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Multimodal Biometric System using Iris and Fingerprint

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ABSTRACT

Most real-life biometric systems are still unimodal. Unimodal biometric systems perform person recognition based on a single source of biometric information. Such systems are often affected by some problems such as noisy sensor data, non-universality and spoof attacks. Multibiometrics overcomes these problems. Multibiometric systems represent the fusion of two or more unimodal biometric systems. Recently, multi-modal biometric fusion techniques have attracted increasing attention and interest among researchers, in the hope that the supplementary information between different biometrics might improve the recognition performance in some difficult biometric problems. The small sample biometric recognition problem is such a research difficulty in real-world applications. In this paper, we present a multibiometric recognition system using two types of biometrics Iris, and Finger Print. The fusion is applied at the matching-score level. The experimental results showed that the designed system achieves an excellent recognition rate .

Keywords: *Biometrics; Multimodal Systems; Iris recognition; Fingerprint recognition; Gabor transformation; Score level fusion.*

I. INTRODUCTION

Biometrics is one of the most widely used approaches for the identification of an individual using physiological or behavioural characteristics such as the face, iris, finger vein or gait [1]. Biometric systems are advantageous because they do not require a person to carry cards or remember information, unlike conventional authentication systems based on smart cards or passwords. Possession - based authentication systems have the disadvantage that keys and tokens can be shar , misplaced, duplicated, lost or stolen, whereas biometric systems avoid these problems [2]. Thus, biometrics has been adopted in many applications. However, unimodal biometric systems (based on a single modality such as the face or fingerprint) face several problems, such as illumination variation, skin condition and the environment, and device variations [3]. For example, the performance of face recognition is easily degraded by the facial pose, expression and various illumination conditions. Iris recognition performance is greatly affected by the huge area of near infrared (NIR) light reflection that hides the iris area, dense eyelashes and defocusing of the input image. To overcome the limitations of unimodal biometrics, much attention has been paid to multimodal biometrics [4]. Multimodal biometrics aims to identify the individual based on two or more human physiological or behavioural characteristics. The key problem of multimodal biometrics is the method used to combine multiple features from each modality to produce better recognition results.

Many studies and algorithms have been proposed for multimodal biometric fusion [5, 6]. The fusion of multimodal biometric system information can be performed at three different levels, i.e., feature level, matching score level and decision level. A popular method is to fuse at the matching score level because it easily facilitates the combination of scores from different matching systems such as face and fingerprint recognition systems [5]. Thus, we focus on fusion at the matching score level to integrate matching scores for the iris and fingerprint in this study. There have been many previous studies of multimodal biometric systems that combine the face with a palmprint or the face with the iris, etc. [4].

In this research, score level fusion is used. This approach has the advantage of utilizing as much information as possible from each biometric modality. Two modalities are used in these researches which are fingerprint and iris. In first sections a brief review for fingerprint and iris acquiring code is provided, and then the combination method of these two modalities and fusion method are introduced.

II. RELATED WORKS

A number of studies have been done on multimodal biometrics and these works show that multi- biometric has more advantage than single- biometric. Brunelli and Falavigna [7] used hyperbolic tangent (tanh) for normalization and weighted geometric average for fusion of voice and face biometrics. Hong and Jain [8] proposed an identification system based on face and fingerprint, where fingerprint matching is applied after pruning the database via face matching. Kittler et al. [9] have experimented with several fusion techniques for face and voice biometrics. Ben-Yacoub et al [10] considered several fusion strategies, such as support vector machines, tree classifiers and multi-layer perception, for face and voice biometrics. The Bayes classifier is also used in many methods. Ross and Jain [11] combined face, fingerprint and hand geometry biometrics with sum, decision tree and linear discriminate-based methods. The authors report that sum rule outperforms others. Shubhangi and Manohar Bali proposed multimodal biometric system using face and fingerprint and combining ridge based matching for fingerprint and Eigen face [12].

III FINGERPRINT RECOGNITION

A fingerprint is the feature pattern of one finger and it is believed that each fingerprint is unique. Each person has his own fingerprints with the permanent uniqueness. So fingerprints have being used for identification and recognition. A fingerprint is composed of ridges and furrows which are parallel and have same width as shown in Fig. 1.

