Face Recognition Systems using Neural Network and Adaptive Neuro-Fuzzy Inference System (ANFIS)

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Abstract- This paper present techniques for recognizing faces, Haar Discrete Wavelet Transform (HDWT) with its three levels, Scale Invariant Feature Transform (SIFT) and Histogram of Oriented Gradient (HOG), all of them are using with Principal ComponentAnalysis PCA for Feature Extraction..
Neural Network and Adaptive Neuro-Fuzzy Inference System (ANFIS) methods are used for classification. The YALE Database with 20, 30 and 37 subjects are used in this paper for the two classified methods. The experimental results give that the use of ANFIS method with various subjectsis achieved better performance than others methods.

Keywords- face Recognition, classification, DWT, Haar, SIFT, HOG, PCA, Back-propagation Neural Network, Neuro-Fuzzy, ANFIS.

I. INTRODUCTION

The usage of artificial intelligence has been appliedwidely in most of the fields of computation studies.Main feature of this concept is the ability of self-learningand self-predicting some desired outputs.The learning may be done with a supervised or anunsupervised way. Neural Network study andFuzzy Logic are the basic areas of artificialintelligence concept. Adaptive Neuro-Fuzzy studycombines these two methods and uses theadvantages of both methods[16].

II. LITERATURE REVIEW

In the end of 2013 Monyah Arasiand others used DCT & DWT for feature extraction & Neural Network for classification and have the recognition rate about 95.33%[3].
In 2016 Ms. PooJABS and othersused haar wavelet analysis for extract the features and Artificial Neural Network Is based on face recognition , feature extraction and categorization , they used ANN feed forward back propagation they minimize the total of time for detecting and increase the accuracy[5].
In December 2013 RaidahSalim used wavelet Gabor filter for extract features and Neuro-Fuzzy system used as classifier depending on the features that extract. He conclude that " the best detection rate is 89.3% in case threshold equal 0.2 and no of fuzzy set = 2 "[6].
In 2014 Rakesh Aditya and othersconclude that an image fusion algorithm based on combination of DWT and PCA with morphological processing will improve the image fusion quality and may be the future trend of research regarding image fusion [8].
In 2014 Jakub Kone_cn and othersconclude that the results seem to have lower varianceerror rate at difficultdata sets, but struggle to obtain strong recognition rate oneasy data sets [9].
In 2015 M. Yuvaraju concludes that The SIFT algorithm produces the better results for multi scale images and the time taken to extract the features from the image is fast. In order to reduce the time for feature extraction a histogram method is needed and the Object recognition and stereo matching are also done using this algorithm. The other parameters like accuracy are also measured using this algorithm[10].
In mid of 2016 Salam Hamdan and others publish paper for human face detection based on Eigen face for skin detection &Neuro- Fuzzy for face recognition and the overall performance of the system was 95%[12].

III. FEATURES EXTRACTION AND RECOGNITION METHODS

A. Features Extraction techniques

i. HAAR Wavelet Transform technique

The Haar waveletTransform (HWT) is one of the simplest and basic transformations from the space domain to a local frequency domain. A HWT decomposes each signal into two components, one is called average (approximation) or trend, and the other is known as difference (detail) or fluctuation [13].

In this paper HWT techniques are used to extract features of the same Facesfor classification.
The image of the face decomposes into four sub bands:
Approximation details (LL), horizontal details (LH), vertical details (HL), diagonal details (HH). DWT canbe repeated many times for multiple levels of resolution by more decomposition of LL sub band as shown in Figure 1.

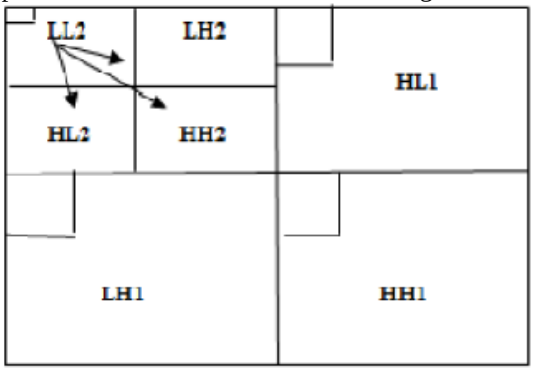

Fig.1: Decomposition of Original Image [14].

