Performance Analysis of Biorthogonal Wavelet Filters for Lossy Fingerprint Image Compression

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***Abstract*—** The increasing amount of fingerprints collected by law enforcement agencies has created an enormous problem in storage and transmission [1]. To reduce the increasing demand of storage space and transmission time, Compression techniques are the need of the day. There are many image compression techniques available at present. Wavelet coding is one of the effective techniques for compression and de-noising of image [2] [3]. In wavelet based image coding, a variety of orthogonal and biorthogonal filters have been developed by researchers for signal analysis and compression. The selection of wavelet filters plays a crucial part in achieving an effective coding performance, because there is no filter that performs the best for all images [4]. The Current Compression system uses the biorthogonal wavelet filters instead of orthogonal. Because Orthogonal filters have a nice property of energy preservation where as biorthogonal filters lack of it. Daubechies, Symlet and Coiflet filters having special property of more energy conservation, more vanishing moments , regularity and asymmetry than other biorthogonal filters [5]-[7]. In this paper we have analyze the best biorthogonal wavelet filter out of Daubechies, Symlet and Coiflet for lossy fingerprint image compression. For this, we have applied Daubechies, Symlet and Coiflet Wavelet Transforms (WT) through different orders at 1 to 5 decomposition levels on the fingerprint images. Our results show that the Coiflet4 (4th order) wavelet filter is more suitable for lossy fingerprint image compression and gives a better compression at 5th level.

***Keywords*—** Decomposition, Fingerprint Image Compression, Wavelet Compression, Wavelet Filter.

I. INTRODUCTION

THE Federal Bureau of Investigation (FBI) deals with a large collection of fingerprints containing more than 200 million cards and this volume is growing at a rate of 30,000-50,000 new cards per day [8]. Digitization of these cards requires greater storage space, likewise their retrieval and transmission requires longer time. Therefore it is often necessary to compress the image while storing the necessary data for subsequent reconstruction [9]. There are many image compression techniques available for compressing the images, such as DCT, JPEG, Sub-band Coding, JPEG2000, and Wavelet etc, [10]. The common aim of all these techniques is to achieve high compression ratio. But still there is a need to develop and more efficient algorithm for fingerprint images [11]. One of the difficulties in developing compression algorithm for fingerprint is the necessity of preserving minutiae i.e. ridges endings and bifurcations, which are subsequently used in automatic authentication in biometric system identification. Wavelet Thresholding is an effective method of compressing and de-noising the noisy signals, which can prove very effective in de-noising images [12]-[17]. In this paper, we have applied different biorthogonal wavelet filters with different order to fingerprint images. And we are trying to choose the best wavelet filter for compression of fingerprint images

II. WAVELET FOR COMPRESSION

The theory of 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 are typically comprising 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 as shown in figure 1.

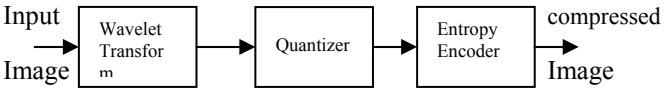

Fig. 1 shows the Lossy Image Coding System

The ability of Wavelet transform is to take into account the Human Visual System (HVS) characteristics and good energy compaction capabilities under transmission and decoding which results the high compression ratio [18],[19]. In addition to these, wavelet transform compression provides a superior image quality at low bit rates. Wavelet analysis can be used to divide the information of an image into approximation coefficients and detail coefficients. The approximation coefficients show the general trend of pixel values, and detail coefficients show the Horizontal (H), Vertical (V), and Diagonal (D) details or changes of the image. The advantage of the wavelet is that often a large number of the detail coefficients turn out to be very small in magnitude. If these

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are noted after the compression, and these are calculated by the fallowing formula.

$$RE = \frac{100*(vn(ccd,2))^2}{(vn(originalsignal))^2} \quad \text{and}$$

$$NZ = \frac{100*(ZCD)}{numberofcoefficients}$$

Where ***vn*** is the vector norm, ***ccd*** is the coefficients of the current decomposition and ***zcd*** is the number of zeros of the current decomposition [5].

V. Result and Discussion

Image compression and decompression depends on NZ and RE. In this paper we have applied Daubechies, Symlet and Coiflet transforms with different orders from 1st to 5th level. We found that at first level of all three transform for all orders the NZs are similar. It shows that compression ratio is same as at first level of all different orders of these three transforms. Further we found that for all orders of these transforms if level increases the NZs are also increases. It means, to get high compression ratio we have to select highest level. In Daubechies transform, the highest compression ratio is achieved at 10th order with 5th level, whereas, in case of Symlet, it is achieved at 8th order with 5th level and in Coiflet, the highest compression ratio is achieved at 4th order with 5th level. We compared these three transforms for fingerprint image compression, and we found that Coiflet is best suited for fingerprint image compression, because it gives highest compression ratio among these three transforms in 4th order with 5th level. So our result shows that the Coiflet is more suitable for fingerprint image compression. The same has been shown in table and graph.

VI. Conclusion

Daubechies, Symlet and Coiflet filters having special property of more energy conservation, more vanishing moments, regularity and asymmetry than other biorthogonal filters therefore in this paper we have applied Daubechies, Symlet and Coiflet transforms with different orders to fingerprint images of FVC2002 database. We determined NZ and RE at different orders from 1st to 5th level. If NZs are more, then compression ratio is also more. We found that to get highest compression ratio, the order and level must be high. We have compared these three transforms and their order as well as levels, and found that Coiflet is most suitable for fingerprint image compression, because it gives more NZs at 4th order with 5th level. Hence for fingerprint image compression Coiflet transform is most suitable.

Acknowledgement

This research work is supported by University Grants Commission, New-Delhi (F14-14/2003(SR)).

VII. References

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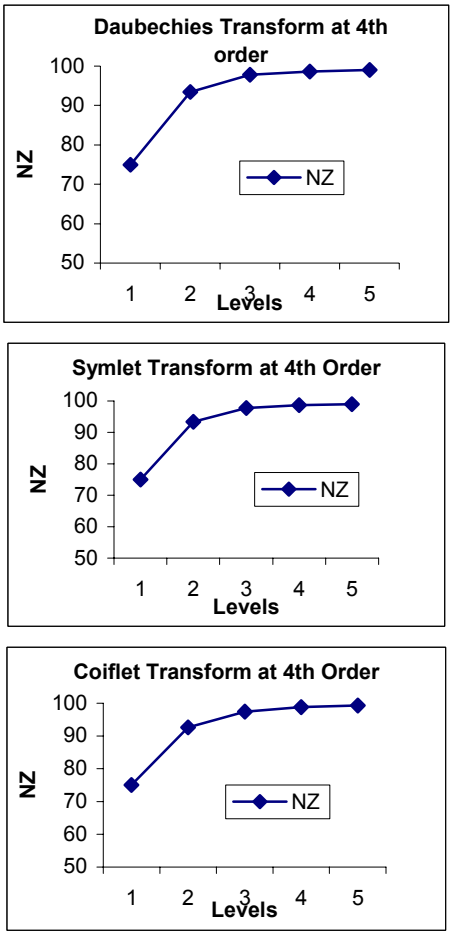

Fig. 3: Daubechies, Symlet and Coiflet transforms at 4th order and its five levels shows the increasing No. of Zeros (NZ)

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