However, in fingerprint recognition, fingerprints are not distinguished by their ridges and furrows; they are distinguished by Minutia, which are features on the ridges. There is variety of minutia types on fingerprint image as in the below figure but two are mostly significant and in heavy usage: one is called termination, which is the immediate ending of a ridge and the other is called bifurcation, which is the point on the ridge from which two branches derive.

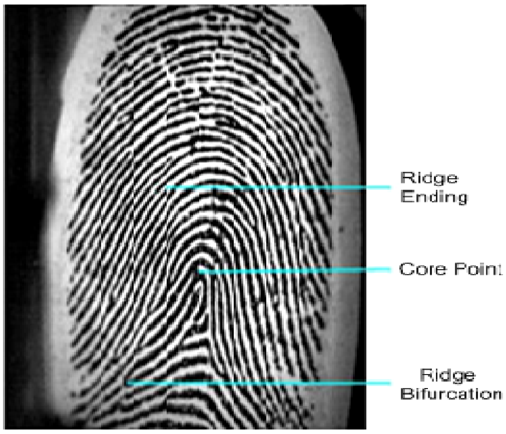

Fig. 1 Ridge ending core point and ridge bifurcation is shown

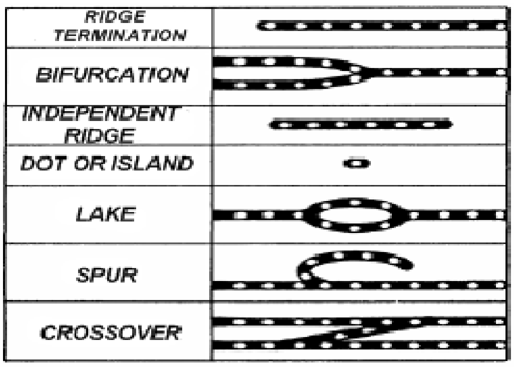

Fig. 2 Variety of minutia types on fingerprint image

Fingerprint identification system has three part that are image acquiring part, feature extraction part and matching part. In image acquiring part, optical sensors are used. The main part is feature extraction and this part has three sections: pre-processing, minutia extraction and post processing. Pre-processing section tries to enhance image quality with binary image and then ridges on fingerprint are making thin.

A. Binarization

Image binarization is the process of turning a gray scale image to a black and white image. In a gray- scale image, a pixel can take on 256 different intensity values, while each pixel is assigned to be either black or white in a black and white image. This conversion from gray scale to black and white is performed by applying a threshold value to the image. In MATLAB, a value of one means the pixel is white, whereas a value of zero indicates the pixel is black. For a gray-scale image, the pixels are decimal values between 0 and 256. When a threshold is applied to an image, all pixel values are compared to the input threshold. Any pixel values below the threshold are set to zero, and any values greater than the threshold are set to one. By the end of this process, all pixel values within the image are either zero or one, and the image has been converted to binary format.

B. Thinning

Ridge Thinning is to eliminate the redundant pixels of ridges till the ridges are just one pixel wide. In each scan of the full fingerprint image, the algorithm marks down redundant pixels in each small image window (3x3). And finally removes all those marked pixels after several scans. In my testing, such an iterative, parallel thinning algorithm has bad efficiency although it can get an ideal thinned ridge map after enough scans. Their method traces along the ridges having maximum gray intensity value. However, binarization is implicitly enforced since only pixels with maximum gray intensity value are remained. Also in my testing, the advancement of each trace step still has large computation complexity although it does not require the movement of pixel by pixel as in other thinning algorithms.

