FACE RECOGNITION SYSTEM USING PRINCIPAL COMPONENT ANALYSIS AND BACK PROPAGATION NEURAL NETWORK

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STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

…… ……

Date Su Sandar Win

ABSTRACT

Face recognition is a computer application which is used to indentify or verify a person in a digital image, based on digital image processing and is an active area of research. The face recognition system proves to be efficient in criminal identification, data privacy, home video surveillance systems etc. Various innovative face recognition systems have been developed so far using a wide range of algorithms. An efficient method of face recognition using Principal Component Analysis and Back Propagation Neural Network is presented in this work. In this work Principal Component Analysis (PCA) is used to extract the facial features and Back Propagation Neural Network is used for classifier to act the recognized image. This system is developed as mobile application.

Face recognition on mobile phones are constantly improving and the majority is currently equipped with digital camera. This facilitates taking a large amount of photos everyday with a camera phone instead of a stand-alone digital camera. The system can be trained the face images to become capable of automatically recognizing a person from the training face images.

In this system, it has developed a human face recognition system using Principal Components Analysis (PCA) with Back Propagation Neural Network(BPNN). There are many techniques which have been used now for this purpose but here in this system our approach has concluded that principal components analysis with back propagation neural network worked even better than the individual Principal Components Analysis. Thus it has developed a face recognition system for human being using both above techniques.

Keywords : Face recognition, Principal Component Analysis, Back Propagation Neural Network.

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INTRODUCTION

Face Recognition is one of the important research in pattern identification algorithms is Face Recognition System. It has many advantages of presentation for biometrics recognition and image processing. Biometrics face recognition can be carried out with the data of human like signature, fingerprint, hand geometry, iris, palm, print face, hand geometry and speech. It shows best authentication or identification for many face datasets with frontal side view and moderate lighting condition.

1.1 Objective of the Thesis

The objective is to carry out the face authentication in the great way and implement for authentication system for the various types of fields. The system of face recognition system is able to apply for the different applications. This system is developed to implement a face recognition application on the android application. Face recognition system is a human based authentication method of identifying many single people by calculating the face image in digital type with the saved biometric data.

1.2 Motivation of the Thesis

For mobile application, it is hard to recognize the person like memory of human beings for verifying system. Although face recognition can be some kind of facts due to various facial motivation, orientation, lighting situation, side of view etc. Though the face recognition is play a key role for many kind of area such as: surveillance system, access control, credit card verification, produces of a verify data in the dataset for crime tracking, video surveillance, building security system, other social media software. During the previous ten years ago, the revolution of techniques has spread out the earth fundamental on digital computing system. In the

computer vision, a challenging problem is the face recognition. This is why, computer science researches are doing for do the human based system, biometrics recognition and scientists in various kinds of subjects which have proved their most focus on implementing a continuous and prominent of the recognition of biometrics system.

1.3 Organization of the Thesis

This thesis is organized as five chapters. The describe chapter is the introduction of the whole system such as the objective of developing this system and the motivation of the system. In chapter, The background theory of this system are presented. And then especially the feature extraction is such play a key role in face recognition system and there exits various kind of feature extraction methods besides it also describes the related work systems. In the chapter, the main two methods using in this system were explained such as the calculation of various equations of the principal component analysis method and back propagation neural network method. In the chapter, it describes the design this system, experimental results and implementation of the purposed system. Furthermore, the advantages of developing this system, useful for further application and different fields , the overview of the system were described in these chapter.

CHAPTER 2

BACKGROUND THEORY AND RELATED WORK

2.1 Background Theory

Face recognition is biometric based digital technique using in computerize system and getting more and more an efficient research area. Face recognition is a type of digital image processing which applies the face image to verity a human. This application contains a features extraction method and a classification method using neural network. For this system, faces features are extracted using Principal Components Analysis and Back-Propagation Neural Network are used as the classification to face classify. This presented system will be implemented on android application.

2.2 Face Recognition

Facial recognition is a method of authenticating or recognizing the single data developing of the face image. The system of facial recognition able to applied to recognize the face of the person in capture images, moving videos, or in outside world. Facial recognition is one of such way in human based facts security system. In different types of biometric applications consists of speech recognition, fingerprint recognition, and eye retina or iris recognition. This methodology is widely implemented in security checking and criminal tracking, although it has been use in various kinds of subjects.

2.3 The Pre-processing Techniques

The pre-processing stage of image analysis might have efficient benefits on the great method for generating the facial facts, also the image processing outcomes. In image analysis, pre-processing technique is a method calculate with a theoretical formula using the a lot of data, that in many feature extraction methods for a common step.

2.3.1 Local Binary Family Pre-Processing Technique

The two-point intensity value comparing compute the local binary preprocessing method, then a lot of point-pair patterns. The comparing several (<, >, =) among pixels is entire facts, thus every pre-processing technique of face image looks necessary. According to that explanation, the two methods for image pre-processing are as follows:

2.3.1.1 Preserving pixels Filtering

It can only develop a difference pixel value getting from computing length, it can also apply in various kind of method like transmitting the list of census besides in another way, due to has effect of removing complex background of the length and another unnecessary facts.

$$if(|Pixe_l\text{-}Value_1 – Pixe_l\text{-}Value_2| > length) \quad (2.1)$$

2.3.1.2 Smoothing Filter

Besides, measuring for compare length, useful filter to delete unnecessary complex facts which are a smoothing-filter or rank-filter. Carry out the different model, apply a filter with sharpen to extend little several facts, the approach might show to process, rely on the information , software.

