3d Finger Identification Using 3d Ridglet Neural Transformation[1]

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Abstract

Processing speeds have increased dramatically, bitmapped allow graphics to be rendered and updated at high rate, and in general, computers have been advanced to the point where they can assist human in complex tasks. Yet the input technologies seems to cause the major bottleneck in performing these tasks

This paper introduces, a proposed new identification method based on 3D Ridglet Transform. First phase, it considers the three dimensional finger-print of human as a Personal Identification Number. Next, it produces the required features using the new proposed 3D Ridglet Transform. This transform is a generalization of adapted 2D Ridglet form.

In the second phase we will consider the Back Propagation Neural Network authentication process, the evaluation tests of the proposed algorithm on a given database, for fifteen human Finger-Print, produce a perfect identification results (in comparison with [12]).

Based on the evaluation test, we obtain that the authentication of the allowed Human Finger-Print on a noisy data, with a noise level up to 69% also with rotation of the input human Finger-Print up to 9 degree of rotation.

Keywords: 3D Ridglet Transform, Back propagation Neural Network, Authentication model.

[1] For the paper in Arabic see pages (47-48).

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1. Introduction

Finger-Print Identification becomes very important for certifying data integrity and security. A key issue in Finger-Print Identification is the design of a compact signature that contains sufficient information to detect illegal tampering yet is robust under allowable manipulations.

In this paper, we recognize that most permissible operations on images are global distortions like low-pass filtering and JPEG compression, whereas illegal data manipulations tend to be localized distortions. To exploit this observation, we propose a Finger-Print Identification scheme where the signature is the result of an extremely low-bit-rate content-based compression.

The central theme of the work presented in this paper is multi-dimensional image processing in the Ridglet Space (RS). It involves computing of three-dimensional Fast Fourier transform then processing the Radon transform, or a set of projections, after all that, we compute the two-dimensional inverse fast Fourier transform then taking wavelet transformation for multi-dimension image, which give us the required signature. While such transform, may arises naturally in many fields of science and engineering, gain authentication as a tool in multi-dimensional image processing [1].

The first stage of the proposed transform is the computation of the principle transform that is the three-dimensional Fast Fourier Transform, now combining this transform, Fast Fourier Transform, with wavelet transform is meaningless since we transform the Finger-Print from time domain to frequency domain then the use of wavelet transform, which transform the image from time to frequency domains is useless. To combine the advantage and disadvantage of the both transforms we must use another transform, called three-dimensional Radon transform [2], which is the second stage of the Ridglet transform. The Radon Transform (RT) is a powerful tool that has revolutionized the field of medical imaging devices involving the reconstruction of an image from its projection [3]. It is also the basis of a wide variety of similar application such as radio astronomy, geophysics, electron microscopy, non-destructive testing (NDT), underwater acoustic imaging, Synthetic Aperture Radar (SAR), and electrical impedance tomography [1]. These applications involve reconstruction of multi-dimensional function, finger-

print in our application, from the measurements available in the transform domain, Radon Transform Domain (RTD) or in both cases.
The results of the second stage is two-dimensional projection, which leads to the reduction in the dimension of operation, and the complexity of the data. In addition, to keep the advantages of the first stage we must take the inverse two-dimensional fast Fourier transform, since the results of the three-dimensional Radon Transform reduce the dimension of data, which is the third stage of the Ridglet transform, after that the results of the third stage have the feature of the Finger-Print in the time domain, which lead that we can implement any transformation while we are keeping the advantages of the fast Fourier transform and the Radon transform. Now we can use the three-dimensional wavelet transform, which is the last phase of the Ridglet transformation to obtain the Finger-Print signature of a human.
Our research involves a new signal/image processing techniques scheme that use different algorithms (Fast Fourier Transform, Radon Transform, Wavelet Transform) to obtain the finger print signature of human person.
It is convenient to distinguish the applications that based on the space in which the data is available. The RS (the projection domain), and authenticities the projection of the image by using artificial neural network.
Our motivation is to process the projections, when the data is available in the Ridglet space, for signature and information - extraction in the Ridglet space itself, without having to post-process a reconstructed image.
The basic motivation behind the use of the radon transform as a tool is to utilize its properties, such as that of reduction of dimensionality, to simplify an m-dimensional processing task. Then the identification process which must be done in an efficient manner with small time, since we have two phases. The first is the off-line phase in with all the allowed finger-print are identified which take a considerable of time and happen once, the next phase is the on-line phase in which any person has to put his Finger-Print in a scanner and then the system will check it with the allowed Finger-Print signatures, if it is in, the person is allowed, this identification process must provides flexibility to deal with system components (and provide a trust in the result of authentication).

