International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459 (Online), Volume 5, Special Issue 2, May 2015)
International Conference on Advances in Computer and Communication Engineering (ACCE-2015)

Robust Iris Recognition using DU-Fusion

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***Abstract*— An Iris Recognition is a commonly used technique to authenticate a person among all other available Biometric Techniques. The Iris Recognition System was developed and continuously improved by Daughman in 1993, which motivated many researchers to develop different techniques. In this paper, different fusion techniques at matching level were employed, which resulted in Robust Iris Recognition. Discrete Wavelet Transform (DWT) and Local Binary Pattern (LBP) feature extracting methods are applied on normalized iris templates to extract features. Further these different features are fused at matching level using LR-Fusion, RL-Fusion, DU-Fusion and UD-Fusion fusion techniques. The verification and identification performance of the proposed model is validated on CASIA dataset.**

***Keywords*— Iris Recognition, LBP, DWT, DU-Fusion, Robust, UD-Fusion, LR-Fusion, RL-Fusion.**

I. INTRODUCTION

The conventional mode of authentication is based on password, ID cards, etc. Biometric Systems are automated methods of recognizing a person. The biometrics brings stronger authentication based on physiological or behavioral characteristics. Iris Recognition is the most accurate approach for biometric authentication. Now a days it has become more common method to identify a person where high security is required like airport, ISRO, etc.

The Biometric System works first by capturing an Eye image, Segmentation & Normalization were employed then a feature extracting method is used to extract only the interested features and stored it as a template. The Figure 1 represents the steps involved in extraction and preprocessing steps for an iris image and is explained as follows :

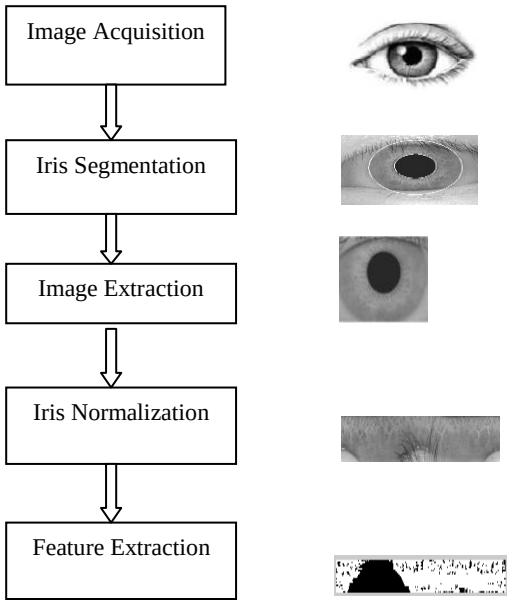

Figure 1: Preprocessing of an Iris image

A. Iris Segmentation:

Iris segmentation is used to locate the boundaries of Iris & Pupil in an image. The result of this is a set of contours extracted from image. Canny edge detection & Hough transform methods are used for segmentation.

B. Iris Normalization:

The captured Irises from different people may be of different size, because of stretching of the iris caused by dilation from varying levels of illumination, image distance etc., which results in mismatching of irises. It can overcome by iris normalization. Where the segmented iris image is transformed to a fixed size under different conditions i.e., unwrapped into rectangular image.

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C. Feature Extraction:

The features of iris image can be extracted by using the techniques like Discrete Wavelet Transform (DWT), Local Binary Pattern (LBP), Gabor filters and many other techniques from the normalized images. The extracted features are further stored in the database.

The paper is organized as follows: In section II, we discuss the existing algorithms and relating to iris research work. The section III, presents our proposed system. Experiments and results are presented on real iris images in section IV.

II. Previous Work

Automatic Iris Recognition has been an active research area since three decades. Some of the research work has been discussed in this section.

The first automatic Iris Recognition System was developed by Daughman [1] in 1993. In which gabor filters were used to extract the features. The hamming distance between Iris code of Training and Test iris images was used for iris recognition. Swanibhar Majumda, Kharibam Jilenkumari Devi, Subir Kumar Sarkar [2], [3] used DWT to produce Iris template and implemented digital watermark technique into data to be protected. Hong Lin Wan, Zhi Cheng Li, Jian-Ping Qiao and bao-Sheng Li [4], [5] presents a circle based Iris segmentation method for non-ideally captured Iris by employing anisotropic diffusion. The author uses an innovative curve evolution to detect exterior boundary, statistical filters were employed to enhance the contrast of iris and sclera. Abduljalil, Kasmiran Jumari, Nasharuddin Zainal [6], [7], [8], [9], [10] used circular gabor filters to find center of the pupil, Integro Differential Operator (IDO) used for localizing Iris & Pupil. The upper and lower eyelid boundaries are extracted using live-wire technique. The results shows that iris segmentation is fast. Brain O' Cannor and Kaushi Roy [11], [12] presented an efficient algorithm for Iris Recognition using the level set method & Local Binary Patten. Jaishanker K. Pillai, Vishal M. Patel, Rama Chellappa, and Nalini K ratha [13], [14], [15], [16] proposed a framework based on random projections & sparse representations that can handle non-constraint images in iris recognition. Adams Wai-Kin Kong [17], [18] proved Iris Code to be a compression algorithm which says templates are compressed iris images.

