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Neural Network Based Fingerprint Classification using DCT Compression

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Abstract
Recognition of the people by the method of their characteristics of biometric is very much popular and common in the society. But among all this, fingerprint recognition is very vital technology for identification which is personal because of its structure which is very unique. Enormous quantity of fingerprint are gathered and then stored in the applications everyday in broad range. Image compression techniques are used in handling a large database of fingerprint images, for example, in access control and forensic science. Fingerprint images are used in various documents like gun registration, police records and passport which needs huge amount of storage memory. The various other fields of fingerprint image compression are log in authentication and other locks, library access and electronic configuration. It is used to validate transactions by requesting biometric authentication before orders are submitted or financial transactions are executed. In this novel approach is presented in which base matrix is constructed initially. Then it is divided into small blocks which are patches and after that quantization of coefficients are done and then coefficients are encoded by using methods of lossless coding. And at the last, features are extracted and are classified by using approach of neural network**.**
Keywords: Wave propagation, ray tracing, tri linear refractivity, ducting, anomalous propagation, PWE, HFSWR

1. Introduction

The recognition of individuals by the method of the characteristics of biometric is an essential technology in the society, on the grounds that it cannot be shared and they represent the bodily identity of the individual intrinsically. Among the numerous technologies of Biometric recognition, the most popular and well known technique for personal identification is Fingerprint recognition because of its invariance, collectability, universality and uniqueness. Fingerprint in very large volumes are collected and stores extensive variety of applications every day incorporating access and Forensics control. [H.S. Vimala(2015)]

In an expanding digital world, personal authentication which is reliable has become very significant activity of interface of computer and human. Access to computer networks, e-commerce, and national security are few instances in which establishing an identity of a person is very important. Majority of the existing measures of security depend upon approach which is knowledge-based such as token based approach or passwords like passport and swipe cards for controlling access to virtual and physical spaces. Nonetheless, such methods all over the place are not very much secure. Token for example access cards might be stolen or shared. PIN numbers and passwords might be electronically stolen. Moreover, they cannot distinguish between user which is authorized and the person who is having access to knowledge or tokens. Biometrics like voiceprint, face, and fingerprint provides personal authentication which is reliable which can deal with these types of problems and is achieving acceptance of government and citizens. Amongst biometric, systems of fingerprint have been standout amongst the most extensively deployed and researched due to their comfortable access, relatively good performance, low price of sensors of fingerprint and scanning which is non intrusive. [Kushal Veer Singh(2015)]

We can see how the sparse representation is utilized for compressing images of fingerprint. Dictionary construction, compressing a fingerprint, quantization and coding and then algorithm's analysis is incorporated. As here more information is present in the dictionary, therefore it has huge size. In this way, there is necessity of pre-processing for acquiring the dictionary of moderate size. Noise, rotation and transformation can impact the fingerprints which are having same finger and could make it look very different. [Swapnil Raut, Nisha Wankhade (2015)]

2. Fingerprint

A fingerprint generally shows up as a progression of dark lines that speaks to the high topping segment of the friction peel of ridge, while the valleys between these ridges appear as white space and are the portion which is low shallow of the ridge peel of the friction. Figure 1 shows the fundamental features of biometric like ridge endings, bifurcations and core of fingerprint where the endings of the ridge are the points at which ridge stops. Bifurcations are the points on the image of fingerprint at which one ridge separates into two. And also Core is the central point of the pattern of fingerprint. [Arthi S, Stanly Jayaprakash J (2015)] Fingerprint recognition is utilized for identification of user on account of its ease, usability and performance which is reliable as contrasted to different biometrics, for example, iris, face, signature etc. and is utilized in applications of commercial and forensic like electronic ID cards which are personal and investigation of crime. The systems database of fingerprint

recognition might have huge number of images of fingerprints. An image of the fingerprint has expansive measure of information and the storage of databases of fingerprint image is on enormous storage devices which are secondary. Fingerprints are remarkable identifiers of persons. The images of fingerprint have high energy in few bands of high frequency acquired from the pattern of ridge-valley and different structures. [Lakshmipriya. S (2015)]

3. Methods of Image Compression

There are mainly two methods of image compression which are explained below:

3.1. Lossless Compression

The techniques of lossless compression compress the information without losing or destroying anything when the process is taking place. At the point when the document which is original is decompressed, it is identical bit-to-bit as the original. Lossless is a term connected to the techniques for compressing data of an image in which there is loss of little of the original data. It is ordinarily utilized by the media of print and photographic, in which there is requirement of high resolution and there is no problem of files having large size. In the schemes of lossless compression, after compression, the image which is reconstructed is identical numerically to the image which is original.