C. Feature Extraction

A Gabor filter is a linear filter used for edge detection in image processing which is named after Dennis Gabor. Gabor filter frequency and orientation representations are similar to those of human visual system, for texture representation and discrimination it has been found to be remarkably appropriate. A sinusoidal plane wave has been modulating a 2D Gabor filter which is a Gaussian function in the spatial domain. From one parent wavelet all filters can be generated by dilation and rotation, thus the Gabor filters are self-similar. With eight different orientations of Gabor filter, features of the fingerprint are extracting and are combined. where f represents the ridge frequency and the choice of x 2 and y 2 determines the shape of the filter envelope and also the trade of between enhancement and spurious artifacts. This is by far, the most popular approach for fingerprint enhancement:

$$G(x,y) = exp\left\{-\frac{1}{2}\left[\frac{x^2}{\delta_x^2}+\frac{y^2}{\delta_y^2}\right]\right\}\cos(2\pi f x) \quad (1)$$

D. Matching

Matching is performed using Hamming distance measure defined in eq. 2:

$$HD = \frac{1}{N}\sum_{j=1}^{N} X_j \oplus Y_j \qquad (2)$$

The result is the no. of bits that are different between the binary codes Xj and Yj. If the hamming distance between two images is 0, provided that there have not been any noise patterns in the image while it was segmented and normalized, the two images are from same subject and same eye. However, it is the ideal case and even in most perfect conditions, it is not the case. Hamming distance in practical conditions, i.e. considering some amount of noise is also available while acquiring the image, varies in the range (0,1]. It is measured against a pre-defined threshold value which says if the calculated hamming distance is greater than the threshold this means the two images are not from the same subject else the images are from the same subject.

IV. IRIS RECOGNITION

The iris recognition process consists of five major steps. The first step is the image acquisition of a person's eye at enrollment time or check time. The second step is to segment the iris out of the image containing the eye and part of the face, which localizes the iris pattern. Step three is the normalization; here the iris pattern will be extracted and scaled to a predefined size.
Step four is the template generation; here the details of the iris are filtered, extracted and represented in an iris code. The last step is the matching phase, where two iris codes will be compared .atypical main steps of an iris recognition system is shown in *Fig. 3*

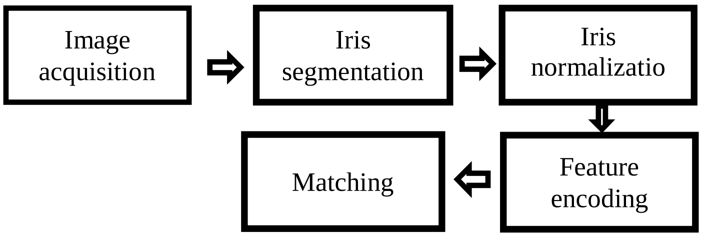

Fig. 3.Typical main steps of an iris recognition system

A. Segmentation

Initially eye images must be segmented to extract only the iris region by locating the inner (pupil) and outer boundaries of the iris. Occluding features must also be removed and the iris pattern normalized. Segmentation is important with only accurately segmented images suitable for proceeding to the later stages of iris recognition.

To segment the iris using Hough transform, center of pupil and iris are located first This is obtained by scanning the pupil vertically and horizontally and then finding the maximum number of pixels in horizontal and vertical lines which will be considered as the diameter of circular boundary of pupil. After this, circular Hough transform is applied to segment the iris and pupil by drawing the circles, as shown in Fig. 4.

B. Normalization

The localized iris is then normalized to a rectangular block with a fixed size radius being in correspondence to the width of the block and angular displacement θ being in correspondence with the length of the block. Fig. 6 shows the normalization process.

C. Feature Extraction and Encoding

Feature Extraction is a process to extract the information from the iris image. These features can not be used for reconstruction of images. But these values are used in classification. Gabor filters are used for the purpose. The 2D Gabor filters were chosen for the extraction of iris information because of the nice optimality properties.
filters that are well localized in frequency are poorly localized in space(or time), and vice versa. The Gabor wavelets have the maximal joint resolution in the two domains simultaneously, which means that both "what" and "where" information about iris features is extracted with optimal simultaneous resolution.
.Gabor filters give rotation – invariant system for feature extraction. In our experiments, we employed a Gabor filter with isotropic 2D Gaussian for rotation invariant classification. Gabor filter's frequency domain equation is as follows:

$$G(x,y) = g(x,y)\exp\left(-2\pi j(u.x + v.y)\right) \qquad (3)$$

$$g(x,y) = -\exp\left(x^2 + \frac{y^2}{2\sigma^2}\right).j = \sqrt{-1} \qquad (4)$$

