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Face Recognition Using Artificial Neural Networks

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***Abstract*-- The paper presents radial basis and back propagation based artificial neural network learning algorithms for solving face recognition problem. We have worked on AT&T database. The facial recognition system has been proposed to recognise the faces which are registered in the database and some new faces which are not part of the database. The basic objective is to understand the ability and capability of both the learning algorithms for face recognition task. Few experimental observations are also provided.**

Keywords: back propagation, Clustering algorithm, face recognition, particle swarm optimization, radial basis function network.

I. INTRODUCTION

Face recognition is used for automatically identifying and verifying a person from an image. Recognition of any person from an image can only possible by using face features. Face feature values are further stored in the database for biometric applications. One of the ways to do this by extracting the face feature values from an image and training of these feature values considered as training database using some learning method. Once training is complete, new images can be recognised using the information learnt during the training process.

Face recognition is very challenging task in real applications because "face images are highly variable so developing an automatic system to mimic the ability of human being has proven to be a very difficult task."[1]. "Variations between images of the same face due to illumination and viewing direction are almost always larger than image variation due to changes in face identity."[2].

Face recognition must be robust with respect to variability over a wide range of conditions to capture the essential similarities for a given human face [3]. Some statistical approaches implemented for this task but these are based on dimensionality reduction to remove redundant information from the original images. Some of the popular neural network techniques includes: back propagation neural network, radial basis function network, self organizing map etc [4].

The basic objective of this proposed work is to understand the ability and capability of some artificial neural network techniques for face recognition task.

This proposed system consists of three basic steps:

- Feature detection
- Feature extraction.
- Face recognition.

This proposed work has been done by using radial basis function network and back propagation neural network technique. The training process of radial basis function has been done with the help of particle swam optimization. Clustering algorithm (reservoir sampling) is implemented in this work for making centroid for RBFN.

II. LITERATURE SURVEY

Mayank Agarwal et all [1], had carried out a research on face recognition using back propagation neural network technique. They had been tested their proposed system on 400 images. They observed that their system was 97% accurate. They compared their results with k-means and fuzzy c-means. They concluded that their proposed system gave better results as compared to these two [1].

Meng joo er et all [2], had carried out a research on face recognition using radial basis function network. They had been used ORL database and extracted features by using principle component analysis. They observed that their system achieved excellent performance both in terms of error rate and learning efficiency [2].

Mohammod Abul Kashem et all [3], had carried out a research on face recognition using PCA with back propagation. They observed that their proposed system was more than 90% accurate. They had used face database with different sources of variations like: lighting, background, accessories etc [3].

N Revathy and T Guhan [4], had carried out a research on face recognition using back propagation neural network. They found that the system was invariant to changes in background and illumination conditions. Their results indicated that the conventional eigen face algorithm worked well when lighting variation was small. Its performance deteriorated significantly as lighting variation increased. The reason for this deterioration was that lighting variation introduced biases in distance calculations. When such biases were large, the image distance was no longer a reliable measure. But they concluded that their proposed system worked well in spite of the lighting variations [4].

Prof.K.Rama Linga et all [5], had carried out a research on face recognition using back propagation neural network and radial basis function network. Their proposed systems were tested on FERET database. They were used 120 faces for training and 80 faces for testing. They concluded that both the techniques were accurate for face recognition [5].

Priyanka Patidar [6], had carried out a research on face recognition using artificial neural network. She implemented back propagation neural network for recognizing the faces. She observed that her proposed system was very accurate as compared with existing face recognition systems [6].

Tej Pal Singh [7], had carried out a research on face recognition using back propagation neural network. He had been done his work using matlab. His proposed system was 85% accurate [7].

V.Radha et all [8], had carried out a research on face recognition using radial basis function network. She had been taken 200 images from ORL database and tested her

proposed system. She observed that her system was 98% accurate for face recognition [8].

Kiminori sato et all [9], had carried out a research on partial face recognition using radial basis function network. They had used database of 100 images. The results of their work were compared with back propagation neural network technique. They observed that radial basis function was far superior to back propagation technique for face recognition [9].

III. PROPOSED WORK

A. Learning algorithm 1(Radial basis function network)

Following are the steps in radial basis function network using particle swam optimization for face recognition task.

1. Centroid was calculated by using reservoir sampling.

For calculating centroid:

a Distance (d) was calculated between all adjacent face values from array. (Array included randomly picked clusters.)

b Average distance A was calculated by using following formula:

$$A = \sum d \ / \ N \qquad (3)$$

N is number of nodes in input layer, *d* represents calculated distance of all adjacent faces in array.

System will repeat this process again and again until we create best cluster (centroid) in the database/dataset.