B. Histogram of oriented gradients(HOG)

Histogram of oriented gradients (HOG) is a feature descriptor used to detect objects in computer vision and image processing. The HOG descriptor technique counts occurrences of gradient orientation in localized portions of an image - detection window.As shown in Figure 2.

The underlying idea is that the appearance and shape of a local object can often be characterized rather well by the distribution of local intensity gradient (or edge) directions, even without precise knowledge of the corresponding gradient (or edge) positions. In practice this is implemented by dividing the image window into small spatial regions ("cells"), for each cell accumulating a local 1-D histogram of gradient directions (or edge orientations) over the pixels of the cell. This can be done by accumulating a measure of local histogram "energy" over larger spatial regions ("blocks") and using the results to normalize all of the cells in the block [9].

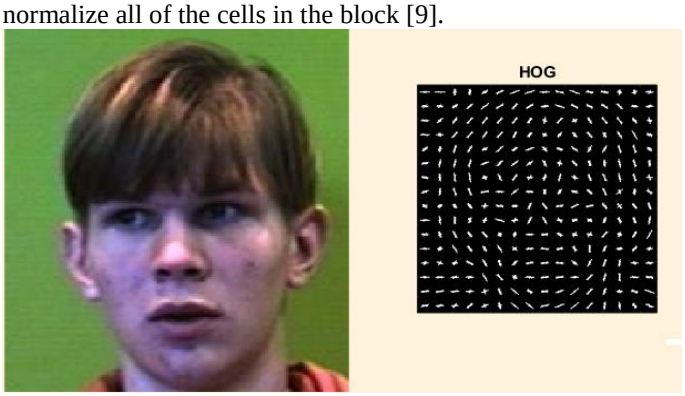

Fig.2: Example visualization of the HOG features

C. Scale invariant feature transform (SIFT)

Scale invariant feature transform (SIFT) is one of the features extraction algorithms. The derived values are built from the features extracted from initial set of data.

Scale Space Extreme Detection , Key point Localization , Orientation Assignment and Key point Descriptor are the four main steps of SIFT algorithm .Key points of extractedfeaturesare shown in figure3

The extracted features are informative, non-redundant and are functions of measurement variables which are widely used in the field of image classification and pattern recognition.

SIFT algorithm can be divided into two major modules they are key point detection Module and descriptor generation module [10].

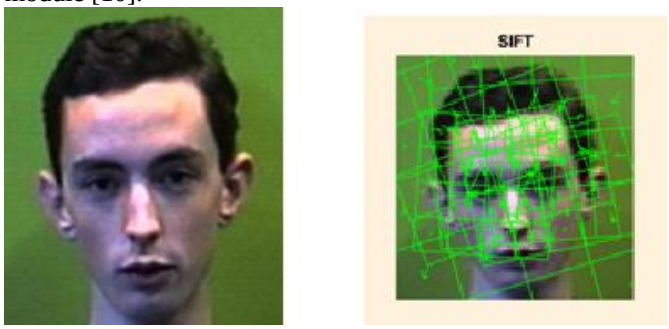

Fig.3: Example visualization of the SIFT features.

D. Principal Components Analysis PCA

To reduce data dimensions given from (Haar DWT, HOG and SIFT) features extractions methods in this paper used PCA mathematical formulation. Once patterns are found, they can be compressed, i.e., their dimensions can be reduced without much loss of information. In summary, a digital image compression algorithm with a low level of loss hasbeen used in the PCA formulation. The reduced dimension computational structure is selected so that relevant data characteristics are identified with little loss of information. Such a reduction is advantageous in several instances: for image compression, data representation, calculation reduction necessary in subsequent processing.

PCA, also known as KarhunenLoeve expanion, is a classical feature extraction and data representation technique widely used in the areas of pattern recognition and computer vision such as face recognition [15].