A Decision Based Artificial Neural Network is chosen to implement the identification process. They are powerful in modeling problems in which the explicit form of the relationships among certain variables are not known. Such neural models try to learn the underlying rules from a given representative problem by matching the input data to the corresponding target value [1], [3].

2. Different Type of Transformation

A good starting point for this section is the well-known transform that is Fourier transform. The Discrete Fourier Transform is analogous to the continuous one and may be efficiently computed using the Fast Fourier Transform algorithm [1].

The Discrete Fourier Transform is a tool widely used for many scientific purposes, which have some drawbacks in the process of multi-domain information [4]:

Its coefficient contains only the frequency domain information.

The Fourier transform of a real function is a complex function which is a big problem in image processing.

Small frequency changes in a Fourier transform will produce changes everywhere in the time domain since the related data is not available.

Yet, another transform that is Wavelet Transform, which represent another approach to decompose complex signal into sum of basic functions [5]. Wavelet Transform is a linear mathematical transformation that can analyze both temporal signals and spatial images at different scales. The wavelet transform is sometimes called a mathematical microscope. Large wavelets give an approximate image of the signal, while smaller and smaller wavelets zoom in on small details. That is similar to the commonly known Fourier Transform in basics but have some different properties:

Wavelet Transform is a form of "multi-resolution analysis", which means that wavelet coefficient for certain function contain both frequency and time domains information while Fourier Transform of the same certain function are localized in frequency domain but not in space domain.

Image generally has more compact representation by using Wavelet Transform than with Fourier Transform [5].

Now if we want to use the above two transformations, on image processing problem, has no meaning because we transform the image from time domain to frequency domain by using Fast Fourier Transform and then it is not useful to use the Discrete Wavelet Transform , but if we want to join the above two transform to make use of these advantages then we can find a way for combining them by using another transform which is called Radon Transform [6], which works in spatial domain, not only in time domain, to obtain more efficient results which explained in section four in this paper.

3. Finger-Print Classification

Finger-Print of human person can be classified into different parts as can be seen in Fig. 1, [7]. From the initial classification of the Finger-Print as a certain type, the image is then broken down into various components or properties. These minutiae are then compared to similar properties of the database image, as shown in Fig. 2

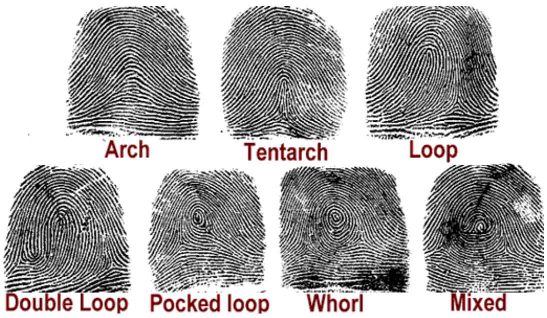

Fig.1: different types of finger print pattern.

4. Proposed Method of authentication using 3D Ridglet Transform

In real life, Identity authentication is a general task that has many efficient application such as transaction authentication (in telephone banking or remote credit card, purchases for instant), voice mail more and more developments in the field of security concentrate on biometric solution in order to get rid of PIN (Personal Identification Number) code and cards which can be stolen or lost, among the possible clues, speech, face, finger-print and ear print modalities receive the largest acceptable from the user [8].

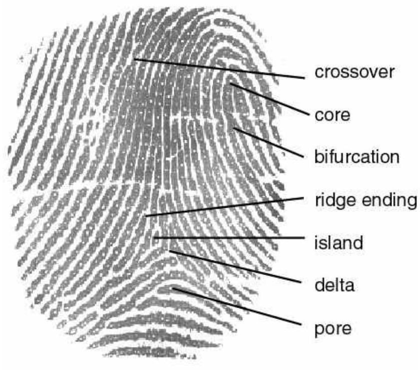

Fig. 2: Properties of Finger-Print.