(According to this algorithm, system will make cluster which has highest average distance.)

2. Width was calculated.

a For Calculating width first, we have to calculate Euclidean distance D between centroid.

$$D = (v1i - v2i) * (v1i - v2i) \qquad (4)$$

b Now calculate width W.

$$W = \sum D / C \qquad (5)$$

W represents width, *D* represents Euclidean distance and *C* represents Number of combinations.

3. After making centroid and calculating width, the next stage is training of RBFN by using PSO:

4. The dimensions in the network :

$$\sum w = H / O \qquad (7)$$

$$M = H * O + b \qquad (8)$$

Here *w* is for weights, *H* for number of hidden nodes and *O* for number of output nodes.

M represents dimensions and *b* represents bias.

5. Random weight values were initialized for network.

6. Mean Square Error was calculated.

7. Euclidean distance was calculated between faces of dataset and centroid of system

$$D = \sum (v1 - c1)\text{^}2 + - - - - + (vn - cn)\text{^}2 \qquad (9)$$

8. outputs of hidden layer

$$r = 1.0 * D\text{^}2 / 2 * W\text{^}2 \qquad (10)$$

$$G = \exp(r) \qquad (11)$$

.

9. 'D' was calculated between all the faces of dataset and all the centroid of the system. .

10. Final outputs of the system:

$$Y = \sum (h1 * w1) + - - - - + (hn * wn) + b \qquad (12)$$

11. Softmax Function was implemented.

$$S = \sum (v - t)\text{^}2 \qquad (13)$$

12. By using softmax function Mean Square Error was calculated for all the face values.

Now average mean square error:

$$AM = \sum (Ms1 + - - - - + Msn) / NN \qquad (14)$$

NN represents training length and *Ms* Represents mean square error.

13. Until the system found its stopping condition we have to update the weights and bias values and again perform the previous steps.

Formula for weight updating and bias updating is:

$$NW = (w * v) + (c1 * r1 * (b - p) + (c2 * r2 * bg - cp) \qquad (15)$$

$$bias = bias + newv \qquad (16)$$

Here *v* represents velocity, which point out next position in the particle.

B. Learning algorithm 2(Back propagation neural network technique)

Following are the steps in back propagation technique for face recognition task:

1. Weight values were initialized.

2. Hidden node results were calculated by using following formula.

$$z = voj + \sum xivij \qquad (17)$$

Z is local outputs of hidden layer. x represents input values and v represents weights.

3. Outputs of the system

$$yink = wok + \sum zjwjk \qquad (18)$$

Yink represents outputs. *W* represents weight values and *Z* represents inputs of hidden layer.

4. Back propagate errors

$$\delta inj = \sum \delta jwjk \quad (19)$$

5. Until the system found its stopping condition we have to update the weights and bias values and again perform the previous steps.
6. Update weight values.

$$Wjk(new) = Wjk(old) + \delta Wjk \quad (20)$$

W represents weight values.

Fig.1 is a network topology or architecture of radial basis function network. We have one input layer, one hidden layer and one output layer in our system. X0 to X3 are four inputs to the network because we use four feature extracted values of face as an input to the network. There are five hidden nodes and each hidden node includes two parameters: centroid value and value of width because these parameters were used in calculating the outputs of hidden nodes. Y0 to Y2 are outputs of the network. These were calculated with the help of radial basis function. All the nodes in the network are connected with each other.

Fig.2 is network topology of back propagation. We have one input layer, three hidden layers and one output layer in this network. All the nodes in the network are connected to each other. Nodes in the input layer depend upon the feature values of the face. Input layer accepts input in the form of feature values. Hidden layer process these values and generate output to the next level layer. Output layer generate the final output of the system in the form of image values. Training process of the system starts from input layer to output layer throughout the hidden layers. When training process is complete, then our system is ready for recognizing the faces.

