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Secured Authentication with Sclera Veins by Wavelet and Feed Forward Neural Networks

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Abstract – Personal authentication nowadays had become the most crucial security reason. Various human features and signals have been used for identification along with hybrid approaches where more than one features and signals are combined for robust security reasons. This paper proposes a novel secure technique of human identification using the veins of sclera portion of a human eye. A 32x32 region is extracted for identification over the sclera part. A unique code is also generated for the 32x32 array for dual identification. Minimum 3 images are taken for an individual into database for training feed forward neural network with Backpropagation and 2 images for testing. The database considered for this implementation belongs to UBIRIS dataset. 12 different individuals are considered to test the validity of the proposed system. Debauchees 6 mother wavelet is used for final feature extraction over the 32x32 grid by converting it into a row vector. The final feature vector, after 4 level wavelet decomposition was a 30x1 array for each individual. The matching rate was 100%.

Keywords - Personal authentication, sclera, UBIRIS dataset, Debauchees 6, mother wavelet, unique code, feed forward neural network, Backpropagation.

I. INTRODUCTION

The well known biometric code developed by John Daugman had been the best biometric code developed till now for identification and had been installed at the most secured campus including airports. Over last 2-3 decades research have been in the field of human authentication [1] for security reasons for safeguarding valuables, bank accounts, computers, security lockers, homes, and other premises [2]. Almost all the biomedical features have been tried for unique access over such systems including voice, thumbs, palm, face, iris, veins etc [3][4][5]. Also researchers have used two or more biometric features for high security reasons that may provide efficient code for access [6][7][8]. The Iris pattern of a human being the unique code for every individual has been a proved to be a boon to identify accurately [9]. Almost all the biometric system worked well when the biometric is acquired within some constraints. That is, the acquired biometric is not prone to any type of noise. For example, detecting the fingerprint would have a 100% probability to match when the lines over the fingers are clearly acquired or the iris acquired are free with the eyelashes [10][11].

Feature extraction for classification involves various methods used by researchers such as principal component analysis, wavelet transform, Fourier transforms, Local Discriminant analysis and other compression techniques which extract significant features from the region of interest. Human features changes as per the age, due to surgeries, burns, wounds, intentional physical changes and other factors involving change in region, atmosphere etc. High confidence features are those which are not based on statistical analysis over the region of interest [12]. Then these features so worked out can be fruitful in accurately detecting the right person, otherwise a false classification overheads even with a good classifier. Implementation of such good robust system is not easy task. The two main components essential for such a good biometric system is that the region of interest selected should not change over a long period of time and should not be pruned to external factors. Mostly humans are affected externally but less affected to sensitive parts such as eyes. Iris and sclera part are the examples of such biometric features. Unless a major injury occurs, these two factor does not change over a long period of time and are unique to an individual [13][14]. Research papers shows use of these two biometric independently or a hybrid approach using both of them to devise a robust system for authentication [15][16]. In [17][18], the authors have used sclera part for recognition with multispectral features. This paper is based on extraction of a small region over the sclera part, finding the unique feature and then classification using the neural networks.

II. PROPOSED SYSTEM

Preprocessing - The input color image is first converted into gray scale image. Then the intensity of the image is adjusted using gray level transformation method. Further the noise in the gray scale image is removed using a Gaussian filter with a window size of 11 by 11. Also other window size has been considered in this project work, but the 11x11 window showed good result. Hence it was taken to be 11x11. The sigma value for the Gaussian filter was taken to be 2.5.

Clustering – The filtered image is then subjected to Fuzzy fast C means clustering algorithm, where the following returned are obtained.

L - Region index as 1, 2 and 3

C - Will have region mean gray values

U : L-by-k array of fuzzy class memberships, where k is the number of classes and L is the intensity range of the input image,

LUT : L-by-1 array that specifies the de-fuzzified intensity-class relations, where L is the dynamic intensity range of the input image.