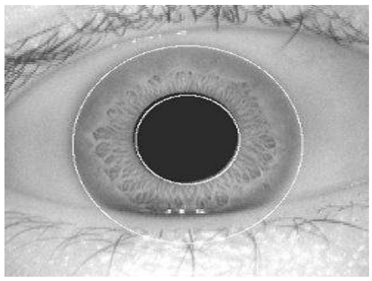

Fig. 4. Iris Segmentation

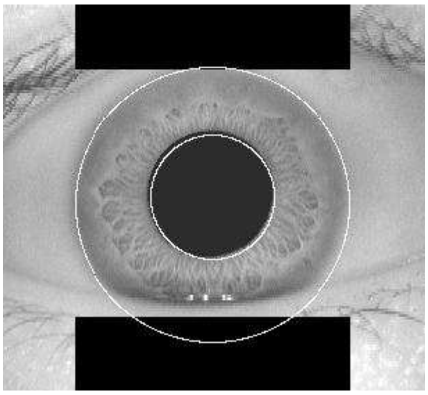

Fig. 5. Occlusion effect

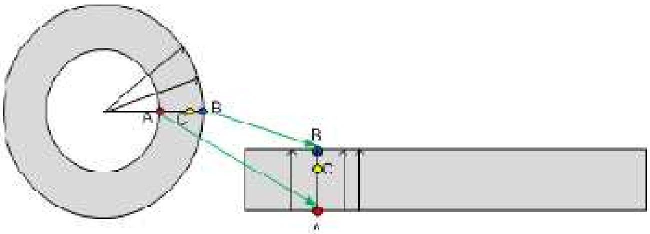

Fig. 6. Normalization process

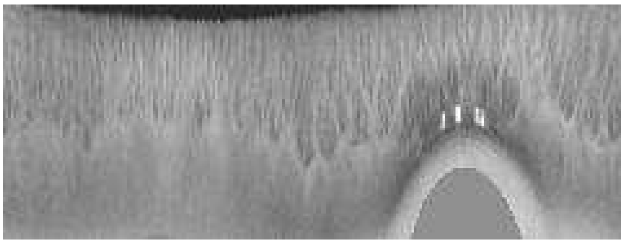

Fig. 7. Normalized iris

Fig. 8. Noise mask

Fig. 9. Iris pattern

D. *Matching*

Matching is performed using Hamming distance measure defined in eq. 2.

V. DATA FUSION

The methods of scores fusion combine information with the level of the scores resulting from the modules of comparison

A fusion system consists of two modules, a fusion module and a decision module; we combine the scores by the Product of the scores of sub-system defined in eq. 5.

$$s = \prod_{i=1}^{N} s_i \qquad (5)$$

S_i :is the sub_score of N system

Each individual matching score are used to combine for generating a single scalar score for making the final decision. An overview of the fusion process is shown in Fig. 10.

VI. EXPERIMENTAL RESULTS

Our system has been implemented in the environment MATLAB development. This environment can quickly develop applications using software components ready to be used and maximum simplifies writing.

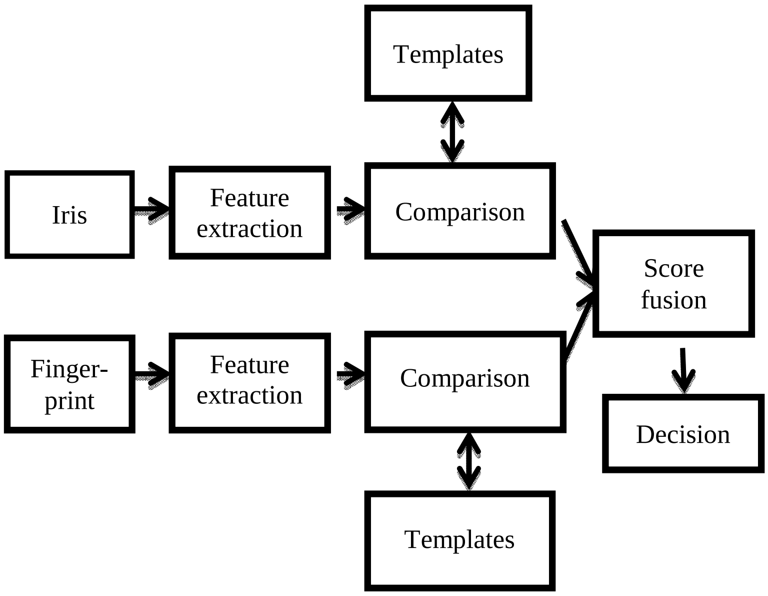

Fig. 10. Fusion at matching score level

In this section, Single biometric fingerprint is used and find results that is shown in table1. Then iris recognition is used and

the result is obtained. Now if multi- biometric is used with fusion fingerprint and iris, better result is accepted.
Table 1 shows differences between two single-biometrics and multi- biometric.

