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FACE RECOGNITION USING NEURAL NETWORKS

NAVDHA VERMA*

*(Electronics and Communication, IGDTUW,DELHI
Email: navdhaverma16@gmail.com)

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Abstract:

. This paper proposes an approach for recognizing human faces. The face detection technique is implemented using artificial neural network, where we use Principal Components Analysis (PCA) for dimensionality reduction of the image and can be represented as the Eigen faces coordinate space, i.e., face image can be divided into a number of pixels and plot them according to eigenvector coordinates. Then the extracted law dimensional feature vectors are considered as the input patterns in back propogation neural network (BPNN) to classify the extracted features into one of the two possible classes: faces or non-faces. Human Brain can easily analyze vast array of faces from the images formed on the eyes and at the same time it is very difficult for a computer to locate the faces in a digital image. But in the present era of computation face detection is very useful in performing face recognition. In fact it is often said that face detection is one of the basic fundamental pillars of face recognition system, which is very challenging in real world applications. The experimental result shows that it is very efficient using PCA followed by BPNN for classification

Keywords **—** Artificial neural network, Back Propogation neural network, Eigen faces, Face detection, Face extraction, Face recognition, Principal component analysis

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I. INTRODUCTION

Face recognition is the problem of identifying and verifying people in a photograph by their face. It is a task that is trivially performed by humans, even under varying light and when faces are changed by age or obstructed with accessories and facial hair.

Nevertheless, it is remained a challenging computer vision problem for decades until recently. Deep learning methods are able to leverage very large datasets of faces and learn rich and compact representations of faces, allowing modern models to first perform and later to outperform the face recognition capabilities of humans [1].

Face detection is basically explained as determination of faces from an image using a certain search strategy under a complex background. It has many applications such as pattern recognition, video surveillance, interface applications and identification. The basic fundamental approach for face detection is to extract the law dimensional feature vectors from input patterns by the feature extractor (for this purpose we use PCA) and then classification of extracted features into one of the two possible classes: face or non-face using neural network approach.

Neural networks are used to recognize the face through learning correct classification of the coefficients calculated by the Eigen face algorithm. The network is first trained on the pictures from the face database, and then it is used to identify the face pictures given to it. This paper represents the development of a system which can identify the person with the help of a face using neural network technique.

II. FACE RECOGNITION SYSTEM

. A facial recognition system is a technology capable of identifying or verifying a person from digital image or a video frame or a video source. Artificial Intelligence based application that can uniquely identify a person by analysing patterns based on the person's facial textures and shapes [2].

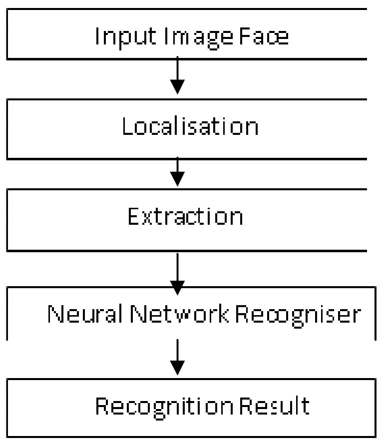

Fig 1 Block Diagram Of Face Recognition System

Input image is acquired by taking photographs using the digital camera. These images are taken in colour mode and saved in JPG format. However, the proposed method is suitable for working with any file format.

Face detection [3] is done by separating face areas from non-face background regions and facial feature extraction locates important feature (eyes, checks, lips, mouth, nose, forehead and eye-brows etc.) within a detected face. The fundamental steps of face detection system is as follows: Normalization[4] :

Alignment Finder: It is used to determine the basic features like head's position, size and pose of face, eye and nose etc. After extracting the feature we select a few combined features that was analysed and stored in different scales to construct a face. Pre-Processing: To speed up the detection process and reducing false positives (i.e., to reduce the variability) in face the images are pre-processed before they are fed into the network. The pre-processing step can reject an acceptable amount of non-face windows. Classification: Neural networks are implemented to classify and localize the faces or non faces i.e., BPNN is trained so that it gives +1 output value for face pattern and -1 value for non-face pattern. To optimize the results of different network configurations the classification procedure is used. Localization: The faces are then localized in a bounding box after searched by a trained neural network. Representation: The system translates the facial data into a unique code for implementation purpose. To detect faces of variable sizes and locations the detector needs to analyse the given input image in different scales. Each sliding window is examined to be of standard size of face or non-face image. The

Boltzmann machine can be thought of as a noisy Hopfield network. It is one of the first neural networks to demonstrate learning of latent variables (hidden units). Boltzmann machine learning was at first slow to simulate, but the contrastive divergence algorithm speeds up training for Boltzmann machines and products of experts.