2.3.2 Spectral Family Pre-Processing

In cause of the widely used approaches for this title model, This being hard to retrieve a prominent preprocessing algorithm which might suitable in use. An instance, the data of gradient facts is related with SIFT calculated at single point. The containing of HAAR wavelets or local rectangular regions of collected value of point is related with SURF, that resizes a prominent for single value of point. In the collected the models of image analysis developing the features of HAAR-like which are the model of “SURF” or the model of “Viola Jones” then there may be little possible choices of pre-processing.

2.3.2.1 Summarizing

The features of the model “HAAR” are calculated in the just collective picture in summarizing the point value of local field; If there is no preserved good feature of

point of value by summarizing, then there is no choice to carry out in pre-processing of picture

2.3.2.2 Removal of Noise

It was no intend to required for a model of “HAAR” pre-processing step, In local areas, it own the affinity for removing the complex due to a collected picture summarizing

2.3.2.3 The problem of illumination

It might need the model of preprocessing; an instance, obviously different improvement might the nice thought when the training data illumination is not the same with a present form. The principal of a preprocessing for the condition use for calculate the whole obviously different method to some picture for a set of training, besides calculate that whole obviously different method for a every single form, justify s obviously different of the picture when a obviously different branch off over the length to gain more come to related the whole obviously different method. Models for obviously different improvement contain remapping of LUT, the whole equalization of histogram, and other relative equalization histogram locally.

2.3.2.4 Blur

There are some problem of unnecessary facts which known as blur for a present form, there might apparent same with the problem of contrast localize, thus local contrast improvement might required, for example, a filter-sharpen. Calculating the whole a metric data for instance, the “SDM” is some piece of real data to taking length some part / whole part obviously different might to use; when a present picture branch off a lot for obviously different, the useable obviously different improvement might used for the pre-processing stage.

2.3.3 The Pre-Processing Model of Basis Space Family

This may impossible to produce basis space models for image preprocessing, as there were pretty branch off, in order to the allocation, it were follow for the method. That basis space algorithm contain visual vocabularies, Fourier, KTL,

wavelets, etc. Nevertheless, it was support a little detail inquiring about the stage of Preprocessing.

2.3.3.1 The Model of Fourier, Wavelets, Slant Transform, Walsh Hadamard, KLT

This method transmits to other field of the value to be allocate, also this was difficult to suppose every Preprocessing unknown purposed software. An instance, calculating the method of “Fourier spectrum” generates measurement step by step is provided to suitable in use for extraction of facts to give various kinds of unnecessary spots, for described with a “LPQ” quantization method which based linear phase.

2.3.3.2 The Model of Sparse coding and visual vocabularies

This method depends for description of feature locally, that might “SURF, SIFT, LBP”, various kind of the related facts, produced getting the point within a domain of spatial. Hence, an algorithm of facts extraction shall decide a great method of Preprocessing. An instance, formulas which apply integration with original point patches as extra facts do not need other Preprocessing. May be any some Preprocessing might applied, for example, for contrast balancing the illumination might be normalize, the balancing of histogram locally / the “LUT” method.

2.3.4 The Pre-processing Technique of Polygon Shape Family

When thinking the Preprocessing stages of the image, the polygon shapes are qualitative many features, the rate of qualitative Preprocessing formulas was pretty wide, a selected the algorithms for apply that too rely on data. Perhaps due to the upcoming facts or purposed the case usage with the shape of polygon lengths, it were developed just several good software, for example biometrics facts. The one popular theory is implemented for preparation of the image before the shape of polygon lengths is accurate the brightness, choose a related environment view.

2.3.5 The purpose system’s Pre-processing Technique

The input image is acquired in this purposed system. Firstly, the acquire-images are transmitted into the image with gray color. Grayscale is a one method in

digital image processing to flatten pixel values of the three RGB values into one same value. This is taken measure by using the following equation:

$$(G)gray = R \times 0.2989 + G \times 0.5870 + B \times 0.1140 \quad (2.2)$$

The converted gray-scale image is cropped.

2.4 The Techniques of Feature Extraction

The technique of the extraction of features that's the one important part in biometric identification. Principal Components Analysis Method that's a one prominent approach in generalization the face feature, dimension reduction. Principal Components Analysis (PCA) also called as Eigen-faces method which consists of a set of eigenvectors. Eigenvector is widely applied in computer vision problem for human face recognition system. The entire vectors of eigen got the related eigen-value , the largest eigen-value of eigen-vector show many data for a various kind of face features compare with the less data of eigen-values. The spread of the principal data of the face image , the covariance matrix's eigenvectors of a set of image of the face, showing the facial image as pixel or length with direction(vector). The individual image of face able to estimated by applying just a great Eigen-faces, which got a biggest values, thus in accordance with a lot of variance during the image of face set.

2.4.1 Feature Extraction methods

Feature extraction is play a key stage in the identification of face. The recognition rate of system depends on the meaningful data extracted from the face image. If the features belong to different classes and the distance between these classes is large then these features are important for a given image.

PCA is a method that takes high-dimensional image data and uses the dependencies between the variables to represent it in a more tractable, lower-dimensional form, without losing too much information. PCA is a statistical procedure that analysis the covariance structure of a set of variables and verify the principal directions in data variables. PCA is applied to recognize sets of orthogonal coordinate axes through the data. Principal components are decided by calculating

eigenvectors and eigenvalues of the data covariance matrix. Based on principal components the verification of face images is done.