IV. RECOGNITION METHODS

A. NEURAL NETWORKS

Neural network is a model of reasoning based on the human brain which consists of a densely interconnected set of nerve cells, or basic information-processing units, called neurons. Some methods of back propagation work slowly, but some are faster. The training resilient back-Propagation (Rprop) algorithm eliminates the harmful effect of having small slope at the extreme ends of sigmoid squashing transfer functions. Only sign of the derivative of the transfer function is used to determine the direction of the weight update; but the magnitude of the derivative has no effect on the weight update.

This paper use Back Propagation Neural network(BPNN) method to recognition the faces with 128 inputs and 37 outputs with one hidden layer which has 5 neurons as shown in Figure 4 .

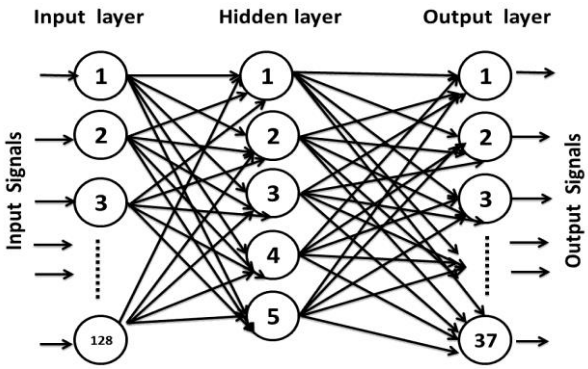

Fig.4: Architecture of Neural Network system.

B. Adaptive Neuro-Fuzzy Inference System (ANFIS)

Natural complementary tools in buildingintelligent systems were Fuzzy logic and neural networks. Fuzzy logic deals with reasoning on a higher level, using linguistic information acquired from domainexperts. Neural networks are low-level computational structures that perform well when they are dealing with raw data, however, fuzzy systems lack the ability to learn and cannot adjustthemselves to a new environment. On the other hand, although neural networkscan belearnt, they are opaque to the user. The merger of a neural network with afuzzy system intowhich one integrated system offers a promising approach tobuilding intelligent systems. Integrated Neuro-fuzzy systems can combine theparallel computation and learning abilities of neural networks with the humanlikeknowledge representation and explanation abilities of fuzzy systems. Figure 5 showANFIS that corresponds to this model.[17]

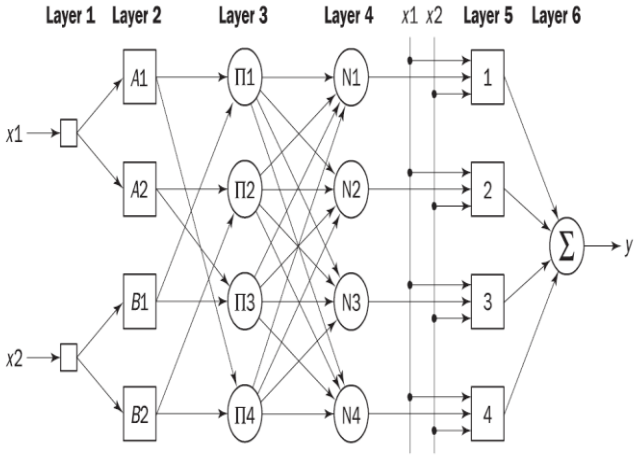

Fig.5: Adaptive Neuro-Fuzzy Inference System (ANFIS) [17]

V. EXPERIMENTAL RESULTS AND DISCUSSION

a. Database Description

The pictures of faces have taken from YALE data base [16],in the beginning twenty subjects (persons) with twenty images(different positions) for each one are trained and tested for extracting the features. Next the images are increased to thirty subjectsand thirty seven subjects with twenty images for each one.Finally, the process of recognition is calculated for each suggested method.

b. Methodology of classification :