H : image histogram.

Number of classes provided along with the image was 3; hence 3 images (clusters) were obtained.

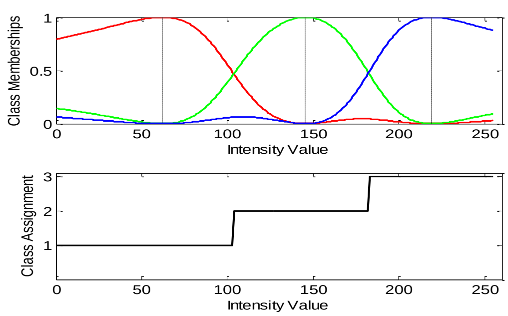

Figure 1.-Class membership and assignment

The third class was taken into consideration for sclera region extraction of the UBIRIS dataset. Since this cluster showed sclera part most significantly, the first cluster concentrated on pupil part and the second part on the remaining portion of the eye except the sclera and the pupil part which included boundary regions and the eyelid portion.

Figure 2.-Three clusters formed

Locating center of the eye – As seen from the database, the center of the eye in the third cluster seems to be darker mark just above the actual center of the eye. The aim was to find the approximate center of the pupil region. Also the database showed that the region was located approximately at the center of the image, the center of the image was first calculated using,

Center_x=xsize/2;

Center_y=ysize/2;

And the division was round up for image indices. Particularly this center was seen on the black region of the pupil part, therefore a window of 50x50 was considered around this center for accurately finding the central white spot on pupil region. The window was then extracted and converted to binary image having zeros and ones only.

Figure 3.-50 x 50 windows around the center of image

The histogram for the window extracted was found out and the maximum bins corresponding to the intensity level after 200 was found from the histogram bins data, since the white spot belongs to the bins after 200 value of the histogram bins. Further the histogram data was threshold using threshold 1. That is the black pixels were eliminated. Now corresponding to the maximum white pixel index, 0 was searched from start to the maximum index. The last 0 index was considered as the threshold for the gray scale window extracted earlier.

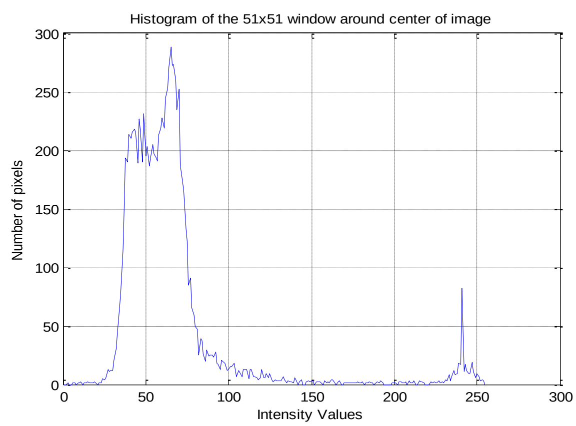

Figure 4.-Histogram for the 51x51 window

The threshold value separated the white region at the center of the pupil and remaining pixels were made background. The aim was to find the center of the white region therefore the extra background (black) was to be eliminated. For this a separate function was implemented that cropped the image automatically just touching the white region at the border on all four sides. The window of 51x51 thus reduced to some less value corresponding to the white region border. The Centroid of the remaining region was the found out as the center of the white region at the center of the pupil. By proper calculations, the exact center of the pupil was then found out. An offset of 5 pixels was added to the rows since the actual center of the pupil was below the center of the white region of the pupil region.

Locating the region of Interest on Sclera – After obtaining the final row and column index, the class 3 cluster was taken into consideration for locating the region of interest. Corresponding to the row index, a first 1 was located after the final row index which corresponds to the starting boundary of the sclera region on the right side of the image. An offset of 50 was added to the index at 1 for proper veins extractions. Finally a 32x32 window was considered for vein extraction on the sclera part of the eye.

