Periocular Biometrics for Human Recognition

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Abstract--Periocular Biometrics provides a secure method of authentication and identification. Biometric data are difficult to replicate and steal. Unique identifiers include fingerprints, earlobe geometry hand geometry, retina and voice waves iris patterns, DNA, and signatures. This paper is based on Periocular biometric human recognition, which is the appearance of the region around the eye. Periocular recognition may be very useful in applications where it is difficult to obtain a clear picture of iris for periocular biometrics or a complete picture of a face for periocular biometrics. Acquisition of the Periocular biometrics is demand high user cooperation and close capture distance. This region usually encompasses the eyelids, eyebrows, eyelashes, and the neighbouring skin area. Periocular biometrics encompasses the information of face recognition and iris recognition system. In this paper, the Local Binary Pattern and Histogram of Oriented Gradients are used for the feature extraction on the Periocular images. LBP is a type of feature used for classification in computer vision and a potent feature for texture. we will use different feature extraction techniques such as LBP, PCA, and ICA for pre-processing of periocular biometrics. Comparative Analysis with other competent technologies is also the essential part of this research work. For an effective classification and recognition of an authorized individual Back propagation neural network (BPNN) classifier is used.

Keywords—Periocular Recognition, Local Binary Pattern (LBP), Histogram of Oriented Gradients (HOGs), Back propagation Neural Network (BPNN), PCA, and ICA Biometrics.

1. INTRODUCTION

Periocular Biometric systems are applied for the unique identification of an individual by evaluating one or more distinguishing biological traits. The number of systems that have been compromised is ever increasing and Periocular biometric verification is any means by which a person can be uniquely identified by evaluating one or more differentiate biological traits. Periocular biometric recognition is based on the appearance of the region around the eye. The performance of iris recognition is pompous if iris is captured at a distance, also affected for subjects who are blind or have cataracts and the performance of face recognition is pompous by lighting changes, hair of the person, the age and if the person wear glasses. Periocular recognition [1] is very useful in applications where it is problems to implement the iris and the face biometrics. Acquisition of the Periocular biometrics has demand to large number of user cooperation. In the existing work, After capturing the periocular region, feature extraction method is done using Local binary pattern, Histograms of Oriented Gradients and Scale Invariant Feature Transform . The human and the machine performance are survey based on these algorithms and this not a complete automated system.

In this manual intervention is demand for the recognition of the features that is obtained using those algorithms.

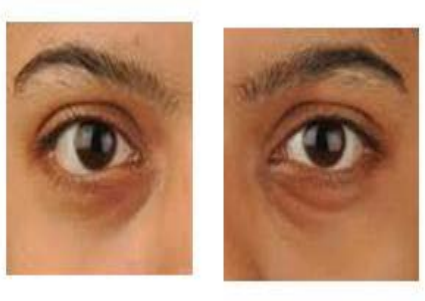


Figure (A) Original Left and Right Periocular Images

(A) J.R.Lyle et al (2010) proposed soft biometric classification using periocular region features in [2]. The focus is on gender and ethnicity classification of individuals using periocular images. The core is to focus whether periocular images carry enough information to reliably obtain similar to soft

biometric information to that secure from face images. This paper describes a soft biometric classification approach using to appearance based periocular features. The soft biometric information thus obtained can be effectively used for improving the performance of survive periocular based recognition approaches.

(B) D.L.Woodard et al (2010) described periocular region appearance cues for biometric identification in [3] The low-level features extracted from the periocular region can be effectively used for identification. The chief novelty in this reseach work lies in our use of only the second step periocular features based on skin texture and color information to perform identification. And this effect, mask the eye in the periocular region thus removing the iris and various first stage features. Although removal of the eye from a periocular region image may be seem like a poor performance of discriminating information, it may be potentially advantageous as the first stage features are very sensitive to the opening and closing of the eyes and may be end up influencing the texture features adversely.