3.2. Lossy Compression

Lossy is a term which is connected to techniques for compressing of data in which some measure of the data which is original is lost when the process of compression takes place. The applications of compression of lossy image endeavor to dispense with unnecessary or redundant information regarding what the eye of human can see. As the measure of information is decreased in the image which is compressed, the size of the file is smaller than the image which is original. The schemes of lossy compression are fir for accomplishing much higher compression. [Priya Kapoor, Sunaina Patyal(2014)]

4. Transform based Image Compression Technologies

Transform-based image compression technologies have been extensively researched and some standards have appeared.

4.1. Discrete Cosine Transform (DCT)

The discrete cosine transform is a transform which is fast that takes an input and then changes it to the linear combination of function which is weighted basis and these functions are ordinarily the frequency, similar to sine waves. It is accepted in JPEG. The main advantages of DCT are availability, universality and simplicity. [Anshuman, Gaurav Jaiswal, Ankit Rai(2014)]

4.2. Discrete Wavelet Transform (DWT)

The DWT (discrete wavelets transform) utilizes a discrete arrangement of wavelet translations and scales complying with some characterized rules. This type of transformation breaks down the signal into set of wavelets which are orthogonal mutually. The wavelet is developed from a function of scaling which depicts the properties of the scaling. DWT can be utilized for reduction in the size of an image with not very much loss of its resolution.

5. Various Existing Methods of Compression

The various methods of compression which are available are explained below:

5.1. JPEG

JPEG stands for Joint Photographic Experts Group. It is standard of image coding which is based on DCT. The JPEG/DCT still compression of an image has turned into a standard as of late. JPEG is mainly designed for compression of images which are grayscale or full-color of the real-world or natural scenes. For exploiting this strategy, an image is partitioned firstly into the blocks of size 8*8 which are non overlapped. A DCT (discrete cosine transforms) is connected with every block for changing the pixels of gray levels in the spatial domain to frequency domain coefficients. The normalization of coefficients are done by distinctive scales as indicated by the standard of JPEG directed by some evidence of psycho visual. The coefficients which are quantized are revamped in an order which is to compressed further by a method of lossless coding which is efficient like Huffman coding, arithmetic coding, run length coding. The loss of information happens just during the coefficient quantization process. The JPEG standard characterizes a standard 8*8 table for quantization for all images which might not be suitable. For achieving the superior quality of different images having the similar compression by utilizing the approach of DCT, an adaptive table of quantization may be utilized rather than standard table of quantization. This method has many benefits like availability, universality and simplicity. [Nirbhay Kashyap, Dr. Shailendra Narayan Singh (2013)].

5.2 JPEG 2000

Since the middle Nineteen Eighties, individuals from each the ITU and furthermore the ISO are working along to determine the joint global commonplace for compressing color still and grayscale images, this effort has been alluded to as JPEG, Joint Photographic consultants cluster. In JPEG 2000, JPEG's DCT is supplanted with DWT. JPEG 2000 has the capacity handle up to information having 256 channels, while the current standard of JEPG has the capacity for handling channels of three colors. Such enormous data quantities of information are produced routinely in imagery of satellite. The main method of compression utilized in JPEG 2000 is the Embedded Block Coding with Optimized Truncation Algorithm (EBCOT), outlined by Taubman. Notwithstanding giving great efficiency in compression, EBCOT produces a stream of bit with various attractive elements, incorporating random access and scalability in resolution [R. Saranya, S. Raja Mohammad (2014)]

5.3. WSQ (Wavelet Scalar Quantization)

The above algorithms are utilized mainly for general compression of an image. Focused at images of fingerprint, there are extraordinary algorithms for compression. The most widely recognized is WSQ. It turned into standard of FBI for compressing images of fingerprint of size 500 dpi. The class of WSQ of encoders includes decomposition of the image of fingerprint into various sub bands, every one of which speaks to data in a band having particular frequency. The decomposition of sub band is accomplished by DWT of the image of fingerprint. Every sub band is quantized by utilizing values form the table of quantization. The coefficients which are quantized are passed to procedure of Huffman encoding which compresses the information. The specifications of Huffman table must be given to the encoder. [Sarath N. S, Anoop K. P, Sasikumar. V. V (2014)]