FLD is a lot of influence method to find for prominent in the data, which has the biggest several and obvious data. This way is also developed, for lower-dimensional representation of the data, which delete some of the obvious “noisy”. The fundamental idea of FLDA is the design an optimal transform, which will be able to extend the ratio of between-class to within-class scatter matrices thus the classes can be separated in the low-dimensional space. FLD way permits a lot of data between members of the same category (images of the same person) to implement a set of feature vectors. FLD applies a linear projection of the n-dimensional data onto a one-dimensional space (i.e., line). Projection onto a line is separated by a class and classification problem becomes selecting a line.

FPBM is a way to generate the features of the images on the basis of matching image areas and sub- pixel displacement approximate by applying similarity measures. The recognition is based on the edge detection. This formula extracts less information than the original image. This is due to it reduces most of the details that are not associated for the purpose of verifying the boundaries, while preserving the necessary information to show the shape and structural characteristics and geometry of the objects represented.

In addition, face detection ways can be recognized into four different categories, even though some methods can belong to more than one category. (1) Knowledge-based methods, where some rules or relationships between features are encoded. Kotropoulos and Pitas followed this method developing projection profiles to locate the face. It has applied a same method to locate the eyes once the face has been detected using this technique. (2) Feature-invariant approaches, where the idea is to detect the facial features first, such as eyes, mouth, eye brows, and group them into candidate faces. (3) Template-matching methods, where there is a predefined face pattern that is integrated with the image. Point distribution models (PDMs) have also been used for this intended. (4) Appearance-based methods, where the goal is to train a classifier that learns the features of the faces from training set with face and non

face images. Many classic models such as principal component analysis, Gaussian mixture techniques, neural networks, hidden Markov techniques, support vector machines, and probabilistic methods have been applied in this way. Many approaches of face recognition have also been intended. Fundamentally, it can be divided into holistic template comparing based systems, geometrical local-feature-based schemes, and hybrid schemes.

(i) The holistic methods develop the wide image as a raw input to the learning process. Examples of these techniques are principal component analysis, independent component analysis, or support vector machines applied to face recognition. (ii) In the feature-based models, some structural features are generalized, such as eyes, mouth, and their local appearance, position, or relative relationship are developed for training the recognizer. The most successful technique is the elastic bunch graph matching presented in where the authors use Gabor wavelets to generate the basic features for the graph- matching scheme. (iii) Hybrid models to apply the great of the holistic and feature-based models consisting local features and the whole face to identify. An instance of hybrid approaches is the use of Eigen-features, which extends the idea of Eigen faces to specific regions of the face such as mouth, nose, or eyes.

2.5 Related works

There are two basic models for face recognition. The first method is based on extracting feature vectors from the basic part of the face such as eyes, nose, mouth and chin with the help of deformable templates and extensive mathematics. A feature vector is created from the information integrated from the basic parts of the face. In this model, information that good shows a face is produced from the whole face image. Any individual face can be represented in terms of a great coordinate system called “Eigen faces”. These are Eigen functions of the average covariance of an ensemble of faces.

This system is mainly addresses the building of face recognition system by using PCA and then classification is done by taking the length of minimum Euclidean

distance. It has some disadvantages over the variations in size of image. It can only access the vertical frontal views of human faces [5].

The author of this system presented the system of face reorganization that could be capable of face identifying the face of a person with a digital image. This system implemented using SVM (Support Vector Machine) for features extraction and combined with CNN and BPNN for classification. Complex computation for recognition because it was combined with CNN and BPNN. Difficult to extract features in complex background [14].

In this system, it presents the deployment of face recognition algorithm on mobile phones and the face recognition application develop using fisher-faces and Euclidean distance. The fisher faces is the computation complexity. This issue hinders the training of the faces on the phone [12].

This system Principal Component Analysis and Back Propagation Neural Network they've carried out for a limited and known atmosphere. Besides it got searched the great outcome in a less side of view, a few differences. The models of PCA combined with BPNN which are great, prominent in the system of face identification. At present, it shall be implemented in many confuses, active atmosphere that unnecessary facts, figures, brightness. [2].

The result of this system was compared with several techniques, then mentioned model provides the more accurate verifying percent than another methods. The Eigen faces model is too effective to side of head, many distinct happen in a face of the image in the big side of head [7].

In this system, the fuzzy set theory capability could be defined to gain the belonging degree of various points' value of the image of face to several areas. The model of common vector can gained to resize the sample number of applied in the stage of training and original PCA which has been applied for identification stuff [13].

CHAPTER 3

PRINCIPAL COMPONENTS ANALYSIS (PCA) AND BACK PROPAGATION NEURAL NETWORK

3.1 Principal-Components-Analysis Theory

Principal Components Analysis (PCA) is the one hit models in extraction of feature then dimension resizing. The human faces recognition by applying PCA has worked by the author “Turk and Pentland” and rebuilding of the faces of human has worked by the author “Kirby and Sirovich”. The model of identification, called the Eigen-face approaches unifies the space of feature that resizes dimensionally of a traditional feature value. The minimized the space of data that applied in identification.

The one mathematical approach is a PCA technique that contains a covariance matrix computation, Eigen-values and Eigen-vectors. The reduction of dimension method is a PCA which able to develop for minimize a big set of variable to a small set of which includes a lot of data for a big set. Besides the mathematical models PCA which transmits the numerous integrated data known’s Principal Components Analysis (PCA) that is a model for the image feature generation.

The key benefits of PCA are developing it in Eigen-face model which supports in resizing the database’s size of a test image for recognition. The images are stored as their feature vectors in the database which are found out projecting every trained image to the set of Eigen faces obtained. PCA is used on Eigen face models to minimize the dimensionally of a large dataset.