C. Network topology:

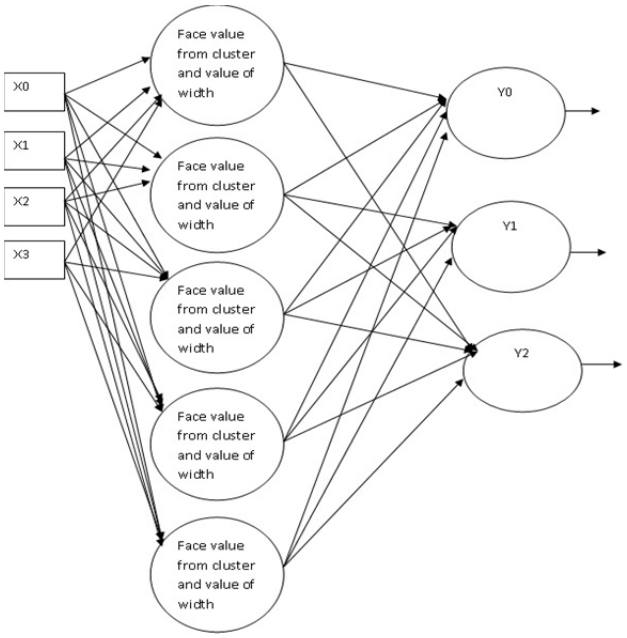

fig1 Radial basis function network

D. Network topology:

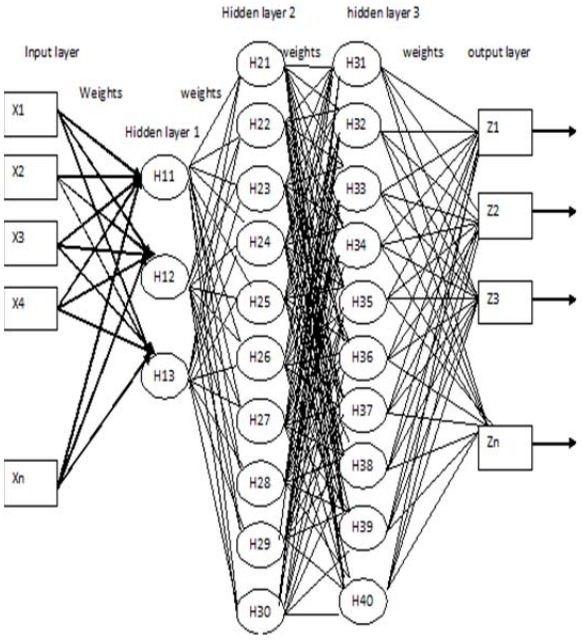

fig2 Back propagation neural network.

IV. RESULTS AND OBSERVATIONS

Following are the results of proposed work of back propagation neural network technique and radial basis function network with particle swam optimization.

In table I, when learning rate parameter is set to be 0.1 then accuracy of the system is 95% and iterations are 11000. When learning rate increased from 0.1 to 0.5 then accuracy of the system is 89% and iterations are 8500. It means when learning rate parameter will increase then accuracy of the system will decrease. But system will take less time in the execution.

In table II, when the network have only one hidden layer at that time system is only 61% accurate and take more time in execution. If there are three hidden layers in the network then accuracy of the system increased to 89% and iterations are decreased to 3000. It means when we increase hidden layers in the network then system will more accurate and take less time in execution.

It means some parameters of BPN affect the performance of the whole network.

In table III, when we have training ratio 60-40 then BPN system is 81% accurate but RBFN with PSO is 75% accurate. When ratio increased to 90-10 then accuracy of BPN system is 91%. And RBFN system is 99% accurate for face recognition. It means in case of large training length RBFN is more accurate than BPN.

In table IV, centroid is most important parameter of RBFN. When we have five centroid in the system then system is 99% accurate but in case of eight centroid system is less accurate. So it means, centroid parameter also affects the accuracy of the system.

TABLEI **Effects Of Hidden Layers In BPN**

Input neurons	Training length	Number of hidden layers	Accuracy	Iterations
04	100	01	61%	10000
		02	77%	8000
		03	89%	3000

TABLEII **Effects Of Learning Rate Parameter In BPN**

Training length	Learning rate	Accuracy	Iterations
100	0.1	95%	11000
	0.5	89%	8500
	1.0	70%	5000

TABLEIII A**ccuracy Of BPN And RBF On The Basis Of Training Size Ratio**

Training size	RBF Accuracy	BPN Accuracy
60-40	75%	81%
80-20	83%	91%
90-10	99%	93%

TABLEIV A**ccuracy Of RBFN On The Basis Of Centroid**

No.of input neurons	Training length	Number of centroid	Accuracy
04	100	05	99%
		07	99%
		08	66%

Observations:

- In this proposed work we observed that accuracy of BPN network for face recognition task can be increased by using its parameters.
- Both the techniques are accurate for face recognition.
- In case of small database BPN is more accurate but when we have large set of images in the database that time radial basis function with PSO is more accurate than BPN.
- RBFN has taken less time in face recognition as compared to BPN.

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V. CONCLUSION

On the basis of this study, we have been validating an accuracy of both the techniques in face recognition task. Both the techniques are accurate for this task but in case of large training length radial basis function network with particle swam optimization are more accurate as compare to back propagation technique.

We observed that some parameters of both algorithms can be adjusted to control up the network and an accuracy of the system can be increased with the help of parameters.

But there is need to evaluate some other parameters of these two techniques for better and applicable results.

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