5.4. K- SVD: K-SVD

(Single value decomposition) is a method of iteration that exchanges between coding which is sparse of the illustrations taking into account the present dictionary and a procedure of updating the atoms of dictionary for better fitting of information. The updating of the columns of dictionary is joined with an overhaul of the sparse representations, in this manner acceleration in convergence. The algorithm of K-SVD is adaptable and can work with any interest strategy (like matching pursuit, FOCUSS, basis pursuit). The K-SVD is not viable when the size of dictionary is very large. [10]

6. Feature Extraction & Classification using Neural Network

Feature extraction is the procedure of mapping the features which are original into fewer features which incorporate the primary information of the data structure. A mapping *f* transforms a pattern $\underline{y}$ of a feature space which is of *d*-dimensional to a pattern $\underline{x}$ of a projected space which is m-dimensional, m<d, i.e.

$$\underline{x} = f(\underline{y}), \quad (1)$$

Such that an optimization of *J* criterion is done. The mapping $f(\underline{y})$ is established from all the transformations $g(\underline{y})$ as the one which satisfies,

$$J\{f(y)\} = max\ J\{g(y)\} \quad (2)$$

The mapping varies by the forms of g(x) which are functional and by the norm they must be optimized.

Feature extraction for projection of exploratory data empowers visualization of data which is high-dimensional for understanding of better data structure and for analysis of cluster. For classification, in feature extraction, it is required for extraction of features which are highly discriminative and having reduced dimensionality which lessen the classification requirements which are computational. In any case, criteria of feature extraction for exploratory projection of data routinely intend for minimizing an error function like mean square error or difference of inter pattern distance while criteria of feature extraction for classification intend to enhance class separability as could be expected. Thus, the optimum features with respect to particular criterion figured for projection of exploratory data are not inexorably the ideal elements in regards to class separability and vice versa. [B. Lerner, H. Guterman, M. Aladjem, I. Dinstein(2015)]

In classification, input matrix which is given to the neural network is 20 by n of size and whereas target matrix is of 2 by n size in which if input feature vector belong to class 2 then the output vector which is corresponding will have at 2nd row 1 and at other rows 0. Here, 1 value in any target vector shows the fitting of an image to the class shown by the corresponding value of row of the target vector. For classification, many methods are available like Learning Vector Quantization (LVQ), Radial Basis Function (RBF) & Back Propagation (BP). [Lalit P. Bhaiya, Virendra Kumar Verma(2012)], [L. M. Palanivelu, P. Vijayakumar(2014)]

7. Motivation

The scope of this research work is wider as the fingerprints are used in many applications in the present world. Fingerprint images are used in several documentations like passport, police records, gun registration, which requires huge amount of storage memory. In this work, the compression algorithm which is adopted has very high ratio of compression and neural network is also used extraction of features. A novel approach which is based on

sparse representation is presented in this work.
The research work is based on following objectives:

- Input images from database and apply pre-processing on images.
- Perform compression using DCT operation.
- Extract image features and classify using neural network.
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8. Proposed Scheme

In our research work, an approach which is dependent upon sparse representation is proposed. The steps involved in the methodology are given below:

- A novel approach based on sparse representation is proposed.
- To construct a base matrix whose columns represent features of the fingerprint images, referring the matrix dictionary whose columns are called atoms
- For a given whole fingerprint, divide it into small blocks called patches whose number of pixels is equal to the dimension of the atoms
- To use the method of sparse representation to obtain the coefficients; then, quantize the coefficients; last, encode the coefficients and other related information using lossless coding methods.
- To classify the features extracted from images using neural network approach.

The flowchart is which is originally present is as shown in the diagram below. Firstly input image is loaded and then converted into gray image and histogram calculation is done. After that, ridge orientations are determined and then DCT compression is done. And in the last, sparse representation and PSNR estimation is done. The modification is done in this algorithm which is explained. In the proposed algorithm, main modification is that extraction of features of an image are done and classified by using neural networks as GOOD, UGLY or BAD.

9. Results and discussions

The main aim of this research work is to propose an approach based in sparse representation. In the algorithm, we first construct a dictionary for predefined fingerprint image patches. For a new given fingerprint images, represent its patches according to the dictionary and quantize and encode the representation. Then a neural network is constructed for classification of images of fingerprint which can easily classify fingerprint images that are complicated.This section presents the simulated results of the proposed work. In Figure. 4, original image is there and then histogram equalization of an image is done which is shown in Figure. 5. The histogram of equalized image is made and shown in Figure. 6. After histogram, ridge segmentation is shown in Figure.7. Figure. 8 represents orientation field and PSNR value is calculated which is shown in Figure. 9. Levels of DWT i.e. DWT-1 and DWT-2 are shown in Figure. 10 and then final result of the wavelet is shown in Figure. 11 i.e. UGLY.