3.2 Eigen Value

Eigen values are related with eigenvectors in Linear algebra. Both terms are developed in the analysis of linear transformations. Eigen values are the special set of scalar values that is associated with the set of linear equations perhaps in the matrix equations. The eigenvectors are also termed as characteristic roots. It is a non-zero vector that can be transformed in many by its scalar factor after the application of linear transformations. And the corresponding factor which the scales the eigenvectors is known as an Eigen value.

Eigen values are the special set of scalars related with the system of linear equations. It is mostly used in matrix equations. 'Eigen' that means 'proper' or 'characteristic'. Hence, the term Eigen value can be termed as characteristic value, characteristic root, proper values or latent roots also. Simply, the Eigen value is a scalar that is used to change the eigenvector. The basic equation is

$$\det | A_n - \lambda_n I| = 0 \tag{3.1}$$

The number or scalar value "**λ**" is an Eigen-value of A.

In Mathematics, an eigenvector corresponds to the real non zero Eigen values which point in the direction stretched by the changing whereas Eigen value is considered as a factor by which it is stretched. In case, if the Eigen value is negative, the direction of the changing is negative.

For any individual matrix, there is an Eigen value. Sometimes it might be confuse. The residence of the Eigen value for the confuse matrices is equal to the basic method of algebra.

3.3 Eigen Vector

The eigenvector is a vector that is related with a set of linear equations. The eigenvector of a matrix is also called a latent vector, proper vector, or characteristic vector. These are defined in the reference of a square matrix. Eigenvectors are also useful in solving differential equations and many other applications related to them.

Eigenvector of a square matrix is defined as a non-vector in which when a given matrix is multiplied, it is equal to a scalar multiple of that vector. Let us suppose that A is an n x n square matrix, and if v be a non-zero vector, then the product of matrix A, and vector v is defined as the product of a scalar quantity λ and the given vector, such that:

$$\mathbf{Av} = \lambda \mathbf{v} \tag{3.2}$$

Where

v = Eigenvector and λ be the scalar quantity that is termed as Eigen value related with given matrix A.

3.4 PCA Algorithm

1. Initially, a set of M images is taken which is called as a training set and it is assumed that each image has the dimensions N*N. In this system, it have to convert every image to an image vector of dimension 1*N2.

2. The average face is subtracted from all the image vectors.

$$\Psi = \frac{1}{M} \sum_{i=1}^{M} \Gamma_i \tag{3.3}$$

3. This average face is calculated by the description shown below

(1) Where the training set of images be $\Gamma_1, \Gamma_2, \ldots\ldots \Gamma_M$.

4. Each face differs from the average by vector

$$\Phi_i = \Gamma_i - \Psi \quad (3.4)$$

Where $\Phi_i = (\Phi_1, \Phi_2, ..., \Phi_M)$

5. After the mean image is subtracted, it has to create the Eigen faces and only M' Eigen faces are considered with the highest Eigen values. The Eigen faces are created by calculating the covariance matrix which is formed by:

$$C = A.A^T \quad (3.5)$$

6. To gain the vector of weight value "w" that is supporting of each Eigen-face to the image of face, the image of faces that changed to their Eigen-face data arranged to a space of face with the function simply.

$$w_k = u^T_k \quad (3.6)$$

7. For k=1,.., *M'*, where *M'* £ *M* is the number of Eigen-faces used for the recognition. The weights form vector $w = [w_1, w_2, \ldots, w_m]$ that describes the contribution of each Eigen-face in representing the face image, treating the Eigen-faces as a basis set for face images. The simplest method for decision which face can support the best description of an unknown input facial image is to find the image *k* that minimizes the Euclidean distance.

3.5 The Method of Euclidean Distance

The Euclidean Distance between two points in the space of 2- dimension taking measures the length of a segment joining the two pixels. This is the a lot of prominent method of behalf the length among the two pixels.

The method able to apply for compute a length among the two pixels described to an illustration follows. When the pixels (x_1,y_1) and (x_2,y_2) are in the space of 2-dimension and a result of the Euclidean-distance among these points that shown in the equation below.

The square root of $(x_1 - x_2)^2 + (y_1 - y_2)^2$ (3.7)

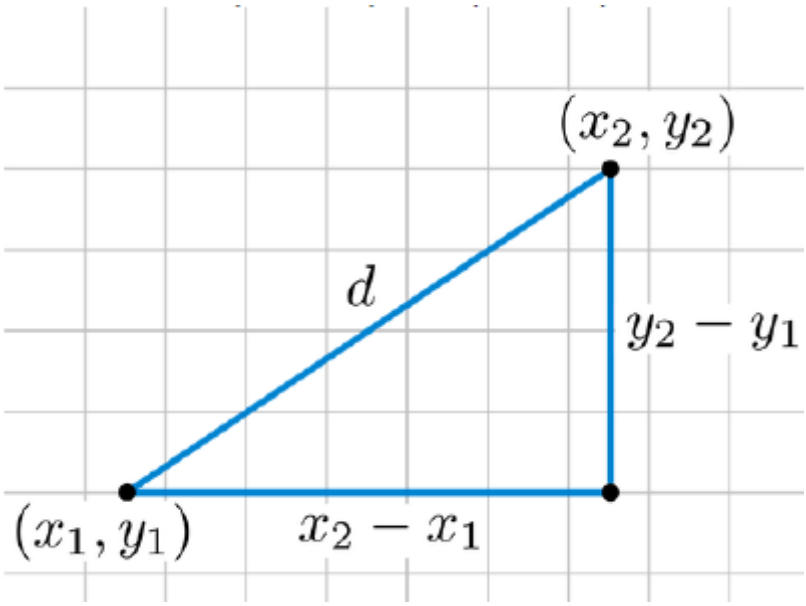

Figure 3.1: **The calculation of Euclidean distance value**

3.6. Artificial Neural Network

A neural network consists of associated each neurons where each association has a weight integrated with its models. It supports to create estimative model. This approach carry out depends on the biometric system. It provides to hold image comprehending. This system intends Back Propagation Neural Network (BPNN) for recognition.

