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Performance Analysis of Fingerprint Identification Using Different Levels of DTCWT

Jossy P. George[1+], Abhilashs. K. [2], Chethana M. D. [2] and Raja K. B. [2]

[1] Christ University, Bangalore, Karnataka, India
[2] University VisvesvarayaCollege of Engineering**,** Bangalore, Karnataka, India

Abstract. The Fingerprint is a physiological biometric characteristic to identify a person. In this paper, we propose Performance Analysis of Fingerprint Identification using different levels of DTCWT. The original Fingerprint is cropped and resized to suitable dimension to apply DTCWT. The DTCWT is applied on Fingerprint to generate coefficient which form features. The performance analysis is discussed with different levels of DTCWT and also with different sizes of Fingerprint database. It is observed that the recognition rate is better in the case of level 7 compared to other levels of DTCWT

Keywords: Fingerprint, DTCWT, Euclidean Distance, Preprocessing.

1. Introduction

The human beings can be authenticated using existing traditional methods such as Passwords, Personnel Identification Numbers (PINs), Tokens and Smart Cards. The disadvantages of traditional methods are (i) Passwords and Pins are difficult to remember. (ii) More chances of losing tokens and smart cards. (iii) The misuse of traditional methods of authentication by miscreants is very high, especially in the case of money transaction through ATMs, access to the unauthorized places, etc. The bio-metric authentication technology is an alternative to these traditional methods. The term *biometric* is derived from the Greek word *bio* (life) and *metrics* (to measure). The biometrics identifies the person, based on feature vectors derived from physiological or behavioural characteristics. The biometric traits must satisfy universality, uniqueness, permanence, accessibility, collectability. The physiological biometrics are Fingerprint, Hand Scan, Iris Scan, Facial Scan and Retina Scan etc. and behavioural bio-metric are Voice, Keystroke, Gait, Signature etc. The physiological biometrics traits are almost constant throughout the life span of a person, even for identical twins. The behaviour biometric trait varies with mood and environment.

Fingerprint is a physiological trait which is constant throughout the life span of a person. The fingerprint is unique even for the twins. It has been used as the identification technique for over a century. The fingerprint authentication officially established as a means of identifying people around 1900s. This authentication got the popularity because; the devices for accessing the fingerprints are small and inexpensive. When a biometric verification is to occur, a scan of the biometric of a person is made and which is to be compared with the stored data of the same person.

Contribution:In this paper the performance analysis of Fingerprint Identification using DTCWT at different levels is discussed. DTCWT generates complex coefficients by using a dual tree of wavelet filters to obtain two parts of the images, i.e., real and imaginary part. DTCWT is applied on Fingerprint to generate different levels to obtain Fingerprint features. The ED is used to match test Fingerprint with database.

+ Corresponding author.
E-mail address: frjossy@christuniversity.in.

Organization: The Introduction is given in section 1, the existing research papers are discussed in section 2, the proposed model is explained in section 3, the algorithm is described in section 4, the performance analysis is discussed in section 5 and finally, conclusion is given in section 6

2. Literature Survey

Different applications and usages of Physiological biometric trait, Fingerprint for individual identification and verification with different technique and the different applications of DTCWT are described in this section.

S. Vasukiet. al., [1] proposed a model for segmentation of a color textured regions of a given images. This is obtained by the segmentation and by applying DTCWT. This model works in two levels where in first level, after applying DTCWT, the image is divided into 16 sub images and from where the maximum energy sub image is selected as a optimum feature space. In the second level, K-means spatial refinement algorithm is applied. The main advantage of this model is the accuracy. Zhao Song and Liu Yuanpeng [2] gave a novel image denosing scheme by applying 2-D DTCWT to the second bandlet transform. This is obtained based on the shift – invariance and better directionality of the DTCWT. The bandlet reconstruction recovers the transitions and directional textures. This improves significantly image denosing results. Chen Feng and Yu Song – nian [3] proposed a model which retrieves the multiscale image by using a new class of image features as the image descriptors from DTCWT. From this work, we can conclude that the performance of DTCWT is better in the experiment on the stander COREL image database due to the rotation invariance, translation invariance, robust to noise and getting the key point according to people's cognitive habits. Sathesh and Samuel Manoharan [4] discussed on advantages and disadvantages of DWT. Also they give the methods to overcome the limitations of DWT and the theoretical analysis of complex wavelet transform and its verification using the simulated images. V. Lulian and B. Monica [5] proposed a method to design and optimize separately two channels perfect reconstruction filter banks. This method ensures the good quality for the two levels. This method is more useful where the only the few levels of decomposition is required. Shahid and Gupta S [6] proposed a novel method to fuse an image using the DTCWT. This is achieved through the formation of a fused pyramid using DTCWT coefficients from the decomposed pyramids of a source image. This methods gives a better qualitative and quantitative results than the DWT methods.