There are two general types of authentication, which they are:

1. Automatic identity authentication.
2. Biometric identity authentication.

The goal of an automatic identity authentication system is either accept or reject the identity claim made by a given person. Biometric identity authentication systems are based on characteristics of a person identity, such as, its face, finger- print, ear-print signatures.

Identity authentication using Finger-Print information is a challenging research area that is very active recently. And identity authentication system has to deal with two kind of events; either, the person claiming a given identity is the one who he claims to be (in which case, he is called client), or he is not (in which case, he is called impostor) [9].

The term identification is also frequently used in biometric field, sometimes as a synonym for verification; actually, in the information technology language, identification a user means to let the system know the user identity regardless of the mode (verification or identification) [9].

Any human physiology and behavioral characteristic can be used as a biometric identifier to authenticate a person as long as it satisfies these requirements [9]:

- Universality: This means that each person should have the biometric.
- Distinctiveness: This indicates that any two persons should be sufficiently different in term of their biometric identifier.

• Permanence: This means that the biometric should be sufficiently invariant over a period.
• Collect ability: This indicates that the biometric can be measured quantitatively.
However, in practical biometric system there are a number of issues that should be considered, including:
• Performance: which refer to achievable authentication accuracy, speed, robustness
• Acceptability: which include the extent to which people are willing to accept a particular biometric identifier in their daily lives.
Now, let us consider the block diagram of the 3D Ridglet Identification Model as shown in Fig. 3.

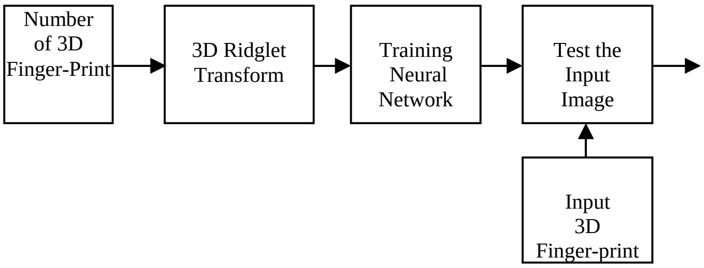

Fig .3: 3D Ridglet Authentication System

Now we will explain each part of the "3D Ridglet Authentication system" block by block. Block one "Number of 3D Finger-Print", this means that we must have a number of input 3D Finger-Print as a database for the authentication system to authenticate any input human Finger-Print to be one of the identified Finger-Print of the client or reject this claim of identity.
Part two "3D Ridglet Transform", this is the most important part of the identification system, which gives the human Finger-Print Signature. The computation parts of this transform shown in Fig.4, which contains the following:
• Three-Dimensional Fast Fourier Transform.
• Three-Dimensional Radon Transform.
• Two-Dimensional Inverse Fast Fourier Transform.
• Two-Dimensional Discrete Wavelet Transform

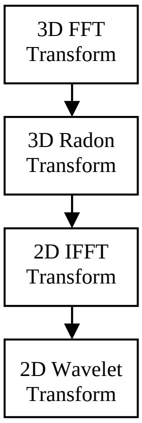

Fig. 4: 3D Ridglet Transform Stages.

Now, second phase of the 3D Ridglet Transform is the computation of 3D Radon Transform of the input three-dimensional Finger-Print images [9]. To obtain the a projection of these human Finger-Print, which reduce the dimension from three dimension object to two dimension projection, we can compute the 3D Radon Transform according to the following flow chart Fig. 5.

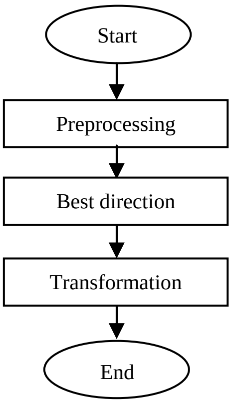

Fig. 5: 3D Radon Transform Flow.

