DWT Based Fingerprint Recognition Approach

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Abstract - ***The popular Biometric used to authenticate a person is Fingerprint which is permanent and unique throughout a person's life. In this paper ,fingerprint images are considered from CASIA (Chinese Academy Of Sciences' Institute Of Automation) database. DWT (3-level Discrete wavelet transform)i.e, Daubechies wavelet is applied and approximate, horizontal, vertical and diagonal coefficients are obtained. Then feature extraction and matching is done. The system has been tested on 25 person's fingerprint images and good matching score is obtained. The simulations are performed in the MATLAB 7.8.0 environment .***

1. INTRODUCTION

The word "Biometric" is derived from the Ancient Greek language i.e, "Bio" means "life "and "Metric" means "To measure". To determine a level of similarity all biometric systems compare a biometric sample against a previously stored template. Biometric identification process works on the principle of a threshold. Because, it is nearly impossible to capture the biometric the same way every time but it is used for access.

To identify a person biometric systems operate on behavioral and physiological biometric data. Examples of behavioral biometric parameters are signature, gait, speech and keystroke, etc. And physiological parameters are face, fingerprint, palm print and iris[2]. Fingerprint recognition is one of the most popular biometric technologies. It requires a less effort from the user, does not capture other information than needed for the recognition process and provides good performance[3]. Fingerprint readers are found everywhere as on laptop, computers, iris scanners are being installed at locations of heightened security, and voice recognition software is being incorporated into automobiles.

This paper proposes a method for matching of fingerprint images. In the first stage feature are extracted for image quality analysis. Then we apply 3-level DWT to it and find the approximate and horizontal coefficients. After that we store it in a database for matching. Finally matching or no-match of the images are displayed and FAR, i.e, False acceptance rate and FRR, i.e, False rejection rate was calculated.

2. RELATED WORK

Ravi. J, K.B. Raja et al. [2] projected Fingerprint recognition using minutiae score matching method (FRMSM). For fingerprint thinning they used block filter, which scans the image at the boundary to preserves the quality of the image and extract the minutiae from the thinned image. They concluded that the false matching ratio was better compared to the existing algorithm. Eun-Kyung Yun et al. [1] proposed an adaptive pre-processing method, which extracted five features from the fingerprint images, analyzed image quality with clustering method, and enhanced the images according to their characteristics. The pre-processing was subjected to the image characteristics (oily/dry/neutral): for oily images and for dry images. Experimental results indicated that the proposed method have improved the performance of the fingerprint identification significantly.

Ayman Mohammad Bahaa-Eldin[3] proposed a novel minutiae based fingerprint matching system. The paper presented a new thinning algorithm, a new features extraction and representation, and a novel feature distance matching algorithm. The proposed system was rotation and translation invariant and was suitable for complete or partial fingerprint matching. The proposed algorithms were optimized to be executed on low resource environments both in CPU power and memory space. The system was evaluated using a standard fingerprint dataset and good performance and accuracy were achieved under certain image quality requirements. The system was compared favourably to that of the state of the art system and it was found very suitable for medium resolution type of finger prints produced by commercial sensors and was expected to perform better when higher resolutions are used. Lavanya B N et al.[4] proposed a Performance Evaluation of Fingerprint Identification based on DCT and DWT using Multiple Matching Techniques (FDDMM). DCT was applied on segmented portion of fingerprint and DWT was applied on DCT to generate four sub bands. Directional information features and centre area features were computed and concatenated for verification using ED, SVM and RF. They found that the success rate of recognition and

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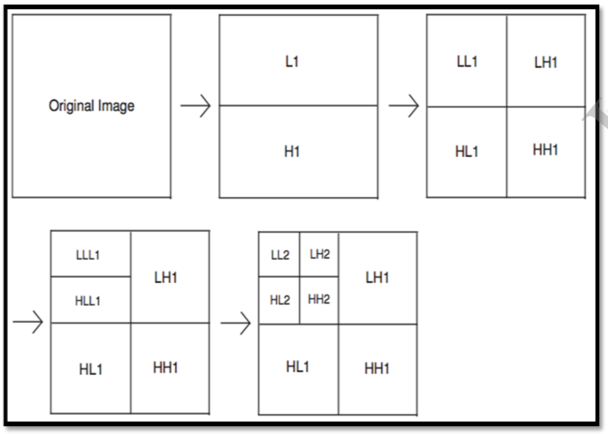
FRR values were better in the case of proposed algorithm compared to existing algorithm.