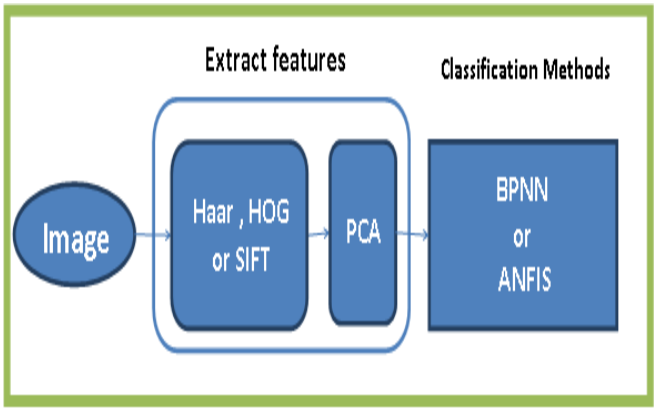

Fig.6: the plan of the classification

Figure6 shows the plan of the classification, firstly the features have been extracted by using Haar DWT feature Extraction method with its three levels. Next the features is processed by the PCA function for reducing.Finally the features have been classified by using BPNN or ANFIS.

c. Feature Extraction

There are a lot of techniques for extracting the features from the images.This paper used Haar (DWT) with its three levels, Histogram of oriented gradients (HOG) and Scale invariant feature transform (SIFT) to extract the features. The PCA is used to reduce the given data dimensions.

d. Face Classification

The paper used two methods for training and classification:

1) Neural Networkback propagation method (BPNN).

The model of BPNN used number of entriesis equal to 128 and the hidden nodes are five with one layer.

2) Adaptive Neuro-Fuzzy Inference System (ANFIS).

This method has combined the advantages of two methods Neural Network and Fuzzy logic.

e. Discussion and Results :

i. Neural Network

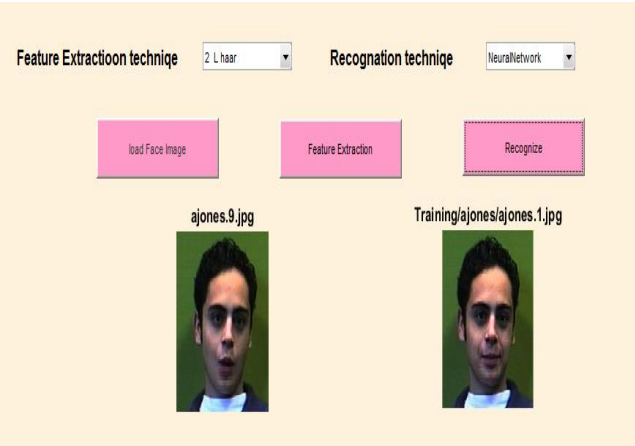

Fig.7: The interfaceof Neural Network Recognition system

Figure7 shows the interfaceof Neural Network Recognition system.The images are loaded, the features are extracted by one of this methods Haar (1st – 3d levels), SIFT and HOG. All of these methods are recognized by Neural Network.The recognition rate is calculated by the following equation:

$$\text{Recognition Rate} = \frac{no\ of\ correct\ Recognition\ faces}{total\ of\ recognition\ faces}$$

Table 1 : recognition rates for Neural Network with Haar ,SIFT and HOG methods

Sub	Recognition Rate				
	Haar (DWT)			SIFT	HOG
	level 1	level 2	level 3		
20	65.71 %	60 %	54.29 %	40.71%	56.43%
30	49.52 %	52.86 %	47.62 %	26.67%	51.91%
37	40.93 %	46.72 %	45.56 %	15.83%	35.13%

The Results of recognition rate for Neural Network method are given in Table (1):

1- With20 subjects, Haar (level1) gives better result than the other, which is equal to 65.71%.
2- With30and 37subjects, Haar (level2) gives better result than the otherwhich are equal to 52.86% and 46.72% respectively.
3- The recognitions with SIFT and HOG gives lessrecognition rates .

