Iris Recognition using Hamming Distance and Fragile Bit Distance

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Abstract— Iris recognition algorithms use the binary iris codes for iris. In iris code the iris information is represented with binary values. Iris recognition algorithms use different kind of filters to get details of iris pattern. The Gabor filters or Log-Gabor filters are mostly used for iris recognition. The iris code is real or imaginary part of the filtered iris template. Hamming distance between two iris codes can be used to measure similarity of two irises. Fragile bit pattern is term which defines location of fragile bits in the iris code. Similar to iris code, a fragile bit pattern for each iris can be generated. Based on hamming distance between two fragile bit patterns some similarity or non-similarity information for two irises can be obtained.

Key words: Iris recognition algorithms, Bit fragility, Fragile bit pattern

I. INTRODUCTION

Reliable identification of person is required in many day to day applications. In organizations like college, hospitals, industries, it is used to take attendance of employs working there. In financial transactions also reliable methods for person identification are required. Biometric identification methods are now days very commonly used for personal identification. In biometrics there are two methods for identification, physiological identification and behavioral identification. Physiological methods are based on physical characteristics of person. It includes face photographs, finger print, iris and DNA. Behavioral methods are based on behavioral characteristics of person like signature and voice. Behavioral methods are easy to duplicate. Therefore behavioral methods are less reliable for person identification. Physiological methods are comparatively difficult to duplicate. Among the physiological methods mentioned before the iris is the good physiological characteristic for person identification.

A. Bit Fragility

In the iris recognition system for the same eye multiple images need to be taken for developing a robust system. For each iris image, iris code is obtained by applying some algorithm. Therefore multiple iris codes for same iris are obtained. For a particular pixel on the iris code throughout the multiple codes, it is not necessary that its value remain constant. If say among 10 different iris codes of same eye a particular pixel has value '1' for 7 times and value '0' for remaining 3 times. Then it can be said that that particular pixel is 70% consistent and 30% inconsistent. i.e. the pixel is 30% fragile. In table.1 for 10 iris images of same eye, 10 iris codes are obtained. If a particular pixel is varying its value among different codes then its fragility is given.

Total images	Pixel value ='1' _ times	Pixel value='0' _ times	Pixel is _% fragile
10	4	6	40
10	6	4	40
10	2	8	20
10	8	2	20
10	7	3	30
10	3	7	30

Table 1: Pixel Fragility

Conventionally, the bit fragility was decided by taking multiple images of same eye. As mentioned in [2], the lowest 25 % values in the Log-Gabor filter output can be considered as fragile bits and there is no need to take multiple images of same iris to decide fragility of pixel.

II. WORK FLOW IN THE EXPERIMENT

A. Iris Database

In the work, iris database from Chinese Academy of Sciences (CAS) is used. This database is created by National Academy for Pattern Recognition of China. CASIA V1.0 is the name of database used in the work.

B. Image Segmentation

The image segmentation is preprocessing step for iris recognition. In the work pupil and iris are two parts which are of interest. The image segmentation is carried out in two steps.

1) Pupil Center and Radius Detection

Pupil is the central part of iris. Pupil is having lowest pixel value in grayscale image of eye. To detect center of pupil this information is used. Thresholding, morphological opening and edge detection are operations used for detection of pupil properties. Thresholding converts gray scale image to a binary black and white image. The threshold is selected such as the black and white image contains the dark parts in the original gray scale image. These parts include pupil and some other dark parts in the image such as eyelids. The morphological opening is performed on thresholded image which removes small connected components in input image and returns connected components which have connectivity more than particular number of pixels. Edge detector operator is applied on the opened image to find shape of pupil. Robert operator, Sobel operator, Prewitt operator, Canny edge detector are the operators available for edge detetion.

2) Iris Outer Radius Detection

Eye image is filtered with Gaussian filter for iris outer radius detection. Integro-differential operator is used for iris outer radius detection.