There exist different types of Artificial Neural Networks.

3.6.1 Feed-forward Neural Network

Artificial Neuron, this neural network is one of the simplest methods of ANN, where the data or the input goes in same direction. The data goes through the input neurons and goes out through the output nodes. This neural network could be or could not be got the hidden layers. Simply, it has a front propagated wave and no back propagation by using a classifying activation function usually.

3.6.2 Radial basis function Neural Network

Radial basic functions consider the distance of a point with respect to the center. RBF functions have two layers, first where the features are contained with the Radial Basis Function in the inner layer and then the output of these features are taken into consideration while calculating the same output in the another time-step which is basically a memory.

3.6.3 Kohonen Self Organizing Neural Network

The objective of a Kohonen map is to input vectors of arbitrary dimension to discrete map consists of neurons. The map needs to be trained to create its own organization of the training data. It comprises either one or two dimensions. When training the map the location of the neuron remains constant but the weights differ depending on the value. This self-organization work has different parts.

3.6.4 Recurrent Neural Network (RNN)

Long Short Term Memory, the Recurrent Neural Network carrys on the principal of saving the output of a layer and feeding this back to the input to provide in estimating the results of the layer. The first layer is consists of same to the feed forward neural network with the result of the sum of the weights and the features. The recurrent neural network access starts once this is calculated, this means that from one time step to the next each neuron will remember some information it had in the previous time-step.

3.6.5 Convolutional Neural Network

Convolutional neural networks are same to feed forward neural networks, where the neurons have learnable weights and biases. Its application has been in signal and image processing. For this model, the input features are carried out in batch-wise like a filter. This will provide the network to recognize the images in parts and can calculate the functions. These computations include the conversion of the image from RGB or HSI scale to the Gray-scale. Once we have this, the changes in

the pixel value will provide to detect the edges and images can be recognized into different categories.

3.6.6 Modular Neural Network

Modular Neural Networks have a collection of different networks working independently and contributing towards the output. Each neural network has a set of inputs that are unique compared to other networks constructing and performing sub-tasks. These networks do not interact or signal each other in accomplishing the tasks. The benefits of a prominent neural network is that it breakdowns a large computational process into smaller components decreasing the complexity. This breakdown will provide in decreasing the number of connections and negates the interaction of these networks with each other, which in turn will increase the computation speed. However, the processing time will depend on the number of neurons and their including in calculation the results.

3.7 Back Propagation Neural Network (BPNN)

The back-propagation neural network (BPNN) is a widely used formula in the stage of training and testing including the feed forward formula of neural networks. In this system, Back Propagation Neural Network is created for the one-input layer, the two-hidden layer and the one-output layer. This system of input layer composes ten-neurons which are derived from the feature extraction method and the input layer is added bias neuron. The hidden layer consists of six neurons plus bias neuron because the network has only one-output neuron, so the number of neurons in the hidden-layer is two-thirds of the number of neurons in the input-layer. The output-layer consists of one neuron because the network is attempting to work as a classifier.

The basic idea of back propagation neural network that accepted upon the carrying the model of a biometric then it is acts as a set of greatly joined nodes together definable joined with the value of weights. The mean of back propagation is the propagation of error into the return side result into acquires data nodes. The

increase decent studying way, the function of activation that developed with the BPNN algorithm then the number of the value of errors which reduced with refreshing the weight of network. It got the total two studying methods called as “batch-learning, incremental-learning”. In batch-learning refreshes the value of weight after computing the number of the value of error of the matrix of full-feature. In other words, improvement studying refreshes the value of weight in every node.

The number of neurons in the layers are depend on the shape of the training data. Traditionally, Number of neurons = Number of training data Feature + 1 , one additional node is to capture the bias term. The network will be used to train the face image from the dataset and to test the query face image.

The back-propagation neural network-(BPNN) of the training stage, testing stage carries out the three stages of follows:

1. calculating the feed forward formula for the both of training stage, testing stage
2. calculating the back-propagation formula for the related error values
3. calculating the adjustment of weight value

Calculating the formula of the Feed-Forward, every input neuron gets an input value and delivers it to every hidden neuron, which in turn computes with the function and passes it on to each output neuron, which calculate again the function to gain the produced output.

Calculating training stage, testing stage, an appropriate error of the net output is calculated. The factor of error is gained which is applied to delivers the value of error back to the hidden-layer. The updated weights are calculated. Similarly, the factor of error is formulated for neurons. And then, after obtaining the error factors, the system must immediately calculate the weights. In this system, output-layer has one-neuron. For this system, there exists an eleven-input neurons, one-output neuron and seven - hidden neurons.

The Back-propagation Neural Network algorithm is as follows.

$$O_n = \frac{1}{1 + \exp[-(\sum_{xiwi} - t)} \quad (3.8)$$

where t represents bias neuron which value gives o or 1 in turn.