The preprocessing block is used to extract the required features (from human Finger-Print) and resize the selected volume into a volume with prime number of dimension (one of the requirement of the computation of 3D Radon Transform).

One of the important facts that must be satisfied is the dimension of the Finger-Print to be passed to the Radon Transform space. Usually it is recommended to be a prime number for such transform of any dimensions. This is facilitating the change to spherical representation and easy reading of the center of the three-dimensional Finger-Print, in this case, is an important stipulation to be satisfied [10].

The Best Direction blocks, shown in Fig. 6, is used for obtaining a new location of any input information which is depending on two angles Φ and θ. Thus, it is required to obtain a new location for arranging the input image with respect to a given view. Therefore, it operates on any arbitrary data with specific size equal to the size of the input data. Hence, it results in creating a new three volumes that represents the different view with respect to X-prime, Y-prime, and Z-prime. This is achieved by taking single slices and converting them to a spherical coordinate. Thus, we can get rid of the complex computation required in Cartesian coordinate. Finally, rearranging of the input information according to the results of the applied Best Direction.

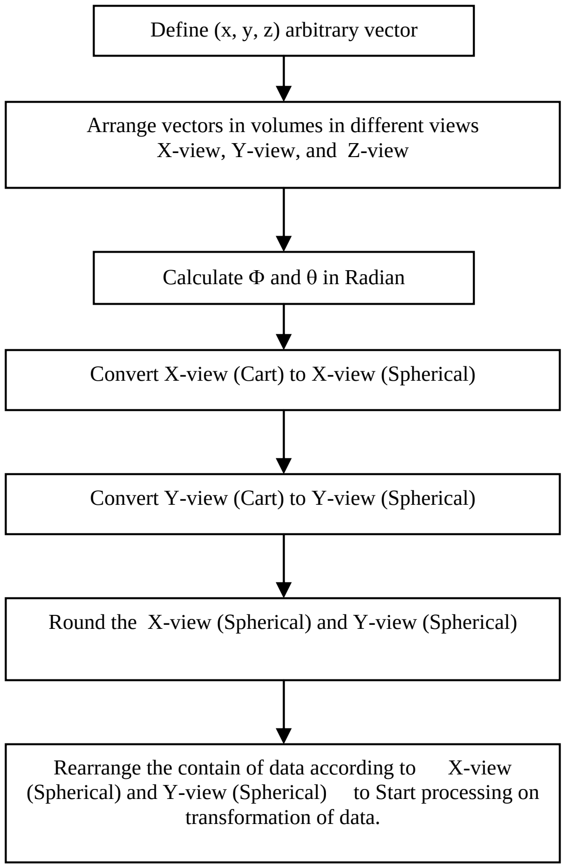

Fig .6: Best Direction Algorithm.

Last part of the 3D Radon Transform is the Transformation block which is used to compute the accumulated summing of the resulting slices after the rearrangement to obtain 3-D Radon Transform Projection.
Then, the computation of the inverse two-dimensional fast Fourier Transform, lastly, the computation of wavelet transform.
Part Three, of Fig. 3 is "Training Neural Network", is used to train the Back-Propagation artificial neural network with adaptive learning rate to

the results obtained by using Radon transform to identify those Finger-Print signatures. Therefore, we can test for any input Finger-Print as in part four [11].

Part four, of Fig.3 is "Test the input Image", is used to authenticate the input Finger-Print by the use of neural network to decide that Finger-Print belong to whom in the client Finger-Print signature list or if not to anyone then reject it.

5. Evaluation Tests of the System

In the evaluation test of the proposed identification system, we take a database of fifteen human Finger-Print signature so that the system can be trained on them. As a result of this system all the input Finger-Print are authenticated with perfect result of 100 percentage of identification even with the addition of noise to the tested Finger-Print. Also we made a Graphical User Interface (GUI) for the system with the use of four human Finger-Print Signature as shown in Fig. 7.