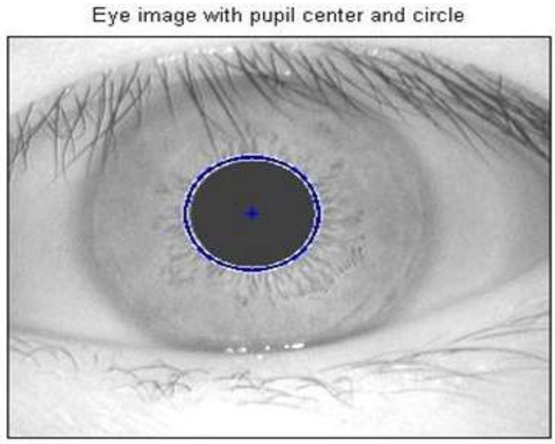

Fig. 1: center and radius show on input eye image

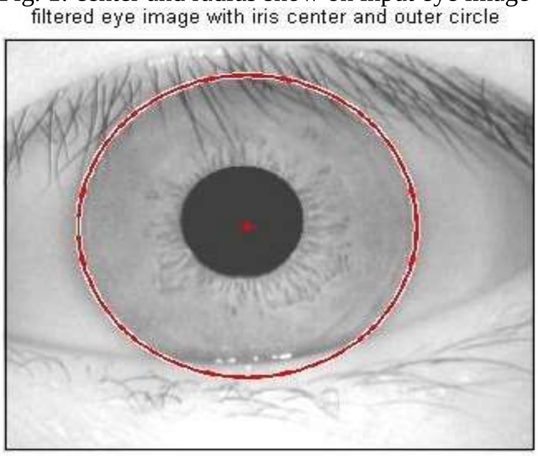

Fig. 2: iris outer radius shown on Gaussian filtered input image

C. *Normalization*

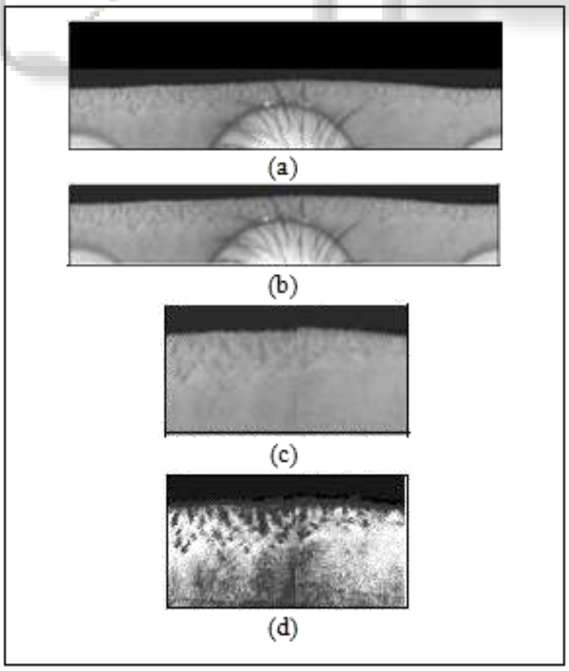

Fig. 3: (a) Normalized iris image (b) Normalized iris image without pupil part (c) Iris template (occluded part removed) (d) Enhanced iris template

The normalization process is used to produce iris regions, which have the same constant dimensions, so that two images of the same iris under different conditions will have characteristic features at the same spatial location [3]. After segmentation has been completed, normalization is performed in all studied iris recognition systems to obtain invariance to iris size, position and different degrees of pupil dilation when matching different iris patterns at a later stage. The problem of that the iris can be rotated in the image is not resolved by this transformation. The method that is widely accepted for doing this is applying Daugman's rubber sheet model to the iris and transforming it into a rectangular block.

D. *Filtering*

In experiment normalized iris template is filtered with Log-Gabor filter.