2. Materials and Methods

Periocular Biometrics for Human Recognition, identification verification is required, a new record is captured and compared with the previous record in the database. If the data in the new record matches that in the database record, the human identity is confirmed. After capturing the Periocular region, feature extraction methods such as Local Binary Pattern and Histogram of Oriented Gradients and PCA, and ICA are used on the Periocular images, to capture the texture and the gradient information.

2.1 Database

The databases are acquired with a Nikon Coolpix S70 and Nikon Coolpix S4000. The periocular images are obtained from 20 subjects, by manually cropping the periocular images with the size of 512X512 pixels. Both the left and the right periocular images are used for the experiment.

Figure –(B) Block diagram of proposed biometric system

2.2. Feature Extraction

The features from the periocular region are extracted using systematic algorithms. The algorithm [6] which is used for feature extraction is Local Binary Patterns and Histogram of Oriented Gradients .

2.3 Local Binary Pattern

A local binary pattern is a type of feature used for classification in computer vision. [4] is found to be a powerful feature for texture classification improves the detection performance. Before performing LBP to the input image the original periocular image is change into grayscale image.

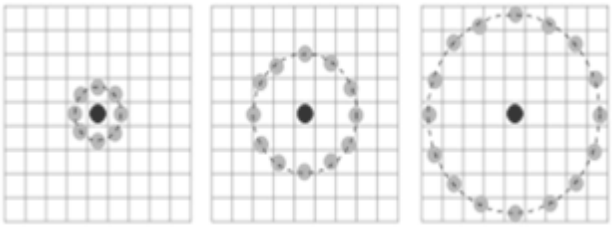


Figure (C) Three Neighborhood examples used to define a texture and calculate a local binary pattern .

The LBP feature vector is created by-

I. Divide the examined window into cells.

II. For each pixel in a cell, compare the pixel to each of its 8 neighbors, follow the pixels along a circle

III. Where the center pixel's value is greater than the neighbor, write "1". Otherwise, write "0". This gives an 8-digit binary number and is converted into decimal code.

IV. Compute the histogram, over the cell, of the frequency of each "number" occurrence.

V. Optionally normalize the histogram

VI. Concatenate normalized histograms of all cells which give feature vector of examined window.

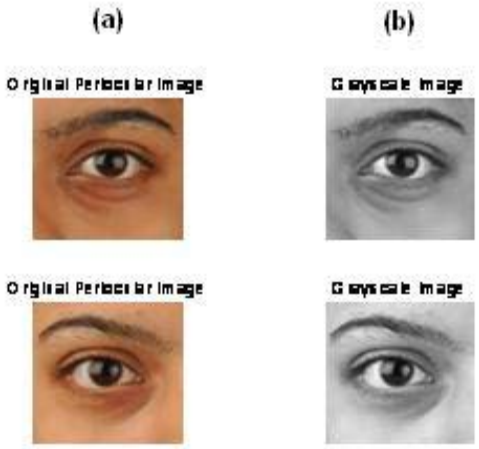


Figure (D) (1) Original Periocular Image
(2) Gray Image

The decimal form of the resulting 8-bit word (LBP code) can be expressed as follows:

$$LBP(Xc,Yc)=\sum_{n}^{7} = 0\ s(\ i_n\text{-}i_c)2^n \quad (1)$$

where *ic* corresponds to the grey value of the center pixel (*xc*, *yc*), *in* to the grey values of the 8 surrounding pixels. The function *s*(*x*) is defined as:

$$S(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x > 0 \end{cases} \quad (2)$$

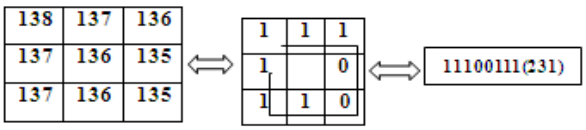


Figure (E) LBP operator

2.4 Principal Component Analysis

Principal Component Analysis (PCA) is used for identifying patterns in data. PCA is information preserving statistical method useful for dimensionality reduction and feature extraction Computer Science & Information Technology .PCA projects data along directions where data varies most. These directions are determined by eigenvectors of covariance matrix corresponding to largest eigenvalues. Direction of Eigen vectors provides useful information of our data by extracting lines that characterize data. The
lines pass through middle of data such that it draws a line of best fit. The eigenvector with highest eigenvalue is the principle components of data set.