10. Conclusion & future scope

The main aim of this research is to compress the data of fingerprints which are utilized in many fields in today's world. It is used to validate transactions by requesting biometric authentication before orders are submitted or financial transactions are executed. The SPARSE compression algorithm adopted has high compression ratio but due to block by block processing mechanism, it has high complexities. By using neural networks used for the classification of the fingerprint images, most of the features are preserved for further identification during the compression and reconstruction. In the future, hardware implementation of this algorithm can be thought over. Secondly, the optimization algorithms for reducing design complexities need to be investigated. Thirdly, matching percentage of the features of the images needs to be improved. The methods for reducing the time duration for executing the program should be considered.

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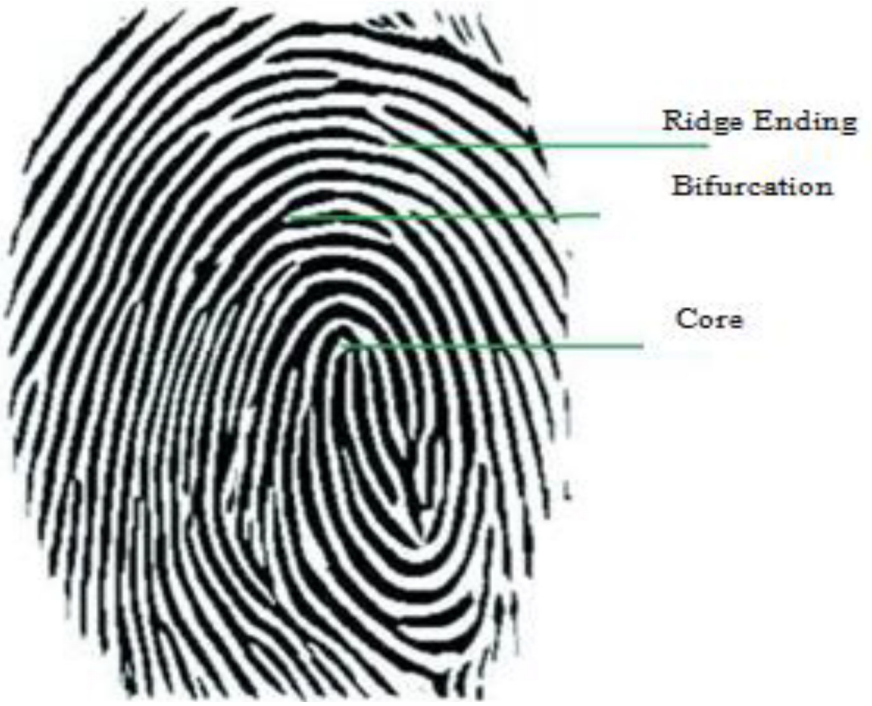