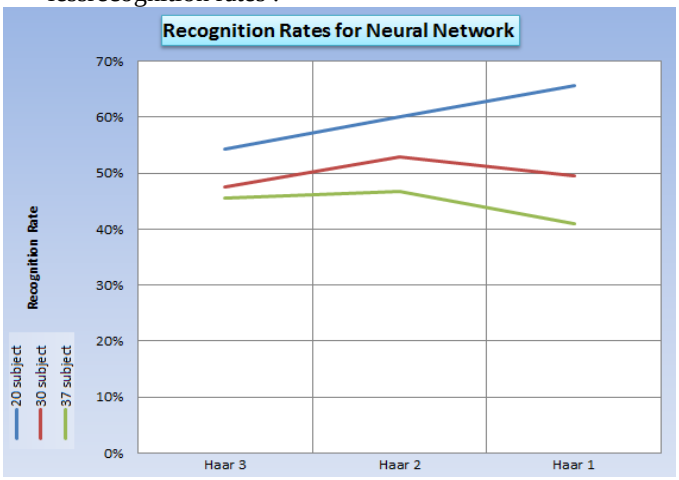

Fig.8: The recognition rates for Neural Network with Haar

Figure 8 shows therecognition rates for Neural Network Recognition system with three levels of haar , Haar (level 1) gives good results than others at 20 subjects and Haar (level 2) gives good results than others at 30 and 37 subjects.From these results we can conclude that the recognition rates are not enhancing with increasing the subjects.

f. Adaptive Neuro-Fuzzy Inference System (ANFIS)

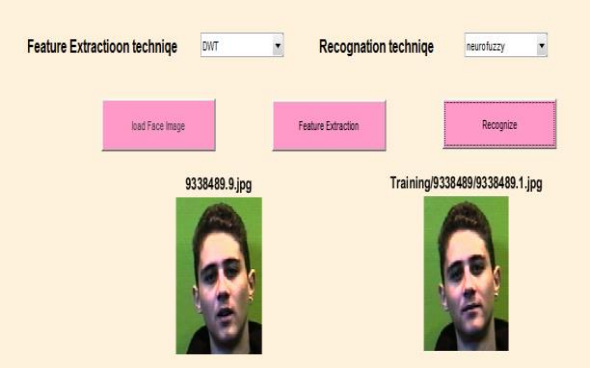

Fig.9: The interfaces of Neuro-Fuzzy (ANFIS) Recognition system

Figure 9shows the interface of ANFISrecognition system.All faces are recognized in this system byusingANFIS methodand the recognition rate is calculated to get good results as given in Table 2.

Table (2) : recognition rate for ANFIS with Haar ,SIFT and HOG methods

Subjects	Recognition Rate				
	Haar (DWT)			SIFT	HOG
	level 1	level 2	level 3		
20	99.98 %	99.98 %	99.98 %	97.69 %	99.64 %
30	99.52 %	99.52 %	99.52 %	95.71 %	99.52 %
37	95.37 %	95.37 %	95.37 %	89.96 %	95.37 %

Therecognition rate for ANFISis given in Table (2) with three features (DWT, SIFT and HOG) extraction methods. The result with20 subjects and with three levels of Haar gives better value(99.98 %) than the others.

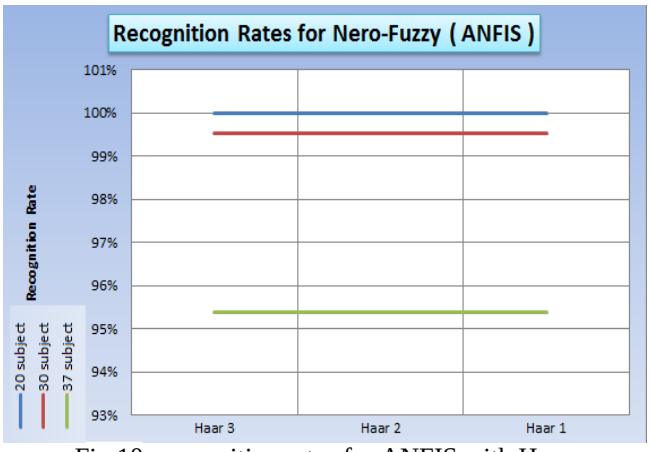

Fig.10: recognition rates for ANFIS with Haar.