E. *Template Generation*

Template generation procedure used in experiment is shown in following fig. 4 and fig. 5. The normalized iris image is iris template. This iris template is filtered with Log-Gabor filter for feature extraction. Log-Gabor filtering gives two output matrices, real output (temp_real) and imaginary output (temp_img). Real output part is used for further calculations. Thresholded real part of Log-Gabor output is called temp_real_bw. Fragile bit pattern is matrix which denotes location of fragile bits in the temp_real. This matrix is obtained by setting logic '1' value for the location of fragile bits and setting logic '0' for the consistent bits. In this way fragile bit pattern (fbp) for temp_real is defined and this is a binary matrix. This template is denoted by temp_real_fbp_bw. Generation procedure for temp_real_fbp_bw is shown in fig. 5.

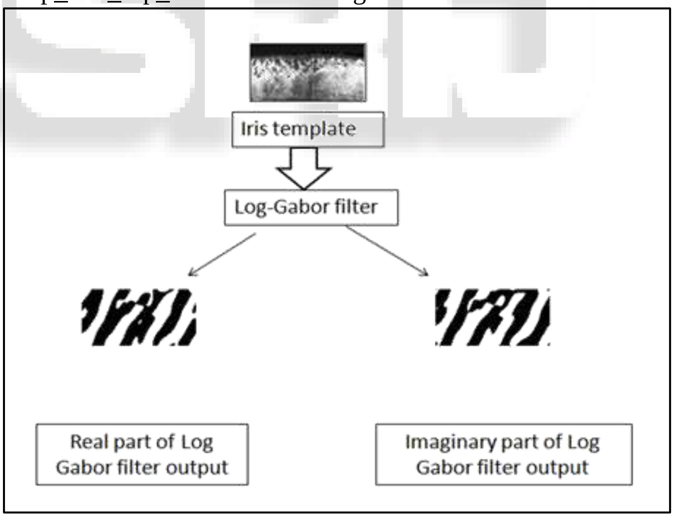

Fig. 4: Log-Gabor filter outputs

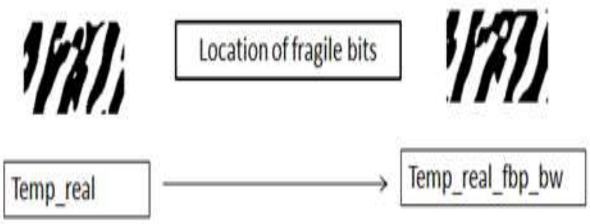

Fig. 5: Fragile bit pattern template

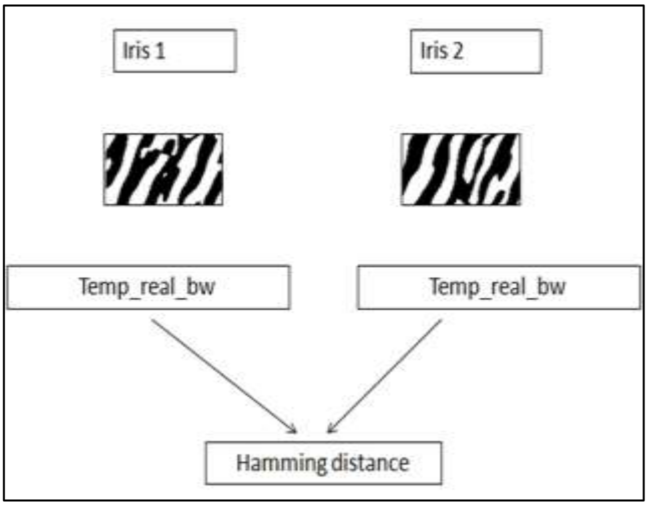

Fig. 6: Hamming distance calculation

F. Hamming Distance and Fragile Bit Distance Calculation

1) Hamming Distance

Hamming distance is calculated between templates temp_real_bw of two iris images.

2) Fragile Bit Distance

Fragile bit distance is the hamming distance between fragile bit patterns temp_real_fbp_bw of two iris images.

3) Combination of Hamming Distance and Fragile Bit Distance

In this method weighted average of hamming distance and fragile bit distance is taken in consideration.

The distance calculation methods are explained in fig. 6 and fig. 7.

1) Match hamming or fragile bit distance

This is the hamming or fragile bit distance calculated between two iris templates of same eye.