Figure 1. Biometric features of fingerprint image

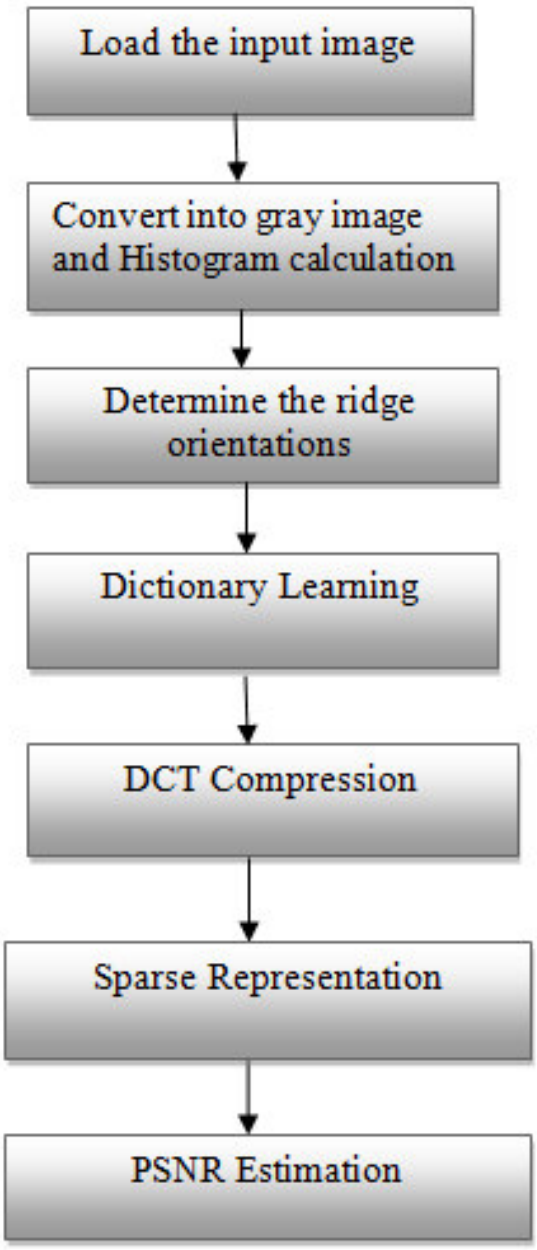

Figure 2. Sparse Representation

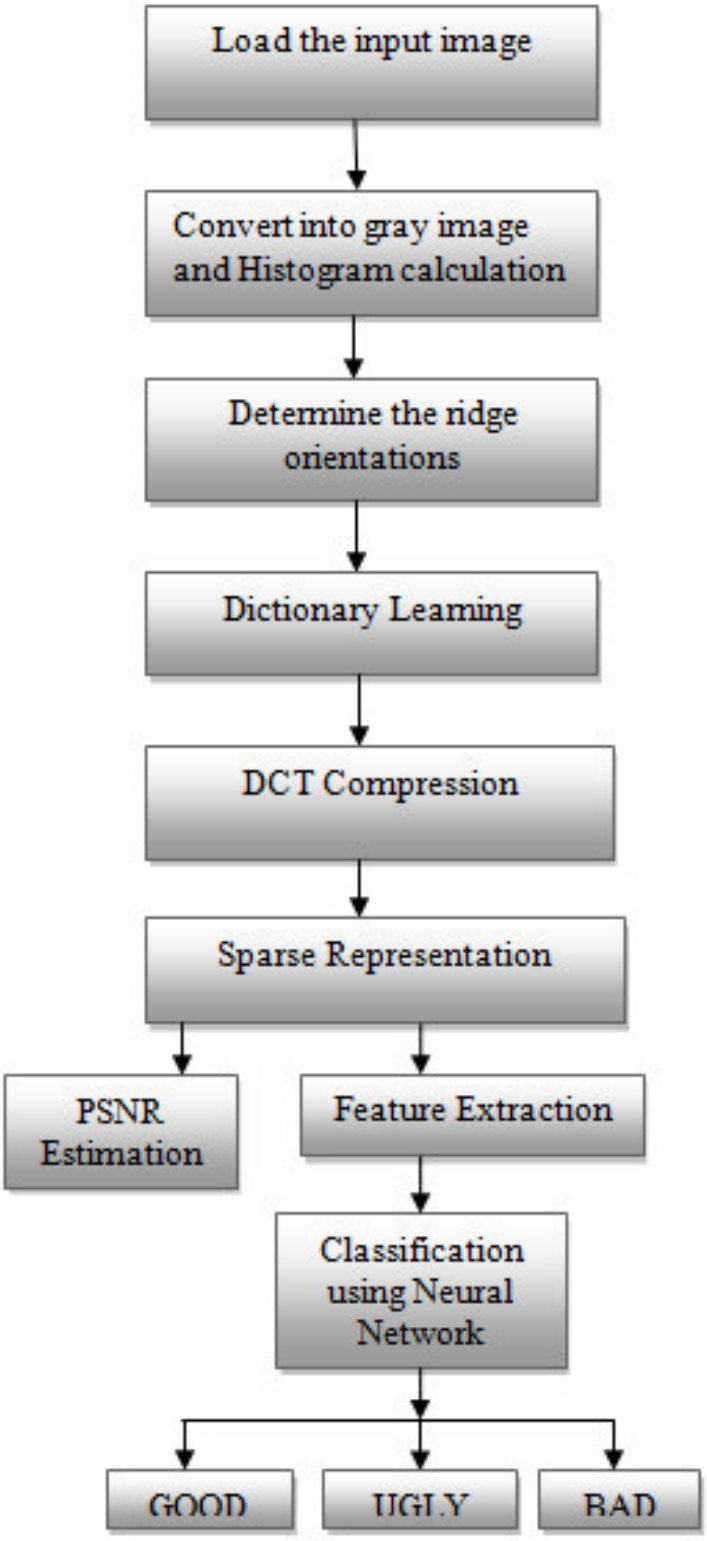

Figure 3. Modification in the Sparse Representation

Figure 4 Original Image

Figure 5. Histogram Equalization

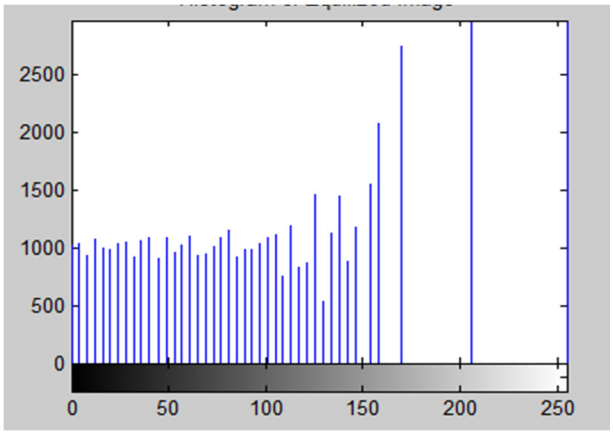