A Boltzmann machine is a network of symmetrically connected, neuron-like units that make stochastic decisions about whether to be on or off. Boltzmann machines have a simple learning algorithm (Hinton & Sejnowski,1983) that allows them to discover interesting features that represent complex regularities in the training data. The learning algorithm is very slow in networks with many layers of feature detectors, but it is fast in "restricted Boltzmann machines" that have a single layer of feature detectors. Many hidden layers can be learned efficiently by composing restricted Boltzmann machines, using the feature activations of one as the training data for the next.

Boltzmann machines are used to solve two quite different computational problems. For a search problem, the weights on the connections are fixed and are used to represent a cost function. The stochastic dynamics of a Boltzmann machine then allow it to sample binary state vectors that have low values of the cost function.

For a learning problem, the Boltzmann machine is shown a set of binary data vectors and it must learn to generate these vectors with high probability. To do this, it must find weights on the connections so that, relative to other possible binary vectors, the data vectors have low values of the cost function. To solve a learning problem, Boltzmann machines make many small updates to their weights, and each update requires them to solve many different search problems.

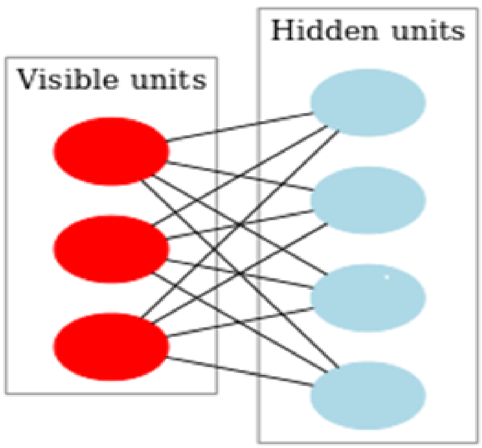

Fig 2 A restricted Boltzmann machine with fully connected visible and hid-den units.

III. METHODOLOGIES

A. *Principal Component Analysis*

. The Principal Component Analysis (PCA) [5] technique plays the important role in feature extraction and feature selection to improve the efficiency of classification. PCA is mainly used for dimensionality reduction of the pre-processed image. PCA from a statistical background is a method for (i) transforming correlated variables into uncorrelated variables, (ii) Finding linear combinations of the original variables with relatively large or small variability, and (iii) Reducing data. PCA [5] is a mathematical procedure that uses orthogonal transformation to convert a set of values of possibly correlated M variables (face images) into a set of values of K uncorrelated variables called Principal Components (Eigen faces). The number of principal components (Eigen faces- K) is always less than or equal to the number of original variables (face images M) i.e. K ⩽ M. Any face image can be (i) Represented as the Eigen faces coordinate space, i.e., face image can be divided into a number of pixels and plot them according to Eigen vector coordinates and (ii) Conversely face image can be approximately reconstructed using a small collection of Eigen faces.

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B. *Back Propogation Neural Network*

. The standard way to train a multilayer perceptron is using a method called back propagation. This is used to solve a basic problem called assignment of credit, which comes up when we try to figure out how to adjust the weights of edges coming from the input layer. Recall that in the single layer perceptron, we could easily know which weights were producing the error because we could directly observe the weights and output from those weighted edges. However, we have a new layer that will pass through another layer of weights. As such, the contribution of the new weights to the error is obscured by the fact that the data will pass through a second set of weights or values.