2) Non-match hamming or fragile bit distance

This is the hamming or fragile bit distance calculated between two iris templates of different eye.

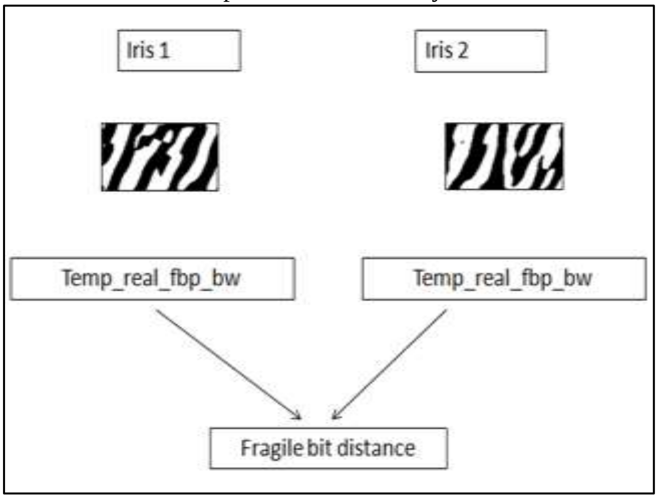

Fig. 7: Fragile bit distance calculation

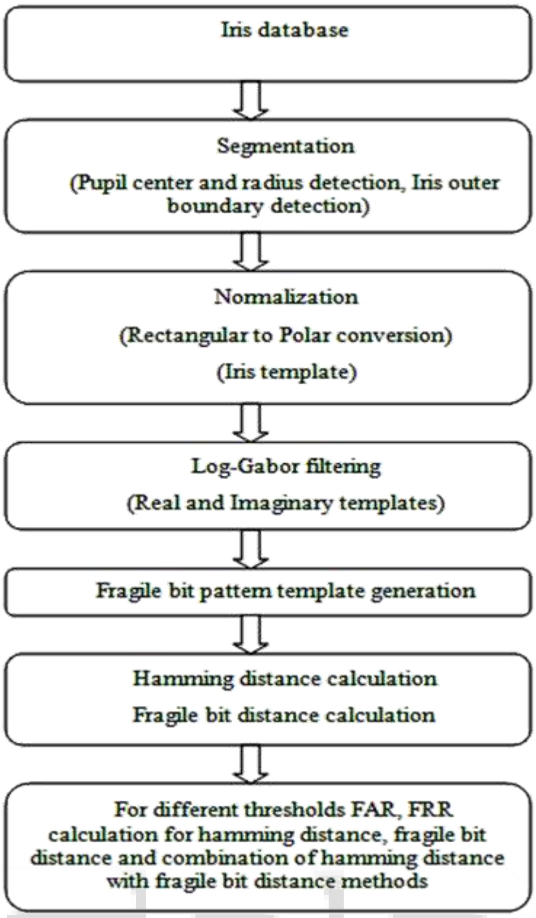

Fig. 8: Work flow of experiment

III. RESULTS

Hamming distance vs fragile bit distance plot is shown in fig. 9. The match comparison points are shown by blue triangles and non-match comparison points are shown by red circles.

As shown in fig. 10 and fig. 11 separation of match and non-match comparison results is better in fragile bit distance method than in hamming distance method. From fig. 11 and fig. 12 it can be said that there is no improvement in separation by combining hamming distance and fragile bit distance.

