



Biometrics Image Compression Using Wavelet

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Abstract: *Biometric is becoming the part of our day to day life right from our home to workplace. For security and safety purpose prime importance is given to biometrics now a days. The big challenge in using biometrics data is about handling of enormous data. As this data is increasing day by day. It becomes difficult to store and transmit the data effectively and efficiently in less time. So we need to go for different compression techniques to overcome this problem. Wavelets can even be used to transform an image in more and less important data items. By only storing the important ones the image can be stored in an amazingly more compact fashion also avoiding the data redundancy, at the cost of negligible distortions in the image. We will have the use of different wavelets for compression of fingerprint images as it is widely used in most of the biometrics application. This work is done in MATLAB using DSP and wavelet toolbox. We can achieve compressed images with compression ratio, MSE, and, PSNR.*

Keywords: *Biometrics, Wavelet, Compression, PSNR, MSE*

I. INTRODUCTION

The terms "Biometrics" and "Biometry" have been used since early in the 20th century to refer to the field of development of statistical and mathematical methods applicable to data analysis problems in the biological sciences. Recently, these terms have also been used to refer to the emerging field of information technology devoted to automated identification of individuals using biological traits, such as those based on retinal or iris scanning, voice patterns, dynamic signatures, fingerprints, face recognition, or hand measurements, especially for authentication purposes. Thus biometrics can be defined as the science and technology of measuring and statistically analyzing biological data. They are measurable physiological characteristics that can be utilized to verify the identity of an individual. For a layman, it could be said that biometrics are the science of measuring physical characteristics that are unique to each individual and they verify that an individual is who he or she claims to be. The biometrics system works in three steps, In first step a sensor takes an observation. The type of sensor and its observation depend on the type of biometrics device used. In second step .A computer algorithm *Anormalizes* the biometric signature so that it is in the same format (size, resolution, etc.) as the signatures on the system's database. The normalization of the biometric signature gives us an *A Normalized Signature* of the individual. Finally a matcher compares the normalized signature with the set of normalized signatures on the system's database and provides a *Asimilarity score* that compares the individual's normalized signature with each signature in the database set. What is then done with the similarity scores depends on the biometric system's application. The big problem related to biometrics is also about storage and transmission of huge data. With the increased use of computers as vehicles of information technology, it is necessary to restrict access to sensitive/personal data. By replacing PINs, biometric techniques can potentially prevent unauthorized access to or fraudulent use of ATMs, cellular phones, smart cards, desktop PCs, workstations, and computer networks. PINs and passwords may be forgotten, and token-based methods of identification like passports and driver's licenses may be forged, stolen, or lost. Thus biometric systems of identification are enjoying a renewed interest Most of the leading banks are considering using biometrics for ATM machine and as a general means of combating card fraud. The increased need of privacy and security in our daily life has given birth to this new area of biometrics science. It will have more future impact on our day to day lives. Images contain large amounts of information that requires much storage space, large transmission bandwidths and long transmission times. Therefore it is advantageous to compress the image by storing only the essential information needed to reconstruct the image. An image can be thought of as a matrix of pixel (or intensity) values. In order to compress the image, redundancies must be exploited, for example, areas where there is little or no change between pixel values. Therefore images having large areas of uniform colour will have large redundancies, and conversely images that have frequent and large changes in colour will be less redundant and harder to compress. Wavelet analysis can be used to divide the information of an image into approximation and detail subsignals. The approximation subsignal shows the general trend of pixel values, and three detail subsignals show the vertical, horizontal and diagonal details or changes in the image. If these details are very small then they can be set to zero without significantly changing the image. The value below which details are considered small enough to be set to zero is known as the threshold. [7] The greater the number of zeros the greater the compression that can be achieved. The amount of information retained by an image after compression and decompression is known as the .energy retained. and this is proportional to the sum of the squares of the pixel values. If the energy retained is 100% then the compression is known as .lossless., as the image can be

reconstructed exactly. This occurs when the threshold value is set to zero, meaning that the detail has not been changed. If any values are changed then energy will be lost and this is known as .lossy. compression. Ideally, during compression the number of zeros and the energy retention will be as high as possible. However, as more zeros are obtained more energy is lost, so a balance between the two needs to be found. The image itself has a dramatic effect on compression. This is because it is the image's pixel values that determine the size of the coefficients, and hence how much energy is contained within each subsignal. Furthermore, it is the changes between pixel values that determine the percentage of energy contained within the detail subsignals, and hence the percentage of energy vulnerable to thresholding. Therefore, different images will have different compressibilities. There are many possible extensions to this project. These include finding the best thresholding strategy, finding the best wavelet for a given image, investigating other wavelet families, the use of wavelet packets and image denoising. Choosing best wavelet for image compression, show the image compression for white colour image, black colour image, then think of fingerprint image, study and get the comparison between these kind of images. according to that choose the wavelet.

