International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Genotyping-Wavelet Approach

Ajitha T. Abraham[1], Yasim Khan M.[2]

[1]College of Engineering, Poonjar, CUSAT, Thekkekara P.O, Kottayam, Kerala, 686582, India

[2]Assistant Professor, College of Engineering, Poonjar, CUSAT, Thekkekara P.O, Kottayam, Kerala 686 582, India

Abstract: ***Fingerprints are used as reliable identification because each person's fingerprints are unique, but people can have similar fingerprint patterns. In this project, we will investigate whether fingerprints are influenced by genetics. Here we proposed a novel method to check whether fingerprints in same family members are inherited by using SVD and Wavelets. This experiment was done on 50 different families fingerprints.***

Keywords: Fingerprints, SVD, Wavelets

1. Introduction

Fingerprints have been used over several hundreds of years as a means of identification and authentification based on their individual peculiarities or uniqueness[2]. More than 60% of all fingerprints have the same basic pattern but no two fingerprints are ever exactly the same (Lewis, 1997). Like any other phenotypic trait, fingerprints are controlled by genes but it is unclear to which extent genes control fingerprint pattern transfer from parents to their children.

Within blood related persons like a family, certain characteristic traits run through them due to inheritance. A child through inheritance may 'burrow' a father's or a mother's trait and /or have a combination of the two in some cases[1]. An example is with the ABO blood groupings. A father and a mother of the blood groups OA and OB can have a child belonging to either the OA or OB (i.e. a duplicate of one of the parents) or may belong to the AB or possibly the O group in which case there have been a combination of genes (Snustad et al, 1997). With these a specific pattern can be identified within a family but can the same be said about fingerprints also since they are also controlled by genes?

Identical twins are the closest in terms of genetic make-up. They therefore share a lot of characteristics in common including height, eye colour, and many other external characters. But the question again is; are their fingerprints also identical based on the fact that they possess identical genetic make-up? Non-identical twin, who are the next closest in genetic make-up should also have some similarities in their fingerprints[4]. Within a family or blood relations, a similar story should unfold where if not similarities in the fingerprints at least there should be a basis pattern running through them. This study was to find if there is any relationship in fingerprint pattern among the same family members.

2. Strategies

Studies so far carried out in dermatoglyphics used the inked fingerprints and their findings are based on the spatial domain analysis of ridges [3]. Earlier work on inheritance of fingerprints based on the analysing of characteristics features. Here we proposed simple method, which completely done in frequency domain analysis using wavelet transform.

A wavelet is a mathematical function useful in digital signal processing and image processing. The use of wavelets for these purposes is a recent development, although the theory is not new. Wavelet families can be divided into two main categories, orthogonal and Biorthogonal wavelets, which have different properties of basis functions. Orthogonality decorrelates the transform coefficients thereby minimizing redundancy. Symmetry provides linear phase and minimize border arti-facts. Other important properties of wavelet functions in image denoising applications are compact support, symmetry, regularity and degree of smoothness. The Biorthogonal wavelet transform is an invertible transform. The property of perfect reconstruction and symmetric wavelet functions exist in biorthogonal wavelets because they have two sets of low pass filters (for reconstruction), and high pass filters (for decomposition). One set is the dual of the other[5].

2.1. Preprocessing

We have collected fingerprints of 50 different families. These fingerprints are obtained by using Fingerprint Optical Scanner, manufactured by Grey Technologies, Kochi, India. Acquired image was in size of Firstly the image was resampled to 300 X 350 number of pixels. Then the resampled image was resized to 256 X 256 number of pixels. This resized image undergoes enhancement technique like histogram equalization.

Fingerprint Image enhancement is used to make the image clearer for easy further operations. Since the fingerprint images acquired from scanner or any other media are not assured with perfect quality, those enhancement methods, for increasing the contrast between ridges and valleys and for connecting the false broken points of ridges due to insufficient amount of ink, are very useful for keep a higher accuracy to fingerprint recognition.

Histogram equalization method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the

histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. The method is useful in images with backgrounds and foregrounds that are both bright or both dark.

2.2 SVD Decomposition

The Singular Value Decomposition (SVD) of a rectangular matrix *A* is a decomposition of the form

$$A = U S V^{T} \quad (1)$$

where *U* and *V* are orthogonal matrices, and *S* is a diagonal matrix. The columns u_i and v_i of *U* and *V* are called the left and right singular vectors, respectively, and the diagonal elements s_i of *S* are called the singular values. The singular vectors form orthonormal bases, and the important relation

$$Av_i = s_i u_i \quad (2)$$

shows that each right singular vectors is mapped onto the corresponding left singular vector, and the "magnification factor" is the corresponding singular value. The using of singular values of such refactoring allows us to represent the image with a smaller set of values, which can preserve useful features of the original image, but use less storage space in the memory, and achieve the image compression process. Derived image can be formed by using singular vectors.

$$P=U * power(S, 5/4) * V' \quad (3)$$

By combining derived image and enhanced image formed a new image by using below equation.

$$J=(single(enhanced\_image)+(0.25*P))/(1+0.25) \quad (4)$$

This newly formed image is used for further operations.