2.5 Classification of periocular image

Once the features are separate from the periocular images for the recognition of an individual similarity measure is used. Due to the illumination in the images an intelligent technique is needed for the effective recognition. For that purpose a neural network classifier is used. A neural network classifier based on Back propagation training is used for the recognition of an authenticated individual and classification

2.6 Neural Network

The feed forward neural network, or perceptions, is a type of neural network first report by Warren McCulloch and Walter Pitts in the 1940s. Feed forward Neural networks can be used for classification and regression. The feed forward neural network [5] is trained with the Back propagation training technique, which uses to weighted connections from an input layer to zero or more hidden layers, and finally to an output layer. Feed forward networks remember what they learn by adjusting weights between the neurons. Feed forward neural network is an interconnection of perceptions' in which data and calculations flow in a single line, from the input data to the outputs. The number of layers in a neural network is the number of layers of recognition.

2.7 Learning using Back propagation

Back propagation [6] training procedure is used for feed forward neural networks. It is first step objective is to provide a mechanism for upgrading connected neurons based upon minimization of error. To accomplish this, gradient descent is generally used to determine the steepest path toward the minimum of

$$\in \left(\underset{w}{\rightarrow}\right) = \frac{1}{2}\sum o\in D\ ((t_d\text{-}o_d)^2) \quad (3)$$

where d is a training instance in *D*, *td* is the target value, *od* is the output value, and is the weight vector. Back propagation demand determining an error by first feedfowarding inputs into the network and subtracting the result from some target output. This difference is then multiplied by the

derivative of the neuron's activation function, in this application sigmoid function is used. After each error term is calculated, the weights are updated by the multiplication of each branch's output with the forward node's error and the learning rate.

2.8 Classification using FFNN

In the classification phase, the weights of the network are fixed. A pattern, presented at the inputs, will be transformed from layer to layer until it reaches the output layer. The classification can occur by selecting the category associated with the output unit that has the largest output value. The periocular images are classified using the FFNN trained using back propagation algorithm. The periocular images are first converted into a gray image and the local binary patterns are extracted from the gray image. A Euclidean distance is calculated with the query image and the images in the database and the corresponding output is obtained. In certain situations, the algorithm does not recognize the accurate periocular images because of the skin aging. Hence, an intelligent classifier is needed to recognize the periocular images with much accuracy and efficiency. A neural network classifier is used to classify the authenticated persons. The number of input neurons fed to the classifier depends on the similarity measures obtained using Euclidean distance measure. One hidden layers is chosen and the number of neurons in the hidden layer is set to 70.

The output layer shows the authenticated periocular image. The hidden layer neurons is activated using a sigmoid activation function given as,

$$f(x) = \frac{1}{1+e^{-1}} \qquad (4)$$

The output layer neuron is activated by using a linear activation function. The images in the database are separated into training and testing images. The 15 periocular images of both right and left eyes are given for training and for the purpose of testing the whole images in the database is given. The algorithm for the periocular image and classification system is given below,

Assign all network inputs and output

Initialize all weights with small random numbers, typically between -1 and 1

Repeat For every pattern in the training set *(xi, yi)*

Present the pattern to the network

For each neuron in the input layer

Calculate the weight sum of the inputs to the node

Add the threshold to the sum Calculate the activation for the node

End

For every node in the output layer

Calculate the error signal

End

For all the neurons in the hidden layer

Calculate the node's signal error

Update each node's weight in the network

End

Calculate the Error Function

End

While ((maximum number of iterations < than specified)

OR (Error Function is > than specified))

3. Experimental Results

The images are preprocessed from various subjects and the periocular images are manually cropped and are stored in the database which is used for the recognition of an authorized person. The Query images are imported and are converted into gray scale image because the feature extraction methods are applied to the grayscale images. LBP which is an efficient algorithm and the parameters used are, P = 8 (P->Number of Sampling Points) R = 3 (R->Radius) LBP preprocess the input periocular image and is represented with its texture patterns given by the LBP operator at each pixel location and the histogram of the Query Image and the LBP is given in the (Figure H)