II. BACKGROUND

One of the major applications where the compression plays crucial part in fingerprint, which is used for application in scientific especially medical, field legal matters as in the investigation of crime etc. There are many image compression techniques available. Still there is need to develop faster, more efficient and reliable algorithms for fingerprint images [4]. One of the main difficulties in developing compression algorithms for a fingerprint is preserving the minutiae i.e. ridges endings and bifurcations, which are subsequently used in identifications. To achieve high compression ratios while retaining these fine details, wavelet packet are used. Wavelet packets also save computational effort, transmission, and storage costs etc. Various image compression techniques already exists like DCT, JPEG, and JPEG2000 [2] and Wavelet etc. all these techniques have their common aim to achieve high compression ratio. Among the exiting compression techniques Wavelet gives better results for lossless as well as lossy image compression.

III. WAVELETS AND WAVELET PACKET FOR COMPRESSION

Fingerprint images can be seen as texture patterns of flow orientations with sharp discontinuities. For this particular nature of fingerprint images and the need for retaining fine details of the ridges and their inter relation, the wavelet decomposition method is most useful .

Wavelet analysis has proved to be very important development in the search of more efficient methods of image compression. Like most Lossy image coders, wavelet based image coders typically comprise three major components. Wavelet filter bank decomposes an image into wavelet coefficients, which are then quantized in Quantizer, and finally an entropy encoder encodes these quantized coefficients into out bit stream i.e. compressed image.

Any signal processing performed on a computer using real-world data must be performed on a discrete signal — that is, on a signal that has been measured at discrete time. So what exactly is “continuous” about it? What’s “continuous” about the CWT, and what distinguishes it from the discrete wavelet transform (to be discussed in the following section), is the set of scales and positions at which it operates. Unlike the discrete wavelet transform, the CWT can operate at every scale, from that of the original signal up to some maximum scale that you determine by trading off your need for detailed analysis with available computational horsepower. The CWT is also continuous in terms of shifting: during computation, the analyzing wavelet is shifted smoothly over the full domain of the analyzed function.

Calculating wavelet coefficients at every possible scale is a fair amount of work, and it generates an awful lot of data. What if we choose only a subset of scales and positions at which to make our calculations? It turns out, rather remarkably, that if we choose scales and positions based on powers of two — so-called *dyadic* scales and positions — then our analysis will be much more efficient and just as accurate. We obtain such an analysis from the *discrete wavelet transform* (DWT). An efficient way to implement this scheme using filters was developed in 1988 by Mallat . The Mallat algorithm is in fact a classical scheme known in the signal processing community as a *two-channel subband coder* . This very practical filtering algorithm yields a *fast wavelet transform* — a box into which a signal passes, and out of which wavelet coefficients quickly emerge. Let’s examine this in more depth.

For many signals, the low-frequency content is the most important part. It is what gives the signal its identity. The high-frequency content, on the other hand, imparts flavor or nuance. Consider the human voice. If you remove the high-frequency components, the voice sounds different, but you can still tell what’s being said. However, if you remove enough of the low-frequency components, you hear gibberish. In wavelet analysis, we often speak of *approximations* and *details*. The approximations are the high-scale, low-frequency components of the signal. The details are the low-scale, high-frequency components.

The filtering process, at its most basic level, looks like this: The original signal, S , passes through two complementary filters and emerges as two signals. Unfortunately, if we actually perform this operation on a real digital signal, we wind up with twice as much data as we started with. Suppose, for instance, that the original signal S consists of 1000 samples of data. Then the resulting signals will each have 1000 samples, for a total of 2000. These signals A and D are interesting, but we get 2000 values instead of the 1000 we had. There exists a more subtle way to perform the decomposition using wavelets. By looking carefully at the computation, we may keep only one point out of two in each of the two 2000-length samples to get the complete information. This is the notion of *downsampling*. We produce two sequences called cA and cD . The process on the right, which includes downsampling, produces DWT coefficients. To gain a better appreciation of this process, let’s perform a one-stage discrete wavelet transform of a signal. Our signal will be a pure sinusoid with high-frequency noise added to it.

IV. IMPLEMENTATION

The purpose is to show how to compress an image using two-dimensional wavelet analysis. Compression is one of the most important applications of wavelets. The image to be compressed is a fingerprint.