Figure 5.-The region of interest selected (black square) for veins extraction

Feature Extraction - Almost more than 50 images were tested to see whether the approach work. Some images having almost nearly closed eyes fail the test. Those images were removed from the database, which were not more than 2 out of 70 such images.

After vein region of 32x32 extractions, canny edge detection was used to lift the smallest vein on the part for identification. A unique CODE corresponding to each eye image was generated by adding columns and then rows. Therefore for a 32x32 matrix, the column sum was 32 digits and then adding all 32 values, it was produce a code with maximum value of 1024. But since the veins are about 50% over the region of 32x32 matrix, a maximum code that would be generated is 512. Also the 32x32 array was converted into a row matrix for further processing.

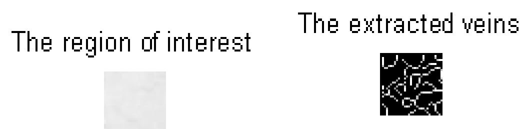

Figure 6.- a) The region of interest from gray scale image. B) The veins after canny edge detection

Training - Both the feature vector of size 1x1024 and the corresponding code was saved to a file. Feed forward Neural Network with Backpropagation was used as a classifier. The minimum number of images for training was restricted to 10. That is the user has to at least generate feature vector a code for 10 eye images. For every individual a number was set from 1 onwards as a Target for the image. Since the feature vector was 1x1024, a 4 level wavelet decomposition was used using 'db6' mother wavelet.

Network Parameters –
Network size – [8 12 1]
Transfer functions – 'logsig', 'logsig' 'purelin'
Training algorithm – 'trainlm'
Performance factor – Mean Squared error
Epochs = 500;
Permissible error = 1e-6;
Minimum gradient = 1e-10;
Learning Rate = 0.1;
The trained network was saved to a file.

Testing – An image was input and its feature and CODE was extracted, 1x1024 array of feature was wavelet decomposed to level 5 and then tested with the trained network. The value obtained after simulating the network was rounded, and the matched code was displayed.

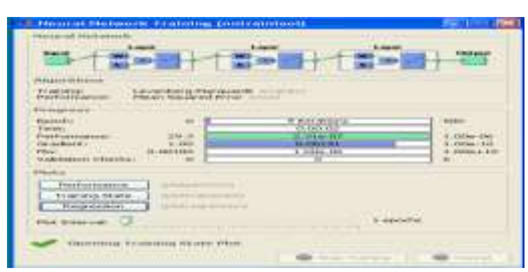

Figure 7.-Neural network training window for 10 images

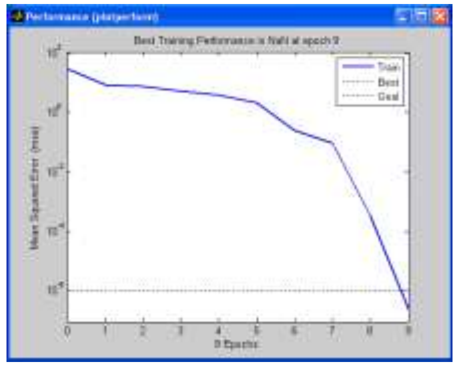

Figure 8.-Training performance

CODE vector generated for first 10 images –

176 174 145 165 159 162 136 131 147 136
177

III. RESULTS & CONCLUSIONS

36 images from 12 individuals were trained and 24 images for the same individuals were tested with the implementation. The UBIRIS dataset has 5 eye images for an individual. 3 out of 5 were used for training and 2 for testing. The result showed 100% accuracy in determining the exact individual. Also the test image was subjected to salt and pepper noise intentionally, and then tested with the trained network. Since the portion of the eye selected is only a small region of 32x32 pixels, the noise had no adverse effect on classification. The result obtained under the noisy test image was again 100%.

The only drawback of the proposed system is that a broad open eye is required. A close eye or eyelashes on the surface of the sclera part would not be recognized for extraction for the veins part and may extract the false area.

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