Samuel P. Fenker, Estefan Ortiz and Kevin W. Bowyer [19], [20] presented a paper on iris template aging occurs, resulting in false non-match rate.

III. Proposed Model

Iris images are first pre-processed as explained in section I. The Figure 2 shows the block diagram of the proposed iris recognition system. Following are the techniques used to extract features:

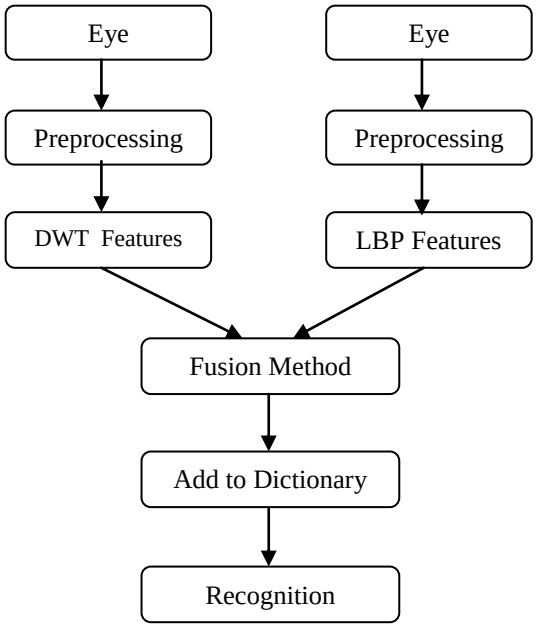

Figure 2: Block diagram of the proposed Fusion method

A. Feature extraction using DWT

There are two ways to extract the features using DWT method. They are

[cA,cH,cV,cD] = dwt2(X,'wname') (1)

[cA,cH,cV,cD] = dwt2(X,Lo_D,Hi_D) (2)

The dwt2 command performs a single-level two-dimensional wavelet decomposition with respect to either a particular wavelet like db1, haar, ribo1, etc or particular wavelet decomposition filters (Lo_D and Hi_D) that user specify.

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The equation (1), is used compute the approximate coefficients matrix cA and detail coefficients matrices cH (Horizontal), cV (Vertical) and cD (Diagonal), obtained by wavelet decomposition of the input image matrix X. The 'wname' string contains the wavelet name.

The coefficients cA, cH, cV and cD also can be extracted using equation (2) based on wavelet decomposition filters that user specify. Where,

Lo_D : Decomposition low-pass filter.

Hi_D : Decomposition high-pass filter.

Lo_D and Hi_D must be the same length.

For our experiments, approximation coefficients cA is considered. Which is stored in Dictionary D_{dwt}.

B. Feature extraction using LBP

Local Binary Pattern (LBP) method is used to extract iris features. The traditional LBP is computed by comparing the pixel of image with the neighboring pixels [11].

$$LBP_{PR} = \sum_{p=0}^{p-1} r(g_p \sim g_c) 2^p, r(x) = \begin{cases} 1, x \geq 0 \\ 0, x \leq 0 \end{cases} \quad (3)$$

Where g_c is the grey level of center pixel, g_p represents the neighboring pixel and r is the radius of neighborhood. If an image of size (x) is considered Local Bit Pattern is computed for each pixel of that image. The computed LBP is stored as a feature and stored in Dictionary D_{LBP}. The Figure 3 is the sample template of extracted LBP features of an iris image.

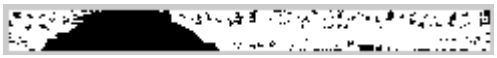

Figure 3: LBP Features

C. Fusion Techniques and Recognition

There are four different fusion methods were employed to combine DWT features and LBP features. They are LR-Fusion, RL-Fusion, DU-Fusion and UD-Fusion. The fusion algorithm is summarized as follow:

1) Perform the pre-processing (Segmentation & Normalization) of a given image.
2) Extract the features using DWT and LBP techniques and store in a database.
3) Combine the features of DWT & LBP and Training dataset is generated.

Repeat the steps 1 - 3 for test image and to carry out the identification. The different fusion methods are performed as follows:

LR-Fusion (Left –Right fusion)

The LR-Fusion is computed as follows:

$$C = A.*(1-P) + B.*P \quad (4)$$

RL-Fusion (Right-Left Fusion)

The RL-Fusion is computed as follows:

$$C = A.*P + B.*(1-P) \quad (5)$$

DU-Fusion (Down-Up Fusion)

DU-Fusion is a technique used for fusing the features of DWT & LBP features. The result of DU-Fusion is computed as:

$$C = A.*P + B.*(1-P) \quad (6)$$

UD-Fusion (Up-Down Fusion)

UD-Fusion is computed using

$$C = A.*(1-P) + B.*P \quad (7)$$

Where A & B in equations (4), (5), (6) and (7) are the features of DWT & LBP respectively, stored in the form of matrix of same size. P is the size of the matrix. C is the resultant matrix of fused features A & B, stored in database. The testing templates are compared with trained templates using Euclidian distance for Iris Recognition. The Figure 4 is a template created using DU-Fusion technique.