The **Wavelet 2-D** tool in MATLAB is used to compress the figure print image

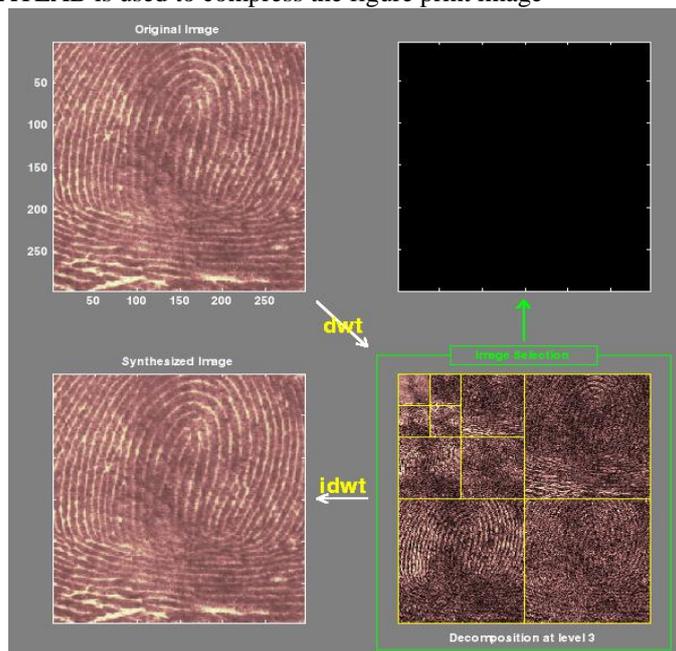


Fig 1, Wavelet 2-D Compressed Fingerprint Image

The graphical tool provides an automatically generated threshold. Values under the threshold are forced to zero, achieving about 42% zeros while retaining almost all (99.96%) the energy of the original image[5]. The automatic thresholds usually achieve reasonable and various balances between the number of zeros and retained image energy. Depending on your data and your analysis criteria, you may find setting more or less aggressive thresholds achieves better results.

Images can also be compressed using Wavelet packets .Notice that the default threshold (7.125) provides about 64% compression while retaining virtually all the energy of the original image. Depending on your criteria, it may be worthwhile experimenting with more aggressive thresholds to achieve a higher degree of compression. Recall that we are not doing any quantization of the image, merely setting specific coefficients to zero. This can be considered a pre-compression step in a broader compression system. .

Setting all wavelet packet coefficients whose value falls below 30 to zero yields much better results. Note that the new threshold achieves around 92% of zeros, while still retaining nearly 98% of the image energy. Compare this wavelet packet analysis to the wavelet analysis of the same image in “Compressing Images” You can see the result obtained by wavelet packet coefficients thresholding and image reconstruction. The visual recovery is correct, but not perfect. The compressed image, shown side-by-side with the original, shows some artifacts. Figure 1 shows the fingerprint image with second level of decomposition. we can go upto n level of decomposition to get the desire level of results. Figure 2 shows graph for retained energy and zeros, Both figure are generated using wavelet toolbox. For different biometrics figure same thing is applicable ,but as fingerprint are widely used we choose n the fingerprint image.

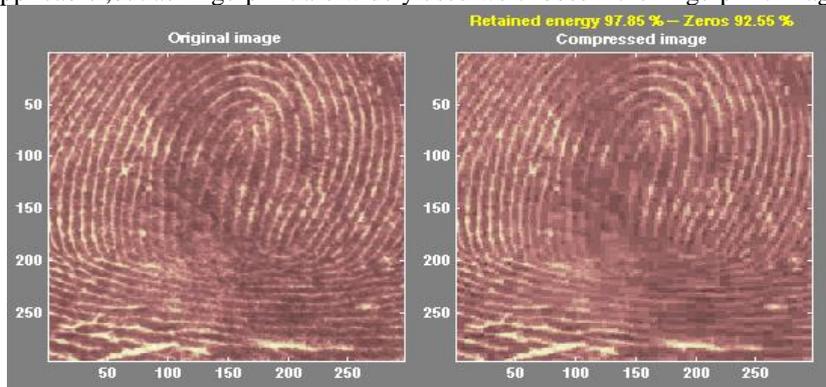


Fig 2 Retained Energy for Fingerprint Image

By adjusting different threshold values, The entropy function, and the wavelets we can obtain better results.

Different wavelets will give different results like ,The bior6.8 wavelet is better suited to this analysis than is haar, and can lead to a better compression ratio. When a biorthogonal wavelet is used, then instead of “Retained energy” the

information displayed is “Energy ratio.”[4] Looking at the pattern of small and large squares in the fingerprint analysis shows that the best tree algorithm has apparently singled out the diagonal details, often sparing these from further decomposition.