Figure 6. Histogram of Equalized Image

Figure 7. Ridge Segmentation

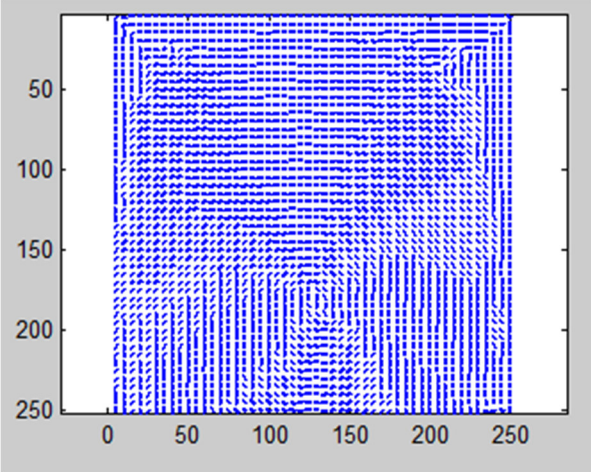

Figure 8. Orientation Field

Figure 9. PSNR Value

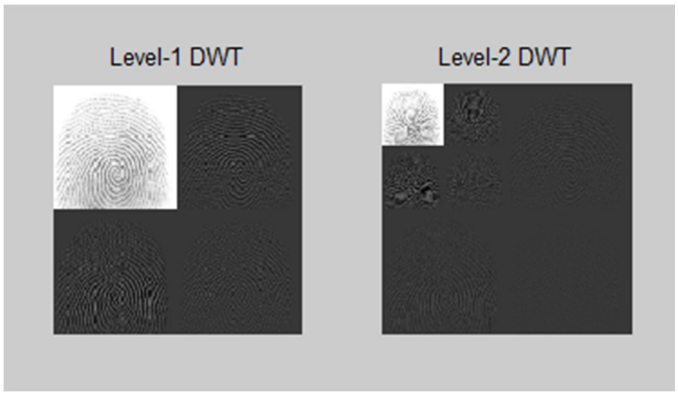

Figure 10 DWT Levels

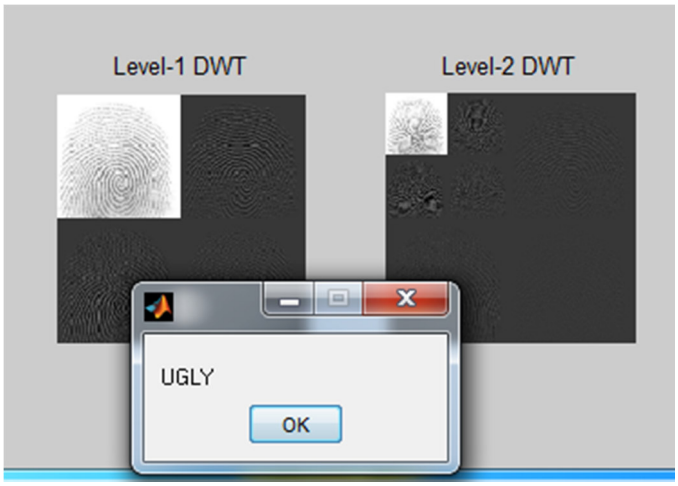

Figure 11. Level Biorthogonal Wavelet Result