Determining Errors: $E = O_{actual} - O$ (3.9)

where O_{actual} represents real output which value is 1 and O represents target output at the output layer.

$$E_n = O_n (1-O_n) \sum_j w_{nj} E_j \quad (3.10)$$

Finding new weights:

$$w^i_{jk}(new) = w^i_{jk}(old) + \alpha E_k^{i+1} x_{jk} \quad (3.11)$$

where α is the rate of coefficient for training which is limited to the value (from 0.01 to 1.0).

This calculated results through the above formula are produce as output which is recognize or not the face image person in the database.

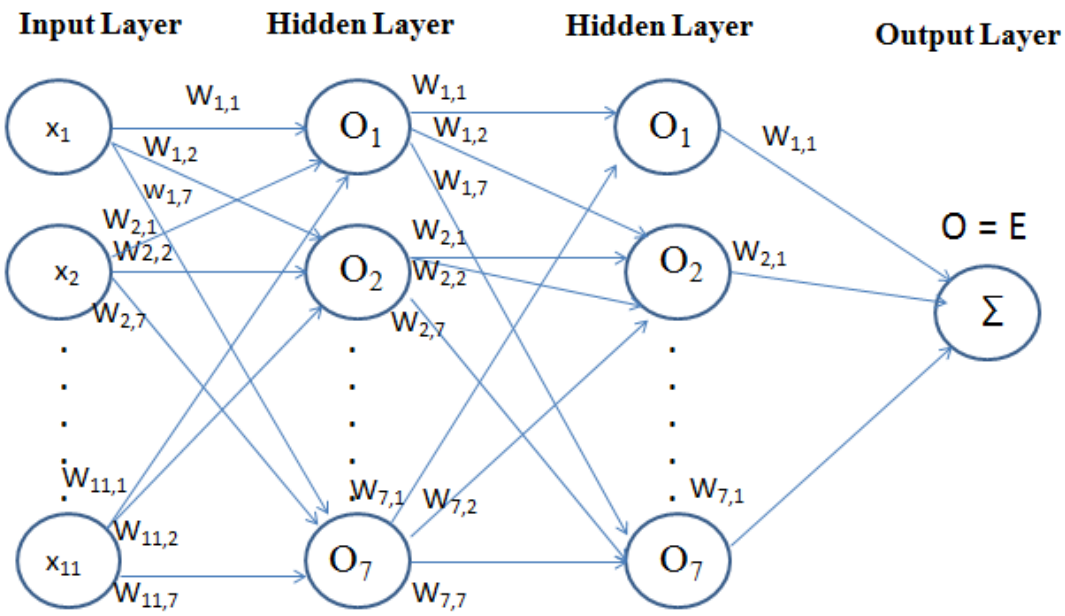

Figure 3.2: **Back Propagation Neural Network for the purpose system**

3.7.1 Weights

The adjustable weights will be updated randomly and is assigned for each node. It can be randomly assigned value decides, when the network will reach its minima or negligible error i.e..

3.7.2 Hidden Layers

The activation function can calculate with the algorithm, it can be seen that an n-input, m-output function requires (2n+1) hidden units. In each hidden layer, the partial derivative for error function (δ) is calculated for each layer and is summarized for neurons in the whole previous layer when a individual layer is under consideration. This approach is frequented for entire the hidden layers. This might not necessarily increase the processing duration. So, it depends on the initial weights that are generally set.

CHAPTER 4

SYSTEM DESIGN AND IMPLEMENTATION

This system process by taking each and every point of data for the human face image which might be saved, the last outcome of feature values which is data as information. This system developed to calculating the information acquired from the face of person's image. The one design of a computer program or software application is a mobile application which to work for the mobile device (phone, tablet, or watch, etc). Mobile software is the most part found on PCs which is moving along from the coordinated programming systems. Similarly, every application provides limited, separated, non suitable to use such as the gaming system, calculator's number or web browsing for mobile. Besides some information which software should moved away working a lot of stuffs because of a limited tool abilities of phone in previous decade.

4.1 The Purposed System design

This system describes the implementation design for the face identification system for android mobile phone platform. The system method combined as two key stages which are stage of training and stage of testing.

In training stage, the face image is acquired from the capture or datasets in the "Input image" step. The face images is preprocessed and the features of this image is extracted using PCA algorithm and the output of "Feature Extraction using PCA" step is have to feed to the "Neural Network Recognizer (BPNN)" and then the value produce from the previous step which will be saved to the Database. The training stage of purposed system is shown in Figure.4.1.