Was used in our tests, the iris database CASIA V1.0 of 108 people, with 7 images in each database and fingerprint VeriFinger_Sample_DB 76 people, with 8 images for each. It was taken to build a base of chimerical database that contains 70 people by combining iris and fingerprint samples from different individuals.

To evaluate the performance of our system, we used both metric FAR false acceptation rate and the FRR false reject rate. Table 1 summarizes the results obtained.

TABLE I. DIFFERENCE BETWEEN UNI-MODAL AND MULTI-MODAL RESULTS

	FAR %	**FRR %**
Unimodal system Fingerprint	5.57	10.02
Unimodal system Iris	3.61	4.31
Multimodal system	1.74	2.14

Table II shows the result obtained by [13] where they use the log Gabor filter to extract the feature vectors from both Iris and Fingerprint, Hamming distance is used to generate a final match score. The fusion is applied at feature level in frequency domain.

TABLE II. FAR AND FRR FOR THE SYSTEM PROPOSED BY [13]

	FAR %	**FRR %**
Multimodal system	0	4.3

VII. CONCLUSION

In this paper, a multimodal biometric recognition system using two modalities including Iris, and Fingerprint with fusion at matching score level is proposed. We show that our system also exhibits an excellent recognition performance and outperforms unimodal systems weather we use two biometrics dynamic architecture to ensure varying security levels using the adaptive combination of multibiometrics.

This work can be used in the development of multimodal biometric system that can include multiple fusion rules in a dynamic architecture to ensure varying security levels using the combination of multibiometrics.

REFERENCES

[1] Nguyen D. T, Park Y. H, Lee H. C, Shin K. Y, Kang B. J, Park K. R (2012) Combining Touched Fingerprint and Fingervein of a Finger, and Its Usability Evaluation. Advanced Science Letters. 5: 8595.

[2] Prabhakar S, Pankanti S, Jain A. K (2003) Biometric Recognition: Security and Privacy Concerns. IEEE Security and Privacy Magazine. 1: 3342.

[3] Khan M, Zhang J (2008) Multimodal Face and Fingerprint Biometrics Authentication on Space Limited Token. Neurocomputing. 71: 3026,3031.

[4] Kumar G. H, Imran M (2010) Research Avenues in Multimodal Biometrics. International Journal of Computer Applications. 1:1□8.

[5] Ross A, Jain A (2003) Information Fusion in Biometrics. Pattern Recognition Letters. 24: 21152125.

[6] Mishra A (2010) Multimodal Biometrics It is: Need for Future Systems. International Journal of Computer Applications. 3: 28□33.

[7] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[8] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[9] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[10] S. Ben-Yacoub, Y. Abdeljaoued, and E. Mayoraz, "Fusion of Face and Speech Data for Person Identity Verification", IEEE Trans. Neural Networks, vol. 10, no. 5, pp. 1065-1075, 1999.

[11] A. Ross and A.K. Jain, "Information Fusion in Biometrics", Pattern Recognition Letters, vol. 24, no. 13, pp. 2115-2125, 2003.

[12] Dr. Shubhamgi D C, Manohar Bali. "Multi-Biometric Approaches to Face and Fingerprint Biometrics". International Journal of Engineering Research & Technology. 2278-0181. 2012.

[13] Ujwalla Gawande, Sreejith R Nair, Harsha Balani, Nikhil Pawar & Manjiri Kotpalliwar"A High Speed Frequency Based Multimodal Biometric System Using Iris and Fingerprint". International Journal on Advanced Computer Engineering and Communication Technology. Vol. 1, 2278-5140, 2012