Figure 10 shows the recognition rates for ANFIS Recognition system with Haar. All the three levels of the Haar method give good results but with 20 subjectsthe result is better than others. From these results we can conclude that the results are not enhancing with increasing the subjects. But the values of recognition rate in this ANFIS method are appropriate even the subjects are increasing.

VI. CONCLUSION

In this paper,the comparison of using Hybrid Neuro-Fuzzy (ANFIS) and Neural Network recognition systems (BPNN)are presented with usingthree levels of Haar,SIFT and HOG Extracting method. The Principal Components Analysis (PCA) is used to reduce the data. With 20 subject, the models (BPNN and ANFIS) give better result, but the results are not enhancing with increasing the subjects over 20 subjects. The Neural Network Recognitions modelwith SIFT and HOG give lessrecognition rates.

The recognition ratewith ANFIS model gives better result thanBPNN model.

VII. REFERENCES

[1]. Rafael.C.Gonzalez,RichardE.Woods,Digital Image Processing,second ed, Prentice Hall 2002.
[2]. Akram A. Moustafa, Ziad A. Alqadi and Eyad A. Shahroury, “Performance Evaluation of Artificial Neural Networks for Spatial Data Analysis”, Wseas Transactions on Computers, Issue 4, Volume 10, April 2011.
[3]. MunyaAbdulmajidArasi, "Mathematical Models for Face Recognition" MSc thesis in November 2013.
[4]. Tadi. Chandrasekhar&Ch.sumanthKhumar " Face recognition using fuzzy Neural Network " 2016
[5]. Shweta Mehta, Shailnder Gupta , Bharat Bhushan &C.k. Nagpal;" Face recognition using Neuro-Fuzzy iterance system "2014
[6]. Bubakir Almuftard, Abdulsalam Ambrek & Khadija Alshari “Handwritten Numeral recognition using wavelet transform and neural network”2013.
[7]. Jawad Nagi, Syed Khaleel Ahmed and Farrukh Nagi, ”A Matlab Based Face Recognition System using Image Processing and Neural Networks”, 4th International Colloquium on Signal Processing and its Applications, March 7-9, 2008, Kuala Lumpur, Malaysia.© Faculty of Electrical Engineering, UiTM Shah Alam, Malaysia.
[8]. Rakesh Aditya Mitra Hirve publish paper entitled " A Comparative Analysis of Wavelet Transform & PCA Image Fusion Techniques " 2014 in IJEDR | Volume 2
[9]. Jakub Kone_cn_ and Michal Hagara publish paper entitled " One-Shot-Learning Gesture Recognition using HOG-HOFFeatures "2014
[10]. M. Yuvaraju and K. Sheela Sobana Rani publish paper entitled Feature Extraction of Real-Time Image Using Sift Algorithm " 2015 in International Journal of Research in Electrical & Electronics Engineering Volume 3 .
[11]. Ms. PooJABS and Mr. ARJUN B C " Face Recognition Using Artificial Neural Networks (ANN) " 2016 .
[12]. Dr.Raidah Salim "Neuro Fuzzy Network and wavelet Gabor for face Detection" Dec- 2013
[13]. The Yale face database. Website. http://cvc.yale.edu/projects/yalefaces/ yalefaces.html.
[14]. Sanjay Kumar Dekate , Dr. Anupam Shukla " Face Recognition and Feature Detection Using Artificial Neural Networks and ANFIS" International Journal of Emerging Technology and Advanced Engineering Volume 5, Issue 7, July 2015
[15]. C. Li, Y. Diao, H. Ma and Y. Li, “A Statistical PCA Method for Face Recognition,” in Intelligent Information Technology Application, 2008, pp. 376-380.
[16]. ftp://ics.uci.edu/pub/machine-learningdatabases/auto-mpg
[17]. Michael Negnevitsky Second Edition (2005) " Artificial Intelligence A Guide to Intelligent Systems "