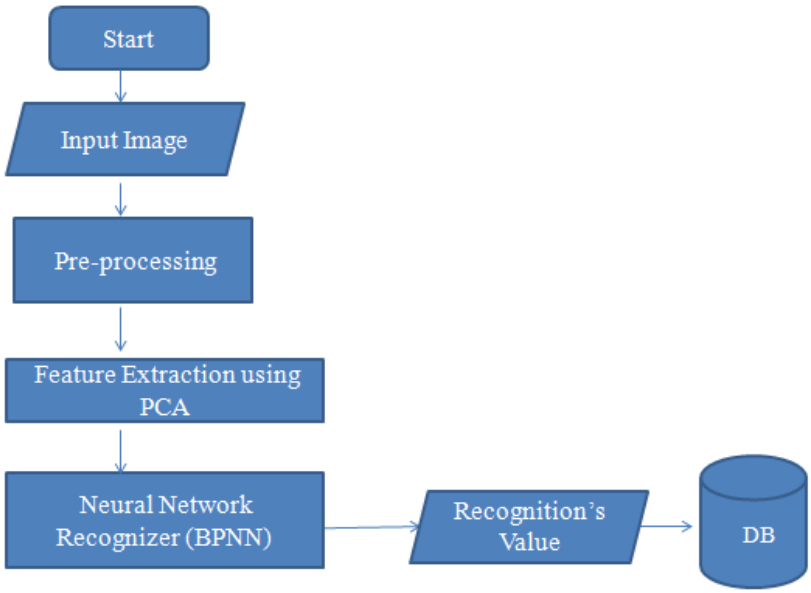

Figure 4.1: The training stage for the system flow diagram

In Stage of testing, the face image is acquired from the capture or datasets in the “Input image” step. The face images is preprocessed and the features of this image is extracted using PCA algorithm and the output of “Feature Extraction using PCA” step is have to feed to the “Neural Network Recognizer (BPNN)” and then the value produce from the previous step will be compared with the value which is the output value saved in the database from the above training stage. If the compared two value are almost similar, the system show the message “ Know user” and if not so, the system show the message “ Unknown user”. The testing stage of purposed system is shown in Figure.4.2

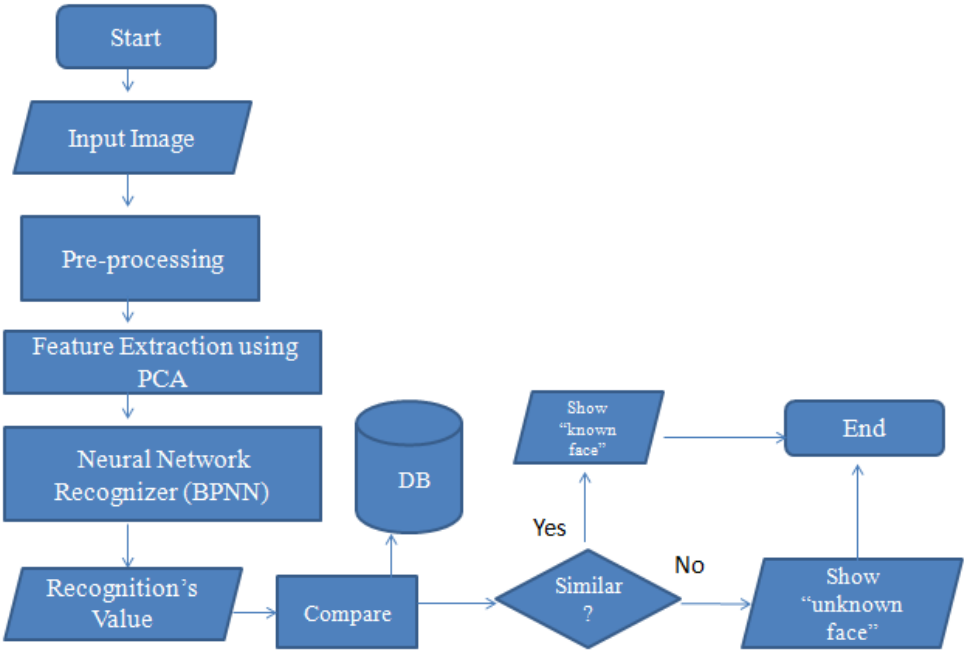

Figure 4.2: **The testing stage for the system flow diagram**

4.2 Datasets

The Dataset of Yale Faces (6.4MB) consists of 500-grayscale faces in the format of gif with 50 individual persons. This dataset includes 10 faces for a person, for a one person with various expressions of face and conditions: center side, front side, light view, side with glass, happy face view, left side, side with no glasses, normal side, right side, etc [18].The example image of dataset is shown in Figure1.

Figure 4.3: The example of face images from Yale face dataset.

4.3 Implementation of the proposed system

The two parts are involved in this system. The extraction's of the image's features is the first step and the recognition is the second step which is according to comparing to the features value. This system implemented by using android application.

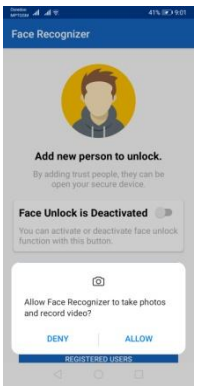

Fig: 4.4 First page of face recognition system

The first page of this system is shown in Figure 4.4. When the user enter the application, the user will see the first page of shown above. Firstly, the application will take permit to user to allow or not capturing picture and taking the image.

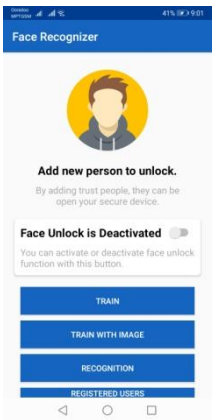

Fig: 4.5 Home Page of the system

After taking allowance of the user, the user will be seeing the home page of the system as shown in Figure 4.6. It includes four buttons such as Train button, Train with image button, recognition button and registered user button.

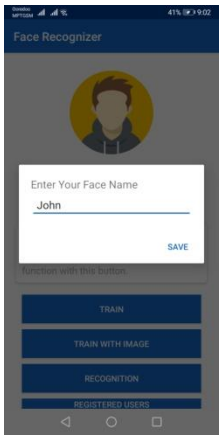

Fig: 4.6 Giving the name of trained user

When the user clicks the Train button, the system will show the text box for giving the name of user as shown in Figure 4.6.

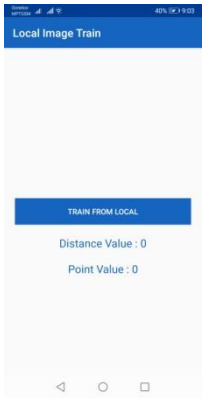

Fig: 4.7 taking the face image form dataset

After giving the user name, the system has to take the image form dataset. So the user have to click the Train form local button as shown in Figure 4.7.Then the system will go to the page which the user can select the image.