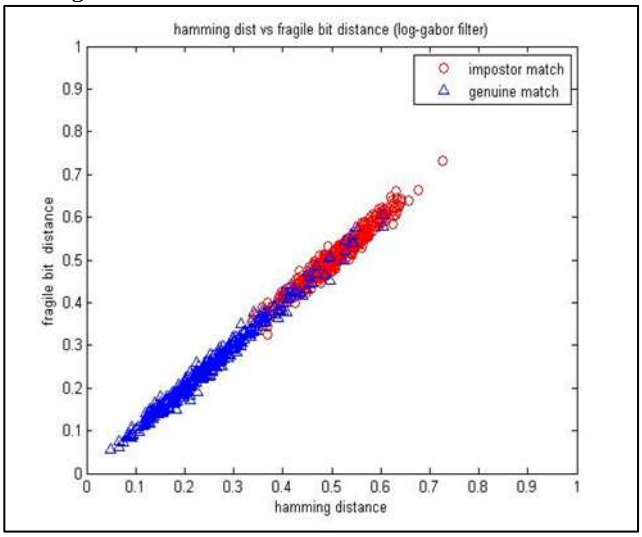

Fig. 9: Hamming distance vs fragile bit distance

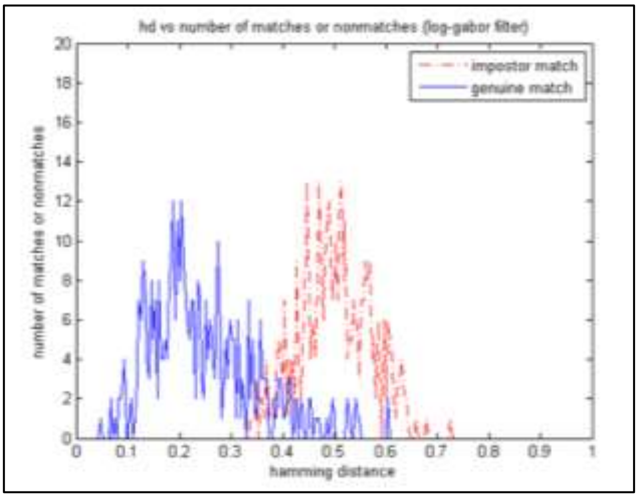

Fig. 10: Hamming distance vs number of matches or non-matches

The FAR (False Accept Rate)-FRR (False Reject Rate) and EER (Equal Error Rate) results are shown in table 2.

Method	**Threshold value**	**EER**
Hamming Distance	0.4014	8.75%
Fragile bit distance	0.4047	8.25%
Combination of hamming distance and fragile bit distance	0.4075	8.25%

Table 2: FAR-FRR Table

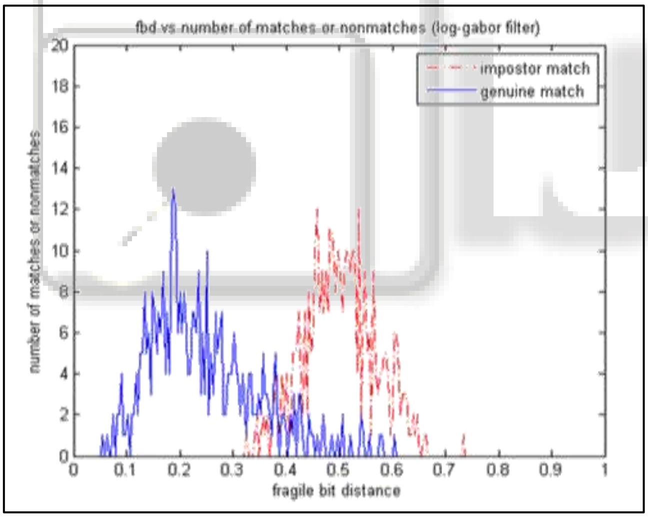

Fig. 11: Fragile bit distance vs number of matches or non-matches

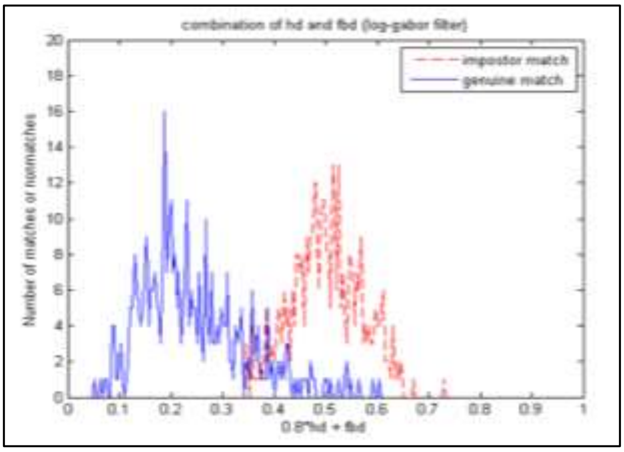

Fig. 12: combination of hamming distance and fragile bit distance vs number of matches of non-matches