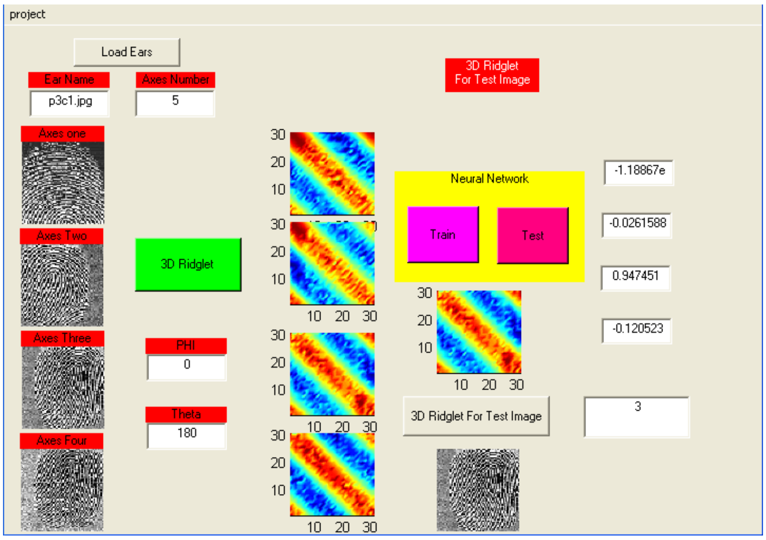

Fig. 7: Four persons Finger-Print Identification system.

The above identification system, for convent, is divided into ten parts as shown in Fig. 8. First part is used to enter the human Finger-Print signature to each axes in the part two by enter the name and the selected axes.

Part two is to show the human Finger-Print Signature. Fourth Part is to select the proper value of Φ and θ for the transformation, such selection of values depend on several tests and the results of those test shows that the best values of Φ is θ and Theta is 180, or Φ is 180 and θ is 0 for the identification model which gives a signature that can be identified by single eye, but we can use the other angle for different applications.

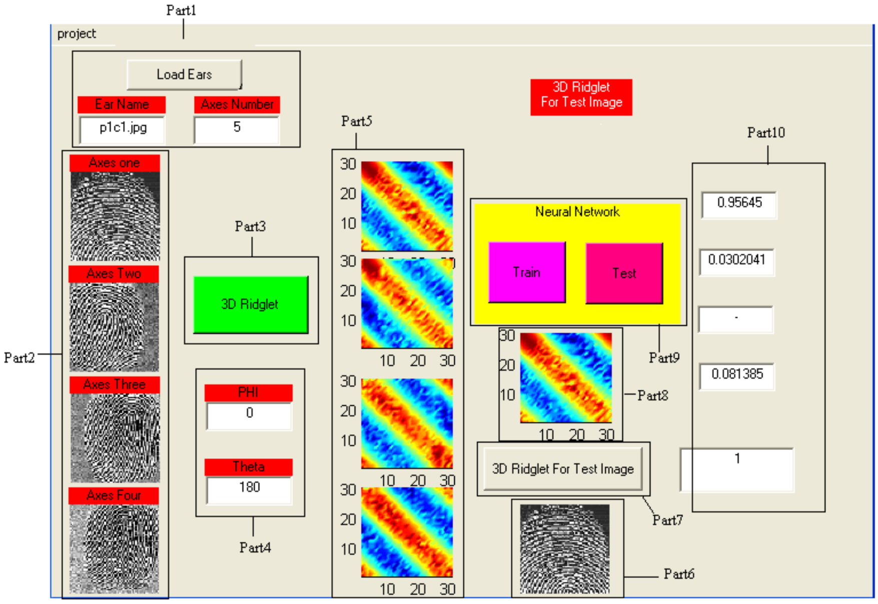

Fig.8: Four persons Finger-Print Identification system parts.

Fig. 9 shows different values of Φ and θ for a single human Finger-Print. For the third part, is a push button to compute the 3D-Ridglet Transformation of the input human Finger-Print Database. While part five is to show the result of the computation of the 3D-Ridglet Transformation of the database. All the above parts of the system are called the off-line system, in which take a considerable time and happen only once for each system, also any new human Figure-Print can be added easily.