2.3 Wavelet Decomposition

The combined image undergoes wavelet decomposition for obtaining the feature vector. In case of two-dimensional image, after a BWT decomposition, the image is divided into four corners.

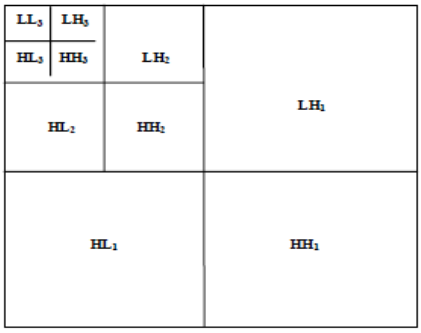

Figure 1: BWT Decomposition model

Such as upper left corner of the original image(low frequency), lower left corner of the vertical details, upper right corner of the horizontal details, lower right corner of the component of the original image detail (high frequency).Decomposition then continue to the low frequency components of the same upper left corner of the 2nd, 3rd inferior wavelet transform. Low frequency component contains the useful information, also, unimportant information gets lost in this component. The (LL) component is ineffective with illumination changes and expression variations. This LL block is used for calculating correlation coefficient.

2.4 Correlation coefficient

It is a measure of the strength and direction of the linear relationship between two matrices that is defined as the (sample) covariance of the first image divided by the product of their (sample) standard deviations. Correlation coefficient can be calculated as

$$r = \frac{\mathrm{cov}(X,Y)}{\sigma_x \sigma_y} \quad (5)$$

Where *cov(X,Y) =covariance of X and Y*

σ_x *and* σ_y *= standard deviations*

Here correlation coefficient between two images can be calculated by using matlab function *r = corr2(X,Y)*, returns the correlation coefficient *r* between *X* and *Y*, where *X* and *Y* are matrices or vectors of the same size. *r* is a scalar double.

3. Algorithm

1 Image acquisition
2 Image resampling to 300 x 350 number of pixel size.
3 Image resizing to 256 x 256 number of pixel size.
4 Image enhancement by applying histogram equalization.
5 SVD decomposition on image.
6 Derived image can be formed using equation(3).
7 Combined image can be formed using equation(4).
8 Wavelet decomposition on six levels.
9 Take LL block only.
10 Repeat the steps 1-9 for fingerprints of father, son/daughter and mother respectively.
11 Calculate the correlation coefficient between father and child and mother and child
12 Take the first digit from correlation coefficient.
13 If it is equal for both cases, all fingerprints undergoes same family.

4. Experiment and Result

This algorithm was written in MATLAB 2014 and was run on Intel Core 2 duo processor 1.66 GHz with 1 GB memory. Results show us that frequency domain analysis of fingerprints can also be followed in future for the study of dermatoglyphics. The proposed scheme is tested using optical scanned fingerprints. Out of 50 different families, we got 85% correct results.

Figure 2: Fingerprints of a father(a), child (b) and mother(c)

Correlation between father and child=**0.3**007
Correlation between mother and child=**0.3**448
p=s=0.3→same family

Figure 2: Fingerprints of a non relatives(a) and (c) child (b)

Correlation between non relative and child=**0.2**726
Correlation between non relative and child=**0.1747**
p≠s→different family

5. Conclusion

In this work, we have proposed a novel and simple method for checking whether inheritance can be seen in fingerprint under same family based on Biorthogonal Wavelet Transform. This method considered the frequency features of the wavelet domain .The six level Wavelet Decomposition is selected as optimum level for wavelet decomposition. After decomposition we choose only LL block for further processing. 2D correlation coefficient was chosen as parameter for deciding whether fingerprints undergoes same family or not.

References

[1] D.Bennet&Dr.S.ArumugaPerumal,(2011)"Fingerprint:DWT,SVD Based Enhancement" Journal of Computer Science and Engineering,Vol.6,Issue1,pp28-32
[2] Herman,Mariassa&Batsheva(1976)"The Inheritance of Fingerprint Pattern",Am J Hum Genet,28:280-289
[3] http://www.scientificamerican.com/article/succession-science-are-fingerprint-patterns-inherited/
[4] http://www.brighthub.com/science/genetics/articles/62996.aspx
[5] Rout S,"Orthogonal vs Biorthogonal Wavelets for image Compression",MS Thesis,Polytechnic Institute and University,Virgina,2003

Author Profile

Ajitha T. Abraham received the Diploma in Electronics from Govt.Poly Technic College, Kottayam and B.E. degree in Electronics and Communication Engineering from CSI Institute of Technology under ANNA university, Chennai in 2007 and 2010, respectively. Currently pursuing Masters Degree program in Signal Processing in College of Engineering, Poonjar under CUSAT, Kottyam, Kerala, India.

Mr.Yasim Khan M is an Associate Professor in Electronics & Telecommunication Engineering Department at College of Engineering Poonjar in Kottayam, Kerala under CUSAT, India..