IV. CONCLUSION

Equal error rate value is 8.75% for hamming distance method, 8.25% for fragile bit distance method and 8.25% for combination of hamming distance and fragile bit distance method. Equal error rate value is decreased by 0.50% in fragile bit distance method as compared to hamming distance method. Combination of hamming distance and fragile bit distance method has same results as fragile bit distance method.

Fragile bit distance method is best for iris recognition (CASIA V1.0 database), taking computational complexity in consideration.

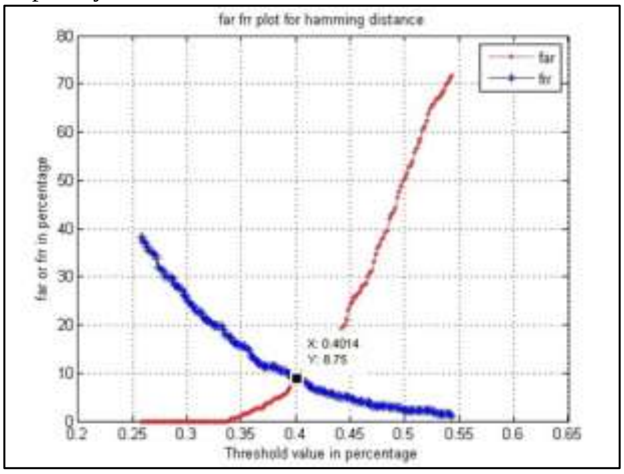

Fig. 13: FAR-FRR plot for hamming distance method

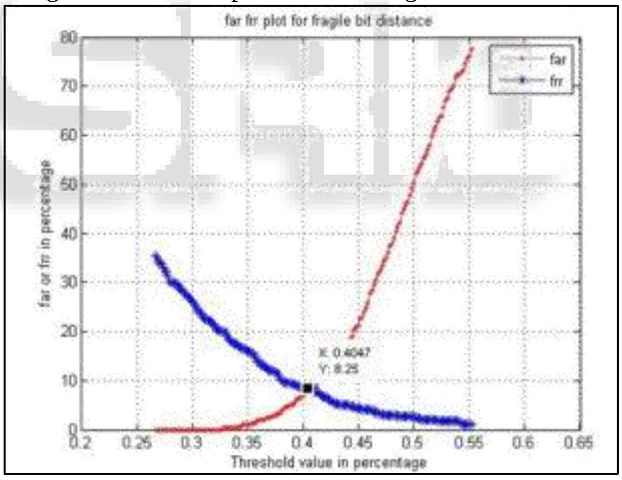

Fig. 14: FAR-FRR plot for fragile bit distance method

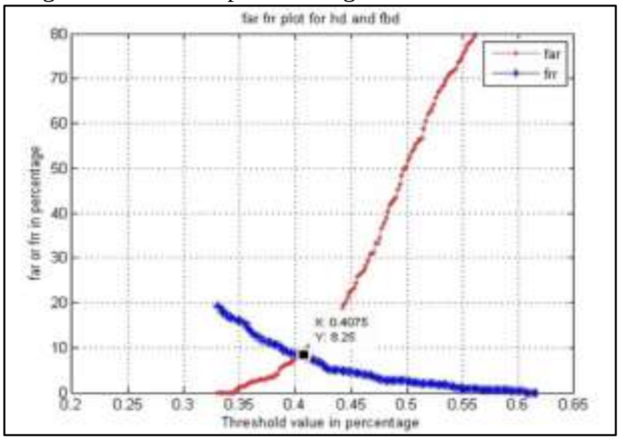

Fig. 15: FAR-FRR plot for combination of hamming distance and fragile bit distance vs number of matches of non-matches

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