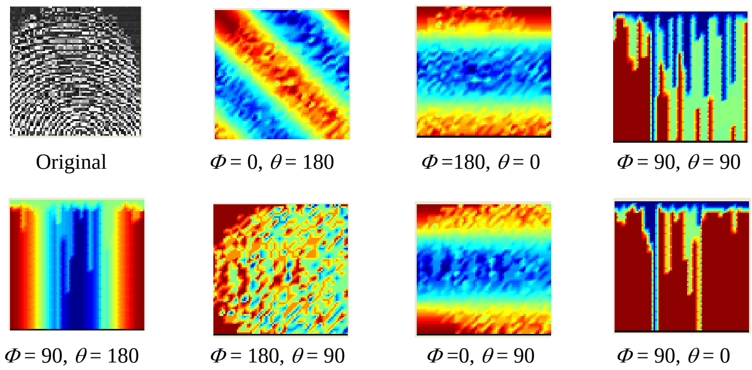

Fig. 9: Various Signatures with Different Φ and θ.

Now, for part six, we show input human Finger-Print for test. Part seven is used to compute the signature for the tested human Finger-Print and then in part eight of the GUI the results are shown. All the above three parts is the beginning of the on-line operation of the system which take a small amount of time to operate as shown in Table.2.
The final phase of the proposed identification model, is the Back-Propagation Neural Network, which consists, first, training phase to all the allowed human Finger-Print signatures that is passed by the training system (this part belong to the off-line phase of the proposed model), the second phase is the testing which is used to test the input human Finger-Print Signature and give a decision whether this signature is allowed to pass by the system or to reject this claim of identity (which belong to the On-Line phase of the proposed model).
That last phase, produce a results and show in part ten. Part ten include a four text which shows the best results and then the decision is made (which one is the identity or none of then) in the fifth text show part.
Now, in Table .1, we present the time need for the computation of the 3D-Ridglet Transform Human Finger-Print Signature with different size.

Table. 1: Time required for the computation 3D Ridglet

Test Name	Size (X, Y, Z)	Time (sec)
Test1	(61, 61, 61)	4.1
Test2	(91, 91, 91)	6
Test3	(127, 127, 127)	7.9

After that, each human Finger-Print signature obtained must be input to the Back-Propagation neural network to be trained. for example we take four human Finger-Prints and in another example we will take 10 input Human Finger-Print signature each with size of (X, Y, Z) = (61, 61, 61) and angles (Φ = 0) and (θ = 180) with different values of accuracy and with respect to time.

Table .2: Results of neural network

Number Input Finger - Print	Accuracy	Time to train (Minute)	Testing Time (sec)
4	0.001	29	0.005
4	0.00001	42	0.01
10	0.001	59	0.09
10	0.00001	81	0.01

From table (2), we conclude that the time required for training the Artificial Neural Network is too big, this process happen only once when the system is first started, in other words the system is working on offline state. But the testing time is very low as compared with the training time.
Comparing the obtained results showing in Table 2, with the results obtained for Human Ear print using Radon Transform [12], It was noticed that when using the same numbers of inputs the accuracy was increased around 25% to 50%, but at the cost of complexity of the system, where the time required for the computation 3D Ridglet was increased 1 sec in Test1, 2 sec in Test2, and 2.7 sec in Test3. However, the increasing in complexity during the execution when using the same numbers of inputs was not noticed, it is between 0.005 sec 0.01 sec. We can conclude that

our proposed algorithm produces better performance than that obtained by using of the radon transform [12].

One of the benefits of our proposed model is that when we want to test an input human Finger-Print with addition of maximum Noise of 69% of the original human Finger-Print, the system can identify this human Finger-Print.

6. Conclusions

Our proposed method of identification produces shows more accurate result on a given database. As well as, it was found that the proposed model resist up to 9 degree of rotation, and gives a security option to the applied application, such feature can be only obtained by the new proposed algorithm.

This new algorithm gives a more accurate performance in time to obtain the feature from the selected human Finger-Print (specially, the time it takes to compute the finger print signature, and the security, than other transformation like fast Fourier Transform and wavelet transform of the obtained signature). However, for the selected angle, no one with its naked eye can differentiate between the features, only with the use of Back Propagation neural network. The proposed algorithm produces better performance than that obtained by using of the radon transform [12].

The method is a promise and open the way for many further research in several other areas of signal processing field.

7. Reference

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Received, 29 March, 2007.