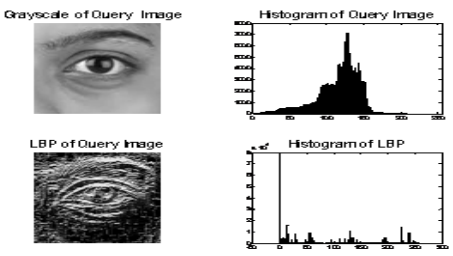


Figure (F) LBP image

Backpropagation method is to train neural network in which the initial system output is compared to the desired output, and the system is adjusted until the difference between the two is minimized. The error rate while training backpropagation is shown in (Figure I)

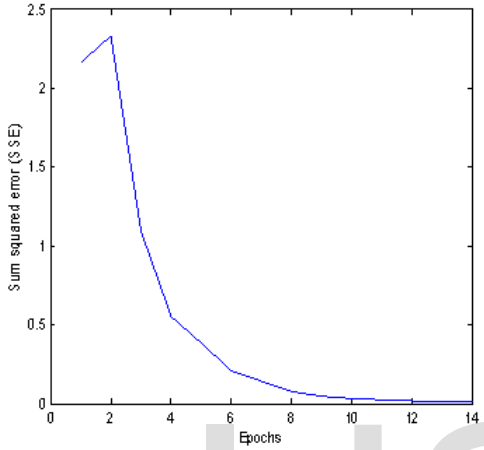


Figure (G) Error Rate of BPNN

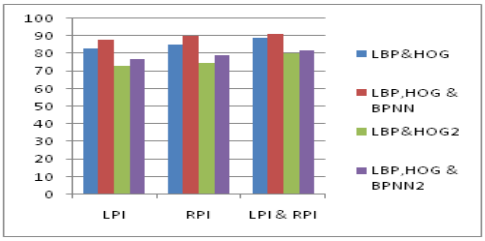
The final output that is the given query image should be recognized as the authorized or an unauthorized image by comparing the query image with the images that is stored in the database that is already collected and stored. The query image given is recognized as the authorized image and the recognized image given in (Figure J)

Figure (H) Recognized Image

The recognition rate for the periocular images are tabulated in (Table 1) by considering only the Left Periocular Image (LPI), only Right Periocular Image (RPI) and by combining both the LPI and RPI Table 1 Recognition Rate of the periocular images.The Performance chart is represented in (Figure J). By this chart it is shown that the feature extraction methods along.

	Recognition Rate (in %) for P=8, R=3		Recognition Rate (in %) for P=16, R=4	
	LB P & HOG	LBP HOG & BPNN	LBP & HOG	LBP, HOG& BPNN
LPI	83	88	73	77
RPI	85	90	75	79
LPI & RPI	89	91	80	82

with the similarity measure provides the better recognition. The recognition accuracy reduces due to the illumination in the images. Due to this, effective recognition training is given by the BPNN classifier which provides very high recognition accuracy. A chart is prepared based on the recognition rate with different P and R values. The recognition accuracy of Left Periocular Image (LPI), Right Periocular Image (RPI) and both LPI&RPI is measured with LBP&HOG alone and also with LBP, HOG&BPNN



Figure(I) Performance Analysis

4. Concusion

In this survey paper Periocular region which is used as the biometrics for the systematic recognition of an authenticated individual. Periocular recognition encompasses both the face and the iris

biometrics. Acquisition of the Periocular image does not require high user cooperation and close capture distance. The features from the periocular region are extracted using feature extraction methods like LBP and HOGs, for the intelligent recognition of an authenticated individual and to make perfectly automated biometric system an powerful classifier is used. Backpropagation neural network classifier is used for powerful e classification and recognition of an authenticated individual. High Recognition accuracy of 91% is achieved in this proposed research work when compared with the existing work. Future research in periocular biometrics can be done by adding more features for the recognition of an individual and various classifiers can be used to exporation the identification performance.

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