3. DWT

A discrete wavelet transform (DWT) is a wavelet transform in which the wavelets are discretely sampled. Advantage it has over Fourier transforms is temporal resolution: it captures both frequency and location information (location in time). DWT of a signal is calculated by passing it through series of filters. Samples are passed through High pass filter (HPF) and Low pass filter (LPF). Frequency resolution is doubled. Output gives the detail coefficients (from HPF) i.e, C_h, C_v & C_d (Horizontal, Vertical and Diagonal) and approximation coefficients (from LPF) i.e, C_a . It captures not only a notion of frequency content of input, by examining it at different scales, but also temporal content, i.e, times at which these frequencies occur. The most significant band is LL1 contains most of the image energy and the remaining sub bands represents texture of the image. Similarly to obtain further decomposition, LLL1 and LL2 will be used[5].

Some examples are Haar wavelets, Daubechies wavelets, The Dual-Tree Complex Wavelet Transform (DℂWT) etc.



“ Figure-1. 3-level DWT”

Function f(x) can be represented by a scaling function expansion in subspace V_{jo} and some number of wavelet functions expansions in subspaces W_{jo}, W_{j0+1},….

$$f(x)=\sum_k c_{jo}(k)\phi_{jo,k}(x)+\sum_{j=j0}^{\infty}\sum_k d(k)\psi_{j,k}(x) \qquad (1)$$

where j_0 is any arbitrary starting scale . The $c_{jo}(k)$ are normally called approximation and/or scaling coefficients and the $d_j(k)$ are called detail and/or wavelet coefficients [7].

$$c_{j0}(k)=\{f(x),\phi_{j0}k(x)\}=\int f(x)\phi_{j0},k(x)dx \qquad (2)$$

and

$$d_j(k)=\{f(x),\psi_{j,k}(x)\}=\int f(x)\psi_{j,k}(x)dx \qquad (3)$$

If the function being expanded is discrete, the resulting coefficients are called the discrete wavelet transform (DWT). If f(n) = f(x_0 + nΔx) for some x_0, Δx, and n=0,1,2,….,M - 1 , the wavelet series expansion

coefficients for f(x) defined by the above two equations become the forward DWT coefficients for sequence f(n).

$$W_\phi(j_0,k)=\frac{1}{\sqrt{M}}\sum_n f(n)\phi_{j0,k}(n) \qquad (4)$$

$$W_\psi(j,k)=\frac{1}{\sqrt{M}}\sum_n f(n)\psi_{j,k}(n) \qquad (5)$$

The $\phi_{j0,k}(n)$ and $\psi_{j,k}(n)$ in these equations are sampled versions of basis functions $\phi_{jo,k}(x)$ and $\psi_{j,k}(x)$.

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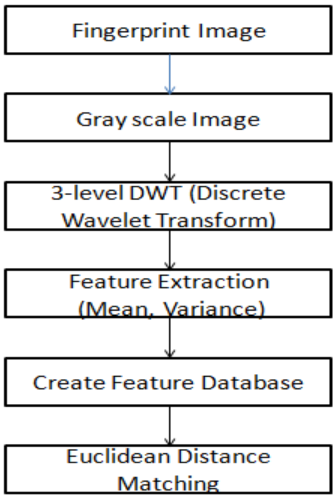
4. Proposed Work



“Figure-2. Proposed System”

The system consists of 6 blocks. Firstly fingerprint images are collected from CASIA-Fingerprint V5(200- 299) [6]. Then fingerprint image is converted to gray scale image. 3 level DWT is applied to gray scale image and feature

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extraction is done using the approximate and detail coefficients. Feature database is created in which 24 features of a person's fingerprint is stored. Finally feature matching is done using Euclidean distance matching technique and 'match' or 'no-match' cases of the fingerprint images is displayed.

5. FEATURE EXTRACTION

Two features are used to grasp the image quality characteristics. The mean and variance of a fingerprint image are defined as follows:

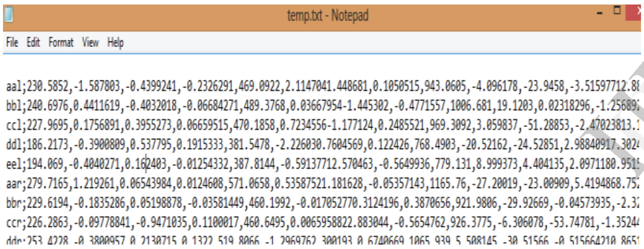
1) Mean = $\frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1} I(i,j)$ (6)

2) Variance = $\frac{1}{NM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1} (I(i,j) - Mean)^2$ (7)

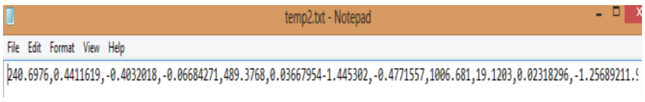
The mean value shows the overall gray level of the image and the variance indicates the uniformity of the gray values [1]. I(i,j) represents the intensity of the pixel at the ith row and jth column and the image I is defined as an M*N matrix.