Fig: 4.8 Dataset page of the system

When the user click the Train from local button mentioned in Fig 4.7, the system will go to the page which the user can select one of the face image in the dataset for training to the system as shown in Figure 4.8.

Fig: 4.9 Showing the selected face image's values

After selecting one of the face image from dataset, the system shows the values of the selected face image which a feature extraction value drive from PCA algorithm and a recognition value drive from BPNN algorithm. And then, the user may be choose another face image from dataset. So the user shall click the Train from local button again. The system go to the dataset page again mention above Fig 4.8. Furthermore, the user have to select the another face image to train. Hence, the system will drive the feature extraction value and recognition value. The training of this system will be implement like this step as shown in Figure 4.9.

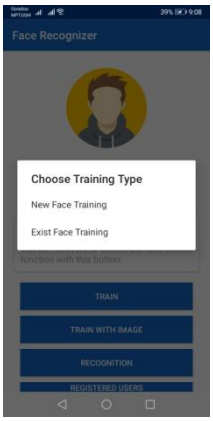

Fig: 4.10 To choose the existing user and the new user

The user click the Train button, the system shows the text box for choosing the new user or existing user as shown in Figure 4.10.

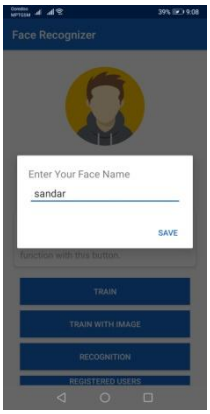

Fig: 4.11 Giving the another user name for training

When the user choose the new user mention above Figure, the system shows the message box to give the user name. Thus the user give the new user name as shown in Figure 4.11.

Fig: 4.12 Capturing the face image

The system captures the face image of the user for training as shown in Figure 4.12.

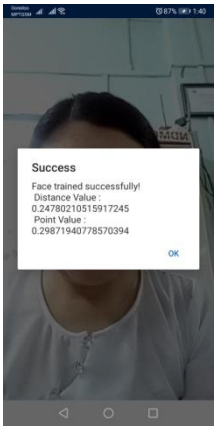

Fig: 4.13 Showing the face image values

The system shows the feature value and recognition value of the captured image as shown in Figure 4.13.

Fig: 4.14 To Choose the user name

When the user click the recognition buttons, the system will show the user to choose the user name as shown in Figure 4.14.

Fig: 4.15 Show the know user

When the user choose the one of the right name, the system will show the feature value, recognition value and user name as shown in Figure 4.15.

4.4. Experimental Results

In this system, the system uses 300 face images of thirty persons as training dataset and 200 face images of twenty persons as testing dataset which was used the yale face dataset.

Table-4.1: Experiment results of trained face images

No	Face Image	Training Value	Testing Value
1		0.42248004467	0.422400012427
2		0.000475 43411	0.000475 43110
3		0.43203 400623	0.41202 400623
4		0.90084 211627	0.90084 200627
5		0.12202040050	0.12200100050
6		0.36128909 42	0.3612890110
7		0.24734590111	0.24772 903410
8		0.19532600625	0.19532600000
9		0.9501 002615	0.9501 001215
10		0.34899 425358	0.34899 4251212
11		0.16117001677	0.161170011010
12		0.54 055793661	0.54 055792300
13		0.40950051646	0.40950051001
14		0.723818 5584	0.723818 5323
15		0.01661 321230	0.01661 321001
16		0.40955001646	0.40955001010
17		0.16117100677	0.16117100100
18		0.56664 055793	0.56664 051010
19		0.24772 901110	0.24772 900001
20		0.67797 116279	0.67797 110000

According to the implementation of the system, the above table shows the two values of face images which were trained in the training stage.

CHAPTER 5

CONCLUSION AND FURTHER EXTENSION

5.1 The system conclusion

The face recognition system is developed in this system by experimenting on android application This model has been implemented for the association with the methods “PCA” and “BPNN”. This system can be used to compound obvious the identification of face algorithm together the good verification percentage. This research chose 50 people with implemented 7 image for training, the 3 image for testing of individual people (for total 350 images of training and 150 images of testing). The results of experimental describe the good verification percentage is 97.8%. The limitation is , this system couldn’t access the left/right hand side of face image and the lighting of image is very weak. This system of face recognition able to extended for various software like the home security system, web based software, tracking application using video surveillance etc.

5.2 Advantages of the System

The system of face recognition by applying the method of PCA as the generation feature then the method of BPNN as the identification of image and recognition helps the great recognizing and quit calculation. In computation the model PCA, for the generation of feature model, a dimension of space is able to minimized. The model PCA can be involved with the model BPNN process which more reliable compare with using the PCA model only based face recognition system.

5.3 Limitations of the System

The limitation of the proposed system is that the variation in various size of image. It can only access the vertical frontal views of human faces.

5.4 Further Extension of the System

To gain the security of user realization, several secure protecting order methods have been presented over the last ten years ago. The system applies as the great of the safeguarding security according to conduction onto computing the lots of data within the cloud. Then the system minimize a processing duration of the encryption, decryption, and identification.

This system intends to develop the face unlock application using the face recognition system on android mobile phone. It can be extended another range of applications on many research areas such as investigation for criminal cases, security management and credit card management. This system will be able to wide range in the image of video, various background.

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