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REAL-TIME FACE DETECTION AND RECOGNITION USING BACK PROPAGATION NEURAL NETWORK (BPNN)

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Abstract–

Face Recognition is one of the most important and fastest growing biometric area during the last several years and become the most successful application in image processing and broadly used in security systems. A real-time system for recognizing faces using mobile device or webcam was implemented. Face detection is the first basic step of any face recognition system. Viola-Jones method is used to detect and crop face area from the image. Feature extraction considered as a main challenge in any face recognition system. Principal Component Analysis (PCA) is efficient and used for feature extraction and dimension reduction. Back Propagation Neural Network (BPNN) and Radial Basis Function (RBF) are used for classification process. RBF is considered the result of BPNN output layer as input. The system is tested and achieve high recognition rates. Information about individuals was stored in a database.

Key Words:*Face Detection, Face Recognition, Feature Extraction, Biometrics, Neural Network, PCA, BPNN, RBF*

I.INTRODUCTION

Face recognition is definitely challenging investigation research area in computer vision and pattern recognition resulting from changes in facial expressions, poses variation, illumination and Imaging conditions. Build an automated system that equals human ability to recognize faces is a true challenge. Although humans are good to identifying known faces, but they are not very skilled when we have to deal with a large amount of unknown faces. The computers, with an almost limitless memory space and computational speed, should solve the problem of human limitations. Several applications, from law enforcement to commercial tasks, request the industry to improve and develop automated and efficient face recognition systems [1]-[2]-[3].Face detection is very important and it's the first step in face recognition system. Face detection is the process of figuring out whether or not a face is occurring in an image. Unlike face recognition which distinguishes different human faces, face detection only tell us whether or not a face is occurring in an image. Some applications of face recognition don't require face detection because in some cases face images stored in the data bases are already normalized [4]. The problem of face detection is definitely complex because of three types of the problem (view dependences, inconstancy, and lighting). Most of the suggested face detection methods have realized that the face and background includes some limitations, but these limitations made the suggested methods difficult in more general cases, so face detection remains to be an important problem to be solved [4]. There are lots of methods in this area. Many proposed methods are available to identify and recognize human faces form given face database. The current improvement in this area has facilitated us with fast processing ability and high accuracy. The hard work is also going in the direction to involve learning methods in this complex computer vision technology [5]. There are many existing systems to identify and recognize faces, but many systems are not so efficient to have automated face detection and recognition [5]-[6].

The technology of biometric recognition systems for individual identification normally change the input data acquired from irises, signatures, fingerprints, voiceprints, human faces, or otherbiometrics. The recognition of irises, signatures, fingerprints, voiceprints, and human faces is assigned to the passive methods that require the camera with a high resolution or acquire people biometric information at a short rang [7]. To making it possible for the system to extract facial features

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much more efficiently and properly, we have to narrow the range of face detection first, and the performance of the face detection method can't be too low [8]-[9].

Researchers have worked many years on the problem of face recognition, but several challenges still need to be solved. Difference in illumination of the scene, changes in pose, orientation and expression are some of the problems to be dealt very carefully. When the size of face database increases the recognition time will become a big problem [1]. Face recognition is furthermore just about the most successful applications in image analysis. As a result of the problem nature of face recognition, not only computer science researchers have an interest in it, but psychologists and neuroscientists are also interested. General opinion tells that improvement in computer vision research will offer useful ideas to psychologists and neuroscientists into how human brain works, and the opposite way round [10]-[5].

Face recognition methods can be divided into either Appearance based or Feature based methods. The Appearance based methods compare the input image with a set of templates using global facial information. The set of templates can be constructed using statistical tools like Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA), Support Vector Machines (SVM), Kernel Methods. The Feature-based methods use local facial features and their geometric relationships. Elastic Bunch Graph Matching (EBGM) method is used. There are methods developed using both Appearance based and Feature based called Hybrid methods. 3D morphable model method can use feature points or texture as well as PCA to build face recognition system [4]-[7]-[8].

II. RELATED WORK

Background Removal Process in our case sample images have solid background color like red, green, blue etc. The distributions of RGB pixel values are almost uniform. So, if we get the statistical Mean and Standard Deviation (SD) of small sample portion of the background and with the help of multiplying factor of SD we will get the total distribution range of RGB of background pixels.