A common Back Propagation Neural Network [6] having multilayer feed forward with supervise learning network is shown in the figure 6 below. In case of training multilayer perceptron (MLP), Back-Propagation is the most well-known and widely used learning algorithm. The MLP points to the network consisting of a set of source nodes that produces the input layer, one or more hidden layers of computation nodes, and an output layer node [6]. At the input layer the pattern of face and non-face images is trained and then gradually distributed to the hidden layer and output layer. The weight at the input layer, associated with each neuron or processing element (PE) in the structure, multiplying with the corresponding interconnecting weights and serve as inputs to the PEs of the hidden layer. Similarly, the output from the PEs of the hidden layer, multiply with corresponding interconnecting weights and serves as input of the output layer.

Face Detection Using BPNN Algorithm:

The algorithm can be described below:

Step1. Read the image and divide it into equal parts of pixels.

Step2. Convert it into grey scale image and find the covariance matrix small dimension (transposed).

Step3. Find Eigenvectors and from Eigen faces, weights are calculated.

Step4. Each part is converted to binary numbers and fix the output for each vector.

Step5. Weight s and bias are initialized randomly for training of each part separately using neural network tool through MATLAB

. Step6. Calculate the output of each part from the previous step and apply it as an input to the next step.

Step7.The above steps are applied to the initial image without dividing it.

Step 8. Results obtained from step 4 and 5 are compared to check the accuracy of this approach.

Step9. The procedure below can adjust the weight in the network a) Using sigmoid activation function compare hidden layer and output layer neuron. b) Calculate the errors of output layer and hidden layer and then calculate the total error of the network. c) Repeat the steps of adjusting weights until minimizing the squared mean error. Adjust Weight is given by the equation:

$\Delta Wji(n) = \eta\, \delta j(n)\, yi(n)$, which is described later in back propagation algorithm and η is the learning rate

IV. Results

For the implementation of face detection technique MATLAB R2013a, Windows 8, Intel(R) Core i3, 4GB RAM is used.

In this project, we use 45% of images from FACES [21] data-base, where each image is of size 869x592, which is freely available on the website for research purpose and the rest are the personal group image. A two hidden layered back propagation neural network has been used, which are initialized randomly. We used single image data set in the experiment that may contain multiple faces within a background. Data set is used to train BPNN classifier and test the detection performance. Several training session have been conducted during our experiments, the training measures the performance on the basis of Mean Square Error (MSE) [22].With mean square error zero means that there is no error in the network and with the decreasing the values of MSE errors the network is considered as better one. During the experiment we use 20, 50, 100, 150 and 190 images datasets. The graphical representation is as shown in figure 10 below. The stopping criteria for MSE is set as 10-11. Table II shows the summery of MSE parameter's values used for BPN during training using 20, 50, 100 and 150 images

TABLE 1 Results On The Basis Of 100 Images

No of Images	False Accepance Rate	False Rejection Rate	Accurate Detection Rate
20	42.5%	15.02%	43.62%
50	33.90%	7.34%	69.89%
100	19.10%	5.38%	76.03%
150	6.89%	3.12%	78.82%

Calculations:

False Acceptance Rate (FAR) considers non-face data as face data, while False Rejection Rate (FRR) classifies face data as non-face data

False Acceptance Rate (FAR) =

Number of Incorrect Detected faces ÷ Total number of Actual Faces

False Rejection Rate (FRR) =

Number of Incorrect Rejected faces ÷ Total Number of Actual Faces

V. CONCLUSION

Under the pre-processing technique Skin Segmentation, Morphological Operation and

Component Labelling are per-formed before the process undergoes the PCA technique. It can be concluded from the experimental result that detection rate increases with increasing the number of images, whereas ARR and FRR decreases. When we considered 20 images dataset, the performance of the system is 43.62% with FAR and FRR of 42.75% and 15.02% respectively. On the other hand, the FAR and FRR decreases gradually for 190 images and that becomes 5.12% and 1.01% respectively and the detection rate reaches up to 85.01%, which is considered as the best detection rate result. From the above statements it can also be concluded that the number of dataset images is directly proportional to performance of the system. This technique is improved, when we properly done the pre-processing steps and PCA technique. So, for obtaining the better training and testing performance different classifiers can be used. Further development includes pattern recognition, face recognition, and other recognition system. This This technique can be enhanced by further refining the image in pre-processing. Different classifiers can be used for better training and testing results. a new face localization technique is proposed and a new feature extraction algorithm is developed for human face recognition. The neural network model is used for recognizing the frontal or nearly frontal faces and the results are tabulated.

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