3. Model

In this section, definitions of Performance Analysis and proposed model are discussed.

3.1 Definitions

3.1.1 False Accept Rate (FAR)

It is the probability that system incorrectly matches with images stored with input image database. The FAR can be calculated using Equation 1.

$$FAR = \frac{\text{No. of persons accepted from out of database}}{\text{Total no. of persons in database.}} \quad (1)$$

3.1.2 False Rejection Rate (FRR)

It is the probability that system fails to recognize the correct pattern to match with the database images. It is the ratio of number of correct persons rejected in the database to the total number of persons in database and can be calculated using Equation 2.

$$FRR = \frac{\text{No. of correct persons rejected}}{\text{Total no. of persons in database.}} \quad (2)$$

3.1.3 Equal Error Rate (EER)

It is the value where both the reject and accept rates are equal.

3.1.4 True Success Rate (TSR)

It is the ratio of total number of persons correctly matched in the database to the total number of persons in the database and is given by Equation 3.

$$TSR = \frac{\text{No. of persons correctly Matched in the database}}{\text{Total no. of persons in database.}} \quad (3)$$

3.2 Proposed Model

The proposed model of Fingerprint Identification using DTCWT is given in the Fig. 1.

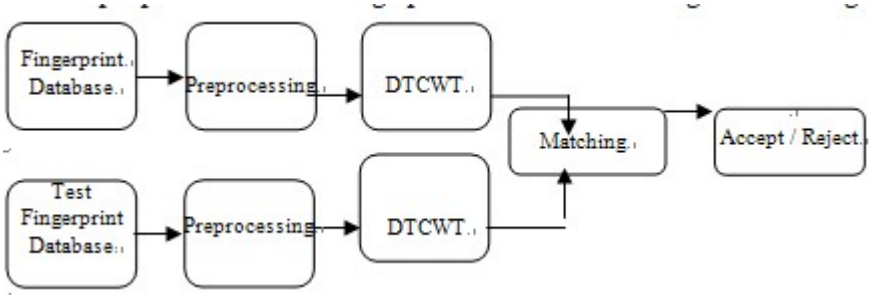

Fig. 1 Proposed model

3.2.1 Fingerprint Database

Database collection is one of the important works in testing the biometric system. The best and advisable way of collecting the database is with a different sensor. There are different databases made available for the researchers to study on the different biometrics systems. The Fingerprint database available are the first, second and third International Competition on Fingerprint verification such as FVC 2000, FVC 2002 and FVC 2004 [7] respectively.Four distinct databases for FVC 2004 provided by the organizers constitute the benchmark: DB1, DB2, DB3 and DB4. Each database is 110 fingers wide and 8 samples per finger in depth.

Source Database: The first seven Fingerprint images of each person from DB3 _A database of FVC 2004 are stored.

Test Template: The eighth Fingerprint of each person from DB3 _A database of FVC 2004 are used in the test template and is compared with source database to compute FRR and TSR.

Mismatch template database: The DB3_B of FVC 2004 database of 10 fingers are stored in Mismatch template database and compared with source database to compute FAR.

3.2.2 Pre-processing

The original Fingerprint image is of size 480 X 300. An observing the DB3_A of FVC 2004, we crop the input image to the size 401 X 201 in order to remove the unwanted portion in the image. And then the cropped image is resized into 512 X 256 for the DTCWT requirement.

3.2.3 DTCWT

Dual Tree Complex Wavelet Transform is a recent enhancement technique to the Discrete Wavelet Transform with some additional properties and changes. It is a effective method for implementing an analytical wavelet transform, introduced by Kings bury[8,9,10]. DTCWT gives the complex transform of a signal using two separate DWT decompositions ie., tree *a* and tree *b*. DTCWT produces complex coefficients by using a dual tree of wavelet filters and gives real and imaginary parts.

The DTCWT has following properties:

1. Approximate shift invariance;
2. Good directional selectivity in 2-dimensions (2-D) with Gabor-like filters also true for higher dimensionality: m-D);
3. Perfect reconstruction (PR) using short linear-phase filters;
4. Limited redundancy: independent of the number of scales: 2:1 for 1-D (2m :1 for m-D);
5. Efficient order-N computation - only.

DTCWT differentiates positive and negative frequencies and generates six subbands oriented in ±15°,±45°,±75°.