To achieve this we have taken five sample blocks of the image:

1. Top Left Corner (TLC),
2. Top Middle (TM),
3. Top Right Corner (TRC),
4. Left Middle (LM)

5.Right Middle (RM). We have calculated Mean and SD of each of these five samples. The multiplying factor is determined by trial and error approach through extensive experimentationOur method uses rejection based classification. The face detector consists of a set ofweak classifiers that sequentially reject non-face regions. First, the non-skin colorregions are rejected using color segmentation. A set of morphological operations arethen applied to filter the clutter resulting from the previous step. The remainingconnected regions are then classified based on their geometry and the number ofholes.

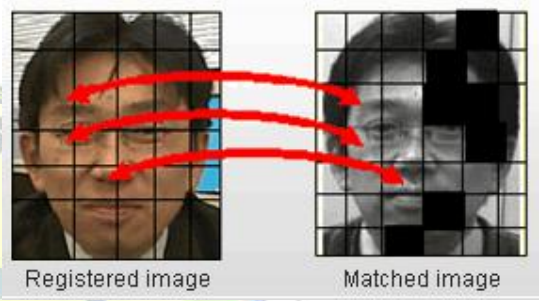

Fig : Blend Matching

FACE RECOGNITION APPLICATIONS

Face recognition is one of the most interesting and fastest growing biometric areas. Face recognition applications that automatically identify an individual from captured images or video stream are everywhere in our daily lives. Large number of applications has been present in face recognition research area [1]-[5]. Important face recognition applications are listed in Table 1.

#	Area	Applications
1	Information Security	Access security, data privacy, user authentication, email authentication on multimedia workstations
2	Personal Security	Home video surveillance system, expression interpretation
3	Biometrics	Automated identity verification, person identification
4	Access Management	Secure access authentication, permission based systems, access log or audit trails
5	Smart Card Applications	In lieu of maintaining a database of face images, face prints can be stored in a smart card, bar code, or magnetic strip and authenticated by matching the live

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		image with stored template
6	Law Enforcement	Suspect identification, suspect tracking, forensic reconstruction, video surveillance
7	Entertainment Leisure	Photo camera application, home video game system
8	Criminal Justice System	Post-event analysis and forensics
9	Multimedia Environments with Adaptive Human-Computer Interface	Part of ubiquitous or context-aware systems, behavior monitoring at childcare or senior citizen centers, and recognizing a customer and assessing the customer's needs

2.A GENERIC SYSTEM

The input of a face recognition system is usually an image or video stream. The output is an identification or verification of the individual or individuals that appear in the image or video stream. Several approaches define a face recognition system as a three step process as shown in Figure 1. Through this point of view, the Face Detection and Feature Extraction phases could run simultaneously.Face detection is considered as the process of extracting faces from scenes. So that, the system absolutely detects a certain image rectangular region as a face. This procedure offers several applications including pose estimation, face tracking or compression.Feature extraction includes acquiring relevant facial features from the data. These features could possibly be certain face regions, variations, angles or measures, and this can be human relevant or not. This phase offers other applications including emotion recognition or facial feature tracking.The Final step of face recognition system is measuring the distance by using classification method to determine the similarity between two images. The system will be able to recognize the faces. In an identification task, the system would report an identity from a database that contain information about the individuals

Fig: Face Recognition Process

III. SYSTEM IMPLEMENTATION

This section introduces the implementation techniques to detect face in the image and recognize it cordingly. The implementation technique is mainly divided into two parts.

A. Face Detection

B. Face Recognition

A. Face Detection The face detection procedure contains input images taken from databases available from internet, image pre-processing, hit miss transform & edge detection to locate face in the image.

B. Image Pre-processing: Image resizing and grayscale conversion is achieved in the pre-processing stage. All the images in database are of size 640x480 pixels. As we are using neural network in this work, there is need to reduce memory space. Hence to accomplish memory requirement, we have resized images to 180x180 pixel size. As morphological perations are grayscale dependent, it is necessary that we convert the color image into grayscale image. So after resizing the images are converted into grayscale. The following fig. 2 shows original database image & its resized grayscale image

C. Face-Detection Mechanism. The basic form of this algorithm follows a process that was very common among former people. The following two steps are performed: Using these techniques, the faces in the input images were recognized quite

D. Skin Detection – Since the training set and the final image are all full colour images, the is the separation of skin pixels from non-skin pixels can be accomplished quite effectively.