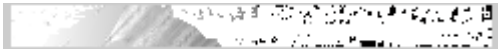

Figure 4: Extracted iris Template

IV. Experimental Results

Many Researchers have invented different techniques for Iris Recognition system. The proposed Fusion algorithm is performed using iris images from CASIA dataset [21]. The CASIA dataset includes 7 images from 108 different persons. The size of the image is 320 x 280 with grey level pixels. The Figure 5 shows randomly selected from the dataset.

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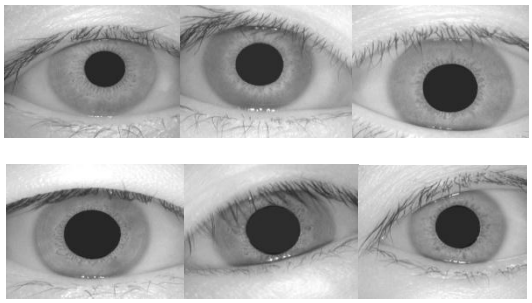

Figure 5: Sample images from CASIA dataset

The experiments are carried out using MATLab tool. Libor Masek's segmentation technique is used to isolate Iris and pupil boundaries. Then the iris image is normalized and unwrapped into rectangular image of size 20 x 240. Extract the N-dimensional vector of DWT & LBP features from the normalized template and concatenated as dictionary D_{DWT} and D_{LBP} respectively.

It has been performed many different experiments to study new algorithm. In order to fuse DWT and LBP features, we employed the different fusion techniques DU-Fusion, UD-Fusion, LR-Fusion & RL-Fusion. The experimental results shows recognition rate is 94% in DU-Fusion method. The Receiver Operating Characteristic (ROC) for True Success Rate (TSR), False Acceptance Rate (FAR) and False Rejection Rate (FRR) are plotted.

Figure 6 shows the results of recognition accuracy (TSR). Figure 7 & Figure 8 illustrates the FAR and FRR respectively. Figure 9 represents the comparison of recognition rate for all the 4 methods of fusion techniques. The results shows significant improvement is observed for DU-Fusion Technique.

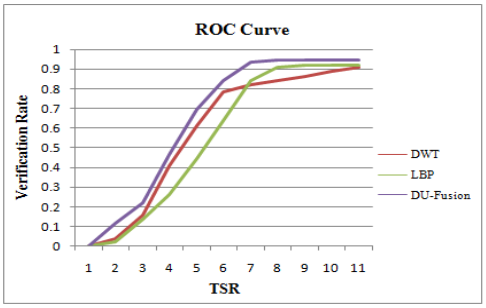

Figure 6: ROC Plots for Iris Recognition

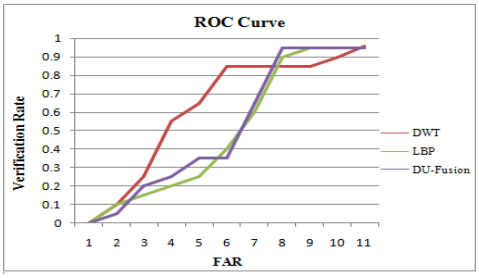

Figure 7: ROC Plots for False Acceptance Rate

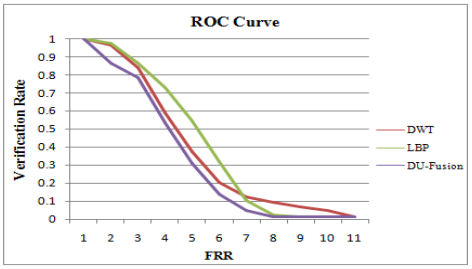

Figure 8: ROC Plots for False Rejection Rate

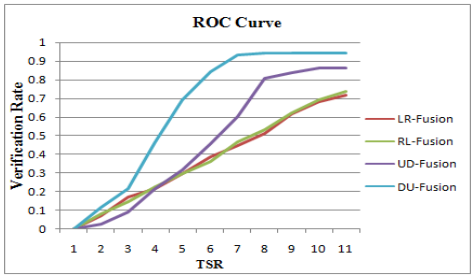

Figure 9: Iris Recognition using different fusion techniques

V. CONCLUSION

In this paper, we have compared recognition rate for DWT, LBP and DU-Fusion methods. The proposed algorithm shows Robust Recognition for iris images. Further iris recognition is performed using different fusion techniques and results were compared. Among all fusion methods, DU-fusion shows the better results. The system provides a new platform for developing a new recognition algorithm. Currently we are exploring the ways to handle unconstrained images like occlusion, specular reflection, segmentation error.

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