International Journal of Electronics and Communication Engineering.
ISSN 0974-2166 Volume 4, Number 3 (2011), pp. 275-282

http://www.irphouse.com

Performance and Comparative Analysis of Still Image for Compression Ratio using Wavelets

Er. Tripatjot Singh[1], Er. Sanjeev Chopra[2], Er. Amandeep Kaur[3] and Er. Harmanpreet Kaur[4]

[1]Assistant Prof., Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib, Punjab, India
[2, 3, 4]Assistant Prof., Rayat and Bahra College of Engineering and Biotechnology for Women, Mohali, Punjab, India
E-mail: [1]tripatjot.singh@bbsbec.ac.in ,
[2]chopra_sanjeev2006@yahoo.com,

Abstract

Wavelet theory and its application have grown tremendously during the last decade. It has become a cutting edge technology in computer and human vision, neural network detecting self-similar behaviour in a time-series area of image processing. This paper synthesise on the amount of compression done, which depends on the threshold value and level of decomposition. The comparison is made on the basis of compression ratio for all members of different wavelets at decomposition level 2 and 5 using wavelet transform. Image compression reduces the storage requirements or transmission time when the information is communicated over a distance. The compression process is achieved by quantising and thresholding the wavelet coefficient.

Keywords: Image Compression, Discrete Wavelet Transforms, Compression Ratio.

Introduction

Fourier Transform is not suitable for non-stationary time varying signal and Short Time Fourier Transform lags in resolution but Wavelet

Transform has the ability to analyse any time varying signal and processes data at different resolution [1]. Wavelet Transform is better choice than traditional Fourier Transform because of its ability to localise in frequency and time domain simultaneously. It uses its multiresolution capability to decompose the image into multiple frequency bands. Also it provides very low mean square error, high compression ratio and good image quality. It is suitable for application where scalability and tolerable degradation are important for its inherent multiresolution nature wavelet coding schemes. In addition, they are better matched to the human visual system [2, 5].

Types of Wavelet Transform

Wavelet transforms treats both continuous and discrete time cases. The choice depends upon orthogonality, compactness, width and shape of wavelet function [3]. In continuous wavelet transforms (CWT), a sinusoidal time varying signal is analysed by calculation inner products with test functions (generated from one oscillating function called wavelet function). In discrete wavelet transform (DWT), filters of different cut-off frequency are used to analyse the signal at different scales. A higher scale corresponds to stretched wavelet. CWT uses Maxican Hat Wavelet for the analyses of ECG signals whereas haar, sym, bior, coif and rbio in DWT is wavelet family used for image compression. Haar, Daublets (db), sym and coif are orthogonal wavelets from which haar wavlet is simplest and fastest to implement. Unlike haar, symmetry and asymmetry is not possible for real compactly supported orthogonal wavelets. Biorthogonal wavelets (B-Spline and V-Spline) are symmetric and exhibit the property of linear phase which is needed for signal and image compression [4, 6].

Implementation

Digital image compression is based on the ideas of sub-bands decomposition or DWT. Redundancy and irrelevancy reduction are the two fundamental components of image compression. Wavelet based image coders are typically comprised of three major components: wavelet filter bank decomposes the image into wavelet coefficients which are then quantised in a quantiser and finally thresholded which makes the coefficient smaller than a chosen threshold value (zero) obtained from the quantiser [1]. As a result, some bits are reduced producing an output bit stream (compressed image). The implementation steps for image compression are shown in Figure 1.

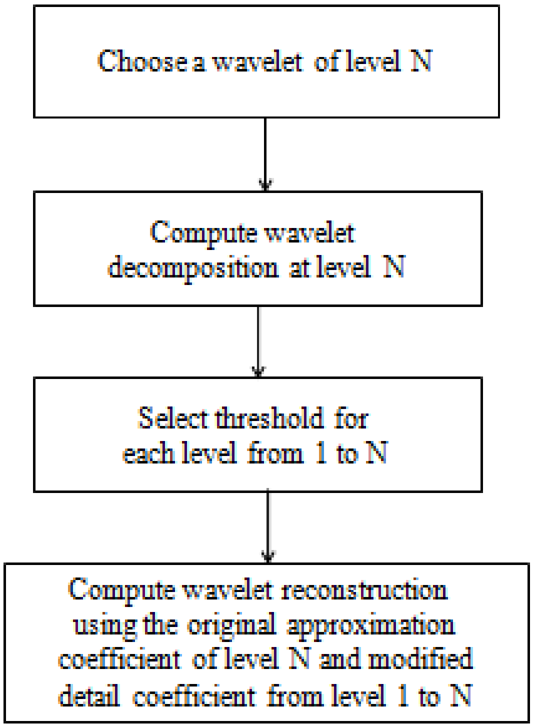


Figure 1: Implementation Steps for Image Compression.