E. Template Matching – By running only the skin pixels through a template matching algorithm, the faces can be separated from other visible skin such as arms or legs more general circumstances, for this approach

F. Skin Segmentation The first step in the face detection algorithm is using skin segmentation to reject as much "non- image based on skin color: converting the RGB picture to YCbCr space or to HSV space. AYCbCr space segments the image into a luminosity componentand color components, whereas an HSV space divides the image into the three components of hue, saturation and color value. The main advantage of converting the image to the YCbCr domain is that influence of luminosity can be removed during our image processing. In the RGB domain, each component of the picture (red, green and blue) has a different brightness. However, in the YCbCr domain all information about the brightness is given by the Y-component, since the Cb (blue) and Cr (red) components are independent from the luminosity. The following conversions are used to segment the RGB image into Y, Cb,Cr components As the histograms show, there is a fairly distinct separation between skin and non-skin in the hue and saturation coordinates with less separation in

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the value coordinate. Using only the first two the face" of the image as possible, since the main part of the images consists of non-skin color pixels.

IV. IMPLEMENTATION OF PROGRAM FLOW

PROPOSED METHODOLOGY

Face recognition is a complex image processing problem in real world applications. The main challenge for a face recognition system is an effective feature extraction. In this work, a real time face recognition system based on Principal Component Analysis (PCA), Back Propagation Neural Network (BPNN) and Radial Basis Function (RBF) is proposed. Face detection is done using Viola-Jones method to detect and crop faces. The system is tested using images captured from mobile device or webcam. The process of the proposed system is shown in Fig

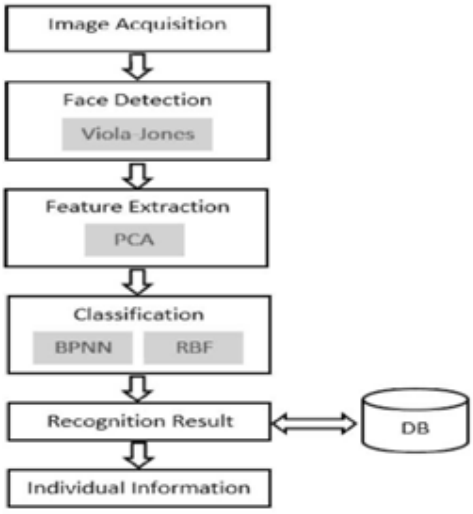

Fig : Image Acquisition

face. If enough of these features are found, then this particular window of the image is said to be a face [11].
Viola-Jones rescale the detector as an alternative for the input image and run the detector more than one time through the image each time with a different size. Viola-Jones have proposed a scale invariant detector which requires the equivalent number of calculations whatever the size. This detector is produced using integral image and some simple rectangular features similar to Haar wavelets[11]-[12].

Back Perception Analysis

Involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components (PCs) [6]. BPA solves the recognition problem within a representation space of lower dimension than image space. BPA is an Eigenface method which helps in the reduction the dimensionality of the original data space.

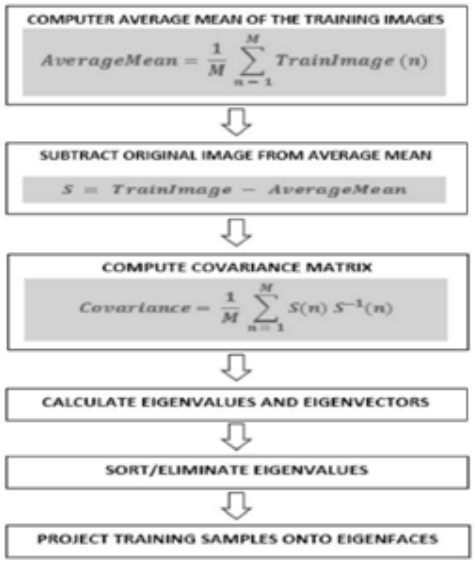

Fig : BPA Flow

Back Propagation Neural Network (BPNN)

Neural network aims to train the network to achieve a balance between the network ability to respond and the ability to give a reasonable response to the input that is similar but not identical to the one used in the training [13].

