face Detection " , Journal Of Kufa for Mathematics and Computer Vol.1 , No.8 , Dec,2013,pp 48-57