V. ANALYSIS AND INTERPRETATION

This compression ratio is determined on the basis of 2-D Wavelet packet analysis i.e. threshold value, retain energy and number of zeros present in the image after compression. Retain Energy (RE) and Number of Zeros (NZ) are calculated by following formulas:

$$RE = 100 * (V_n(\text{CCD}, 2) / (V_n(\text{Original Signal}) / (V_n(\text{Original Signal})))$$

&

$$NZ = 100 * (ZCD) / (\text{No. of Coefficient})$$

Where, V_n is the Vector norm, CCD is the coefficients of the current decomposition and ZCD is the Number of zeros of the current decomposition. A central question about many threshold procedures is how to choose the threshold, because it is a trade off between closeness of fit and smoothness. A small threshold yields a result close to the input, but this result may still be noisy. A large threshold produces the large number of zeros of wavelet coefficients. This sparsely is short of smoothness the output is simple, paying too much attention to smoothness, however, destroys some of signal and it may cause blurs and the artifacts.

VI. CONCLUSION

Wavelet analysis is extremely useful for compressing images. It is because of multiresolution. Although other transforms have been used but wavelet analysis can be seen to be far superior, as it doesn't create blocking artefacts. This is because the wavelet analysis is done on the entire image rather than sections at a time. A well known application of wavelet analysis is the compression of fingerprint images by the FBI. The work involves Matlab programming for taking input image which is to be compressed, then with different wavelet families are used for compression. With different composition level and thresholding values for better result. Still optimization of thresholding is not fixed. However, this was still not the optimal thresholding in that it is possible to get a higher energy retention for a given percentage of zeroes, by thresholding each detail subsignal in a different way. Changing the decomposition level changes the amount of detail in the decomposition. Thus, at higher decomposition levels, higher compression rates can be gained. However, more energy of the signal is vulnerable to loss. The wavelet divides the energy of an image into an approximation subsignal, and detail subsignals. Wavelets that can compact the majority of energy into the approximation subsignal provide the best compression. This is because a large number of coefficients contained within detailed subsignals can be safely set to zero, thus compressing the image. However, little energy should be lost. Wavelets attempt to approximate how an image is changing, thus the best wavelet to use for an image would be one that approximates the image well. However, although this report discusses some relevant image properties, there was not time to research or investigate how to find the best wavelet to use for a particular image. The image itself has a dramatic effect on compression. This is because it is the image's pixel values that determine the size of the coefficients, and hence how much energy is contained within each subsignal. Furthermore, it is the changes between pixel values that determine the percentage of energy contained within the detail subsignals, and hence the percentage of energy vulnerable to thresholding. Therefore, different images will have different compressibilities. There are many possible extensions to this project. These include selecting the best thresholding strategy, selecting the best wavelet for a given image, study other wavelet families, the use of wavelet packets and image denoising.

REFERENCES

- [1] Sugreev Kaur¹ And Rajesh Mehra² High Speed And Area Efficient 2d Dwt Processor Based Image Compression Signal & Image Processing : An International Journal(SIPIJ) Vol.1, No.2, December 2010 DOI : 10.5121/sipij.2010.1203 22
- [2] Sonja Grgic, Mislav Grgic, *Member, IEEE*, and Branka Zovko-Cihlar, *Member, IEEE* Performance Analysis of Image Compression Using Wavelets IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 48, NO. 3, JUNE 2001
- [3] **Jamuna.M, A.M.Vijaya Prakash, J.Pushpanjali** Low Power VLSI Architecture for Image Compression System Using Discrete Wavelet Transform **International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-1, Issue-5, June 2012 490**
- [4] S. S. Gornale, Vikas T Humbe, R. R. Manza, K.V.Kale **Fingerprint Image Compression using Retain Energy (RE) and Number of Zeros (NZ) through Wavelet Packet (WP)** International Journal of Computer Science and Security, Volume 1: Issue (2) 35
- [5] Wavelet Toolbox, **For Use with MATLAB®** User's Guide *Version 2.1 Michel Misiti Yves Misiti Georges Oppenheim Jean-Michel Poggi*
- [6] Sugreev Kaur¹ and Rajesh Mehra² HIGH SPEED AND AREA EFFICIENT 2D DWT PROCESSOR BASED IMAGE COMPRESSION Signal & Image Processing : An International Journal(SIPIJ) Vol.1, No.2, December 2010 DOI : 10.5121/sipij.2010.1203 22
- [7] Sonja Grgic, Mislav Grgic, *Member, IEEE*, and Branka Zovko-Cihlar, *Member, IEEE* Performance Analysis of Image Compression Using Wavelets , IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 48, NO. 3, JUNE 2001