BPNN consist of three layers (input layer, hidden layer and output layer). These layers of elements put together independent computation of data and pass it to another layer. The computation of processing elements is completed on the basis of weighted addition of the inputs. The output is compared with the target value and the mean square error is computed which is certainly processed back to the hidden layer to adjust its weights. This process would be having iteration for each and every layer to decrease the error by repeatedly adjusting the weight of each layer [14]. A typical BPNN with Multi-layer feed-forward supervised learning is shown in Fig. have recently attached extensive research interest in the community of neural. The RBF neural network has a feed

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forward architecture with an input layer, hidden layer and output layer. The result obtained from the BPNN output layer is given as the input to the RBF [15]-[16].

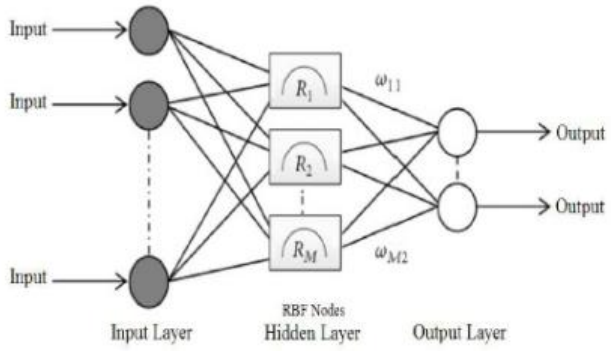

Fig : BPNN

Classification part is performed using RBF. A network with radial basis function is an artificial neural network that uses radial basis function as activation functions. The function of an RBF-NN can be viewed as a process which maps a non dimensional input pattern from input space to a decision space of m-dimension. The training is done by adjusting the center parameters in the radial basis functions that will be used to calculate the connection strengths between the hidden layer and output layerfor classifying the images because of its simple structure and faster learning abilities. The RBF classifier is a hidden layer neural network with several forms of radial basis activation functions. In a RBF network, a neuron of the hidden layer is activated whenever the input vector is close enough to its center vector [16]-[18]. The most common form is the Gaussian function defined by the equation below:

$$(Fx)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k} \text{----(1)}$$

Where the width parameter, u is is the vectordetermining the center of basis function F and x isthe n-dimensional input vector.

V. RESULT AND DISCUSSION

In this work, images that contain faces are taken using 8 megapixel iPhone 6 camera or webcam. Images are converted from JPG to PNG format. PNG support lossless data compression. The size of images taken from iPhone 6 camera is 2448 * 3264 pixels. Viola-Jones face detection method shows the ability to detect faces and cropping them. Once the face is detected from images, cropped faces can be trained and store in database. Images captured from mobile device or webcam are detected and cropped. After that, feature extraction is done using PCA. PCA method is used to calculate the Eigen face. After finding Eigen faces for trained face images, Eigen face for input test image will be also calculated. Finally, classification process is done using BPNN and RBF-NN. The combined model ofBPNN and RBF-NN recognize all faces. System performance was very good and able to detect and recognize faces.

Software and Hardware Implementation

The analysis is done using a laptop with Intel(R) Core(TM) i3-5500U CPU 2.40 GHz with 12.0 GB RAM. The programming language MATLAB R2015a is utilized to build the application program. The operating system is Windows 8.1 Single Language. The face image snapshots have been taken using 8 megapixel iPhone 6 camera with 1.52m pixel size.

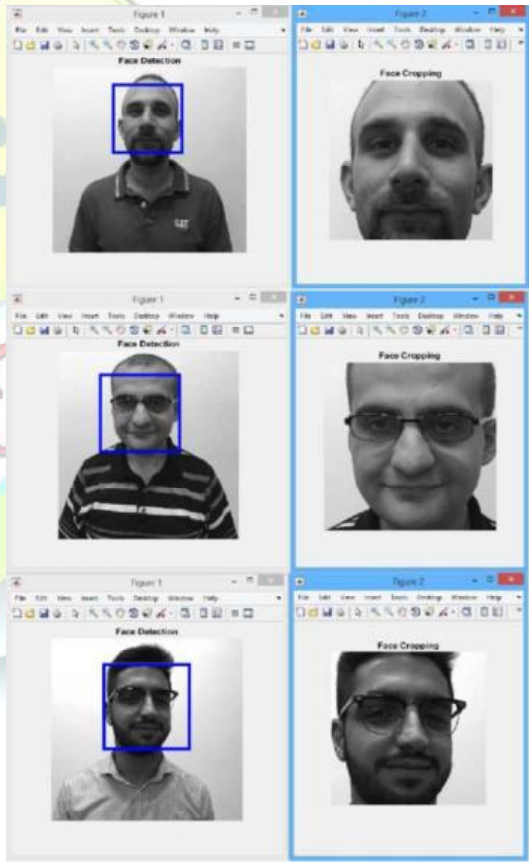

Fig : Face detection BPNN

Once the face is detected from images, cropped faces can be trained and store in database. Three images will be used as training images and only one image will be used as testing image. Increasing the number of training