5.1 Feature Database Creation

Main data

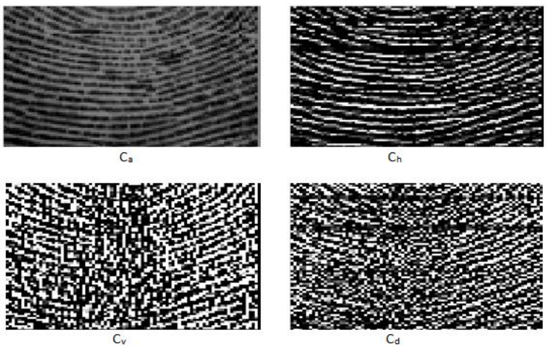

temp.txt - Notepad
File Edit Format View Help
aal;230.5852,-1.587803,-0.4399241,-0.2326291,469.0922,2.1147041.448681,0.1050515,943.0605,-4.096178,-23.9458,-3.51597712.8
bbl;240.6976,0.4411619,-0.4032018,-0.06684271,489.3768,0.03667954-1.445302,-0.4771557,1006.681,19.1203,0.02318296,-1.25689
ccl;227.9695,0.1756891,0.3955273,0.06659515,470.1858,0.7234556-1.177124,0.2485521,969.3092,3.059837,-51.28853,-2.47023813.1
ddl;186.2173,-0.3900809,0.537795,0.1915333,381.5478,-2.226030.7604569,0.122426,768.4903,-20.52162,-24.52851,2.98840917.302
eel;194.069,-0.4040271,0.162403,-0.01254332,387.8144,-0.59137712.570463,-0.5649936,779.131,8.999373,4.404135,2.0971180.951
aar;279.7165,1.219261,0.06543984,0.0124608,571.0658,0.53587521.181628,-0.05357143,1165.76,-27.20019,-23.00909,5.4194868.75
bbr;229.6194,-0.1835286,0.05198878,-0.03581449,460.1992,-0.017052770.3124196,0.3870656,921.9806,-29.92669,-0.04573935,-2.3
ccr;226.2863,-0.09778841,-0.9471035,0.1100017,460.6495,0.0065958822.883044,-0.5654762,926.3775,-6.306078,-53.74781,-1.3524
ddr;253.4228,-0.3800957,0.2130715,0.1322,519.8066,-1.2969762.300193,0.6740669,1065.939,5.508145,-30.51566,-0.515664210.865

Query data

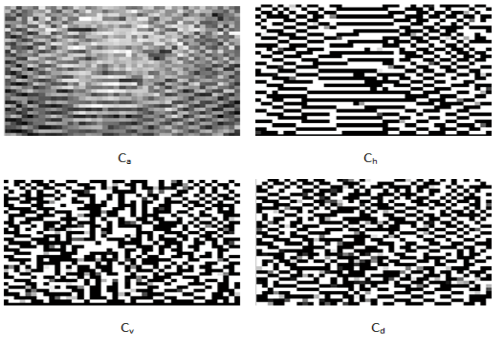

temp2.txt - Notepad
File Edit Format View Help
240.6976,0.4411619,-0.4032018,-0.06684271,489.3768,0.03667954-1.445302,-0.4771557,1006.681,19.1203,0.02318296,-1.25689211.

6. Simulation Results

6.1 DWT of images



"Figure 3. 1st level DWT a) Approximate coefficients b) Horizontal coefficients c) Vertical coefficient d) Diagonal coefficient"



" Figure 4. 2nd level DWT a) Approximate coefficients b) Horizontal coefficients c) Vertical coefficient d) Diagonal coefficient"

"Figure 5. 3rd level DWT a) Approximate coefficients b) Horizontal coefficients c) Vertical coefficient d) Diagonal coefficient"

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6.2 Definitions

1. False Acceptance Rate (FAR) :

It is the measure of likelihood that biometric security system will incorrectly accept an access attempt by an unauthorized user. FAR of a system is stated as the ratio of false acceptances divided by no of identification attempts.

2. False Rejection Rate (FRR) :

It is the measure of likelihood that biometric security system will incorrectly reject an access attempt by an unauthorized user. FRR of a system is stated as the ratio of false rejections divided by no of identification attempts.

3. Euclidean distance :

Euclidean distance between two points a and b is the length of line segment connecting them.

4. Euclidean distance matching was done and names were displayed for ‘match’ cases.

$$d(a,b) = d(b,a) = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2 + \ldots\ldots + (a_n - b_n)^2} \qquad (8)$$

The matching code is as follows :-

```
For i=1:2(ghm1+1)
Sum1=0;
For j=1:ghm2
Euc=(mydata(j)-mydata2(i,j))^2;
Sum1=sum1+euc;
End;
Format short
Dist=sqrt(sum1);
If dist<=0.002 && dist>=0;
Disp('match')
Names{1}{i}
End;
Disp('no match')

End;
Fclose(fid);
```

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7. CONCLUSION

In this paper, we presented Fingerprint matching technique using Euclidean distance measurement. The system gives False acceptance rate as 2.3 % and False rejection rate as 0.9 %.

8. REFERENCES

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