3.2.4 Matching

The Euclidean Distance (ED) is used to verify the test image with the database images using Equation 4.

$$d1(p,q) = \sqrt{\frac{1}{M}\sum_{i=1}^{M}(p_i - q_i)^2} \quad (4)$$

where, M =the dimension of feature vector, p_i = is the database feature vector and q_i = is the test feature vector.

4. Algorithm

The physiological trait Fingerprint is used to identify a person using the features obtained by the coefficients of DTCWT. The proposed algorithm for the performance analysis of the fingerprint identification for different levels of DTCWT is given in the Table1.The objectives are;

(i) Fingerprint verification to authenticate a person using DTCWT
(ii) To achieve high TSR
(iii) To have FRR and FAR very low

Table 1 Proposed Algorithm.

Input : Fingerprint Database, Test Fingerprint
Output: Person is identified.

1. FVC 2004, DB3_A database is considered.
2. Pre-processing is done by cropping the input fingerprint image to 401 X 201.
3. Cropped image is resized to 512 X 256 for DTCWT requirement.
4. DTCWT is applied on Fingerprint with levels 5, 6, 7.
5. Magnitude and phase resulted from DTCWT are concatenated and considered as features.
6. Source database is created with the features obtained by step 5.
7. For the test Fingerprint DTCWT is applied and features obtained using step 5.
8. Test Fingerprint is compared with the database fingerprint using ED to verify a person

5. Performance Analysis

For the performance analysis, DB3_A of FVC 2004 Fingerprint database is considered. The number of Persons Inside the DataBase (PIDB) to compute FRR and TSR are varied from 30 to 90 and the number of Persons Outside the DataBase (PODB) are 10 to compute FAR is given in Table 2.

Table 2 EER and TSR for different levels of DTCWT

Levels		PIDB:PODB					
		30:10	40:10	60:10	70:10	80:10	90:10
5	EER	0.5	0.2	0.573	0.34	0.36	0.33
	TSR	50%	80%	42.7%	66%	64%	67%
6	EER	0.45	0.2	0.59	0.3	0.282	0.3
	TSR	55%	80%	41%	70%	71.8%	70%
7	EER	0.36	0.15	0.228	0.21	0.197	0.197
	TSR	64%	85%	77.2%	79%	80.3%	82.1%

It is observed from the Table 2 that the values of EER and TSR depend on the quality of Fingerprint image than the number of images in PIDB and PODB. The values of EER and TSR are better in the case of

PIDB: PODB of 40:10. The performance of recognition rate is better in DTCWT level 7 compared to other lower levels of DTCWT. The TSR and EER is 85% and0.15 respectively for DTCWT level 7 with PIDB:PODB of 40:10.

The variations of FRR and TSR with threshold for POIB : PODB of 40:10 is shown in Fig. 2. It is noticed that as threshold increases, the value of FRR decreases, whereas the values of FAR and TSR increases. The highest success rate of recognition of 85% is achieved for the threshold value of 2.4.

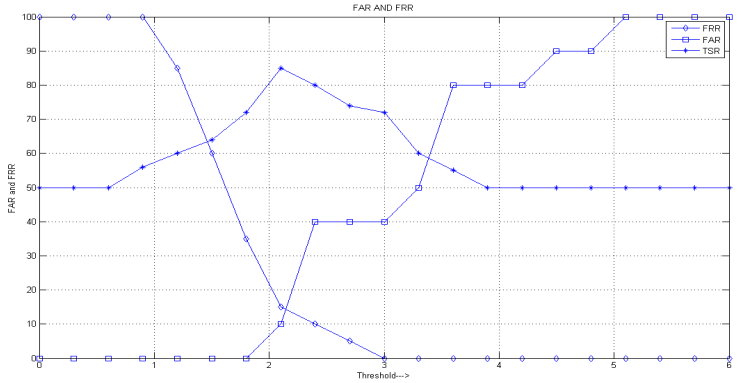

Fig.2 Variations of FRR, FAR and TSR with respect to different threshold

6. Conclusion

The biometric is used to authenticate a person. In this paper, the Performance Analysis of Fingerprint Identification using different levels of DTCWT is proposed. The Fingerprint is preprocessed to a suitable size that suit DTCWT. The Fingerprint features are obtained by applying DTCWT with different levels. The test image features are compared with Database images using Euclidean Distance. It is observed that the recognition rate is better in the case of DTCWT level 7 compared to lower levels with PIDB:PODB of 40:10. In future, the algorithm may be combined with spatial domain features such as global and local features to enhance recognition rate.

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