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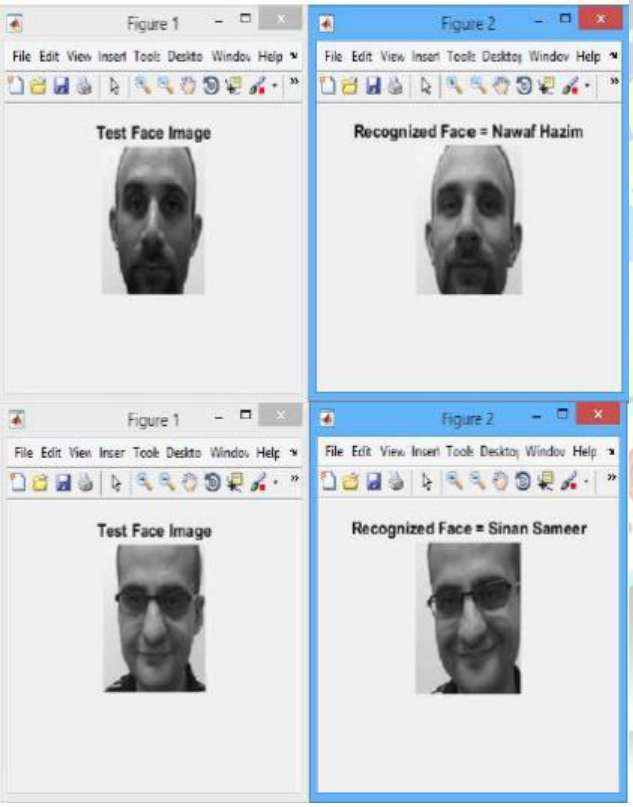
images will increase the recognition rate. Trained face images are shown in fig.

Classification Using BPNN and RBF

The classification is performed in a low dimensional feature space through the use of BPNNand RBF-NN. Neural networks are actuallyemployed and compared to typical classifiers for avariety of classification problems. The results showthat the accuracy of the neural network methodsequal or slightly better than other methods likeEuclidean distance and Mahalanobis distance. RBFcomes up with the best performance while allowingless neurons in the hidden layer. The system canrecognize faces and give information from thedatabase about the recognized person.



and RBF-NN. Neural networks are actually employed and compared to typical classifiers for a variety of classification problems. The results show that the accuracy of the neural network methods equal or slightly better than other methods like Euclidean distance and Mahalanobis distance. RBF comes up with the best performance while allowing less neurons in the hidden layer. The system can recognize faces and giveto detect and crop facesin the images taken from mobile device or webcam.The method was able to detect all faces fromimages taken from mobile device and webcam.

VI. CONCLUSION

In this work, a real-time face recognition systemis implemented. Images are captured from a mobiledevice or webcam. Face detection is the first step inface recognition system. Viola-Jones method is used for face detection. BPA is used for feature extraction. Classification process is done using BPNN and RBF-NN. The neural networks aimed to provide artificial intelligence to the system. Neural networks using Back Propagation and Radial Basis Function is presented for face recognition. The BPNN method is preferred over other neural network methods because of its unique ability to minimize errors. The use of BPNN shows acceptable results. The recognition rate is increased when combine BPNN with RBF-NN. From these results, it can be concluded that this method has the acceptance ratio is more than 90 % and execution time of only few seconds. The results of the experiments indicate that the RBF-NN achieves the best performance while allowing less neurons in the hidden layer. The RBF-NN method shows also to be less sensitive to the choice of the training set. This method can be suitably extended for moving images and the images with varying background.

Future work

Future work must involve finishing the implementation discussed in this report. Once working a full usability tests and tests measuring the accuracy and robustness of the tracker can be assessed.

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