While compressing an image, compression ratio (CR), compression time and energy ratio are taken into consideration. The image compression mainly depends on the wavelet used and level of decomposition.

Performance parameter CR with respect to different threshold (THR) values are obtained for all members of different wavelets at decomposition level 2 and level 5 using wavelet transform. From the various simulations haar, dmey, db2, coif1, sym4, sym5, bior1.2 and rbio3.1 gives maximum CR at different THR values at level 2 and haar, dmey, db2, coif1, sym4, bior1.3, rbio3.1 and rbio1.3 gives maximum CR at different THR values at level 5 as shown in Table 1 and 2 respectively.

Table 1: THR vs CR for different wavelets at level 2.

	haar	dmey	db2	coifl	sym4	sym5	bior1.3	rbio3.1
THR	CR	CR	CR	CR	CR	CR	CR	CR
5	21.69	27.615	26.215	26.717	28.199	27.954	24.483	17.092
10	46.509	48.245	47.641	48.159	49.692	50.004	45.418	30.319
20	68.976	70.067	72.45	72.587	74.081	74.206	69.331	49.564
30	80.56	78.193	82.569	82.624	83.168	83.146	80.165	61.804
40	86.09	81.699	86.734	86.741	86.799	86.675	85.298	70.046
50	88.539	83.598	88.809	88.796	88.538	88.493	87.896	75.954
60	90.183	84.826	90.072	90.048	89.77	89.679	89.469	80.327
70	91.269	85.765	91.011	91.006	90.666	90.576	90.517	83.232
80	91.93	86.527	91.7	91.707	91.357	91.264	91.271	85.512
90	92.45	87.128	92.187	92.225	91.876	91.788	91.886	87.217
100	92.888	87.588	92.607	92.553	92.248	92.126	92.311	88.525
200	93.748	88.786	93.526	93.443	93.237	93.174	93.45	93.191
300	93.75	88.789	93.532	93.462	93.249	93.182	93.462	93.531
400	93.75	88.789	93.532	93.462	93.249	93.182	93.462	93.532
500	93.75	88.789	93.532	93.462	93.249	93.182	93.462	93.532

Table 2: THR vs CR for different wavelets at level 5.

	haar	dmey	db2	coifl	sym4	bior1.3	rbio1.3	rbio3.1
THR	CR	CR	CR	CR	CR	CR	CR	CR
5	22.545	22.381	27.319	27.942	29.427	25.991	27.713	18.04
10	48.027	39.252	49.46	50.006	51.638	47.33	50.125	31.549
20	71.498	58.562	75.202	75.363	76.885	71.861	76.276	51.219
30	83.682	67.538	85.974	86.003	86.618	83.218	86.658	63.866
40	89.711	72.637	90.605	90.59	90.823	88.814	91.003	72.455
50	92.612	76.197	93.111	93.049	92.955	91.796	93.31	78.674
60	94.576	78.895	94.694	94.591	94.498	93.67	94.882	83.335
70	95.889	81.049	95.869	95.801	95.642	94.999	95.956	86.536
80	96.779	82.789	96.764	96.682	96.53	95.967	96.789	89.054
90	97.443	84.285	97.37	97.359	97.192	96.744	97.467	91.001
100	98.029	85.52	97.926	97.809	97.709	97.315	97.967	92.523
200	99.545	91.296	99.496	99.369	99.318	99.268	99.513	98.315
300	99.742	93.163	99.698	99.598	99.534	99.543	99.672	99.17
400	99.812	94.119	99.773	99.689	99.627	94.662	99.724	99.944
500	99.852	94.719	99.801	99.737	99.674	99.708	99.755	99.606

Simulation Results

Simulations have been performed to compare the image compression ratio (CR) using number of wavelets. The original standard indexed image of Barabra with 256 X 256 pixels is used as the test image. After examining the THR vs CR comparison table for different tables the following observations are made

For Level 2: In the low threshold range 5 to 40, the wavelet sym4 gives the highest CR. At THR = 50, the wavelet db2 gives the highest CR. In the threshold range 60 to 500, the wavelet haar gives the highest CR. In the threshold range 5 to 80, the wavelet rbio3.1 gives the lowest CR. In the threshold range 90 to 500, dmey gives the lowest CR.

For Level 5: The wavelet rbio1.3 gives the highest CR in the threshold range 30 to 90 and the wavelet haar gives the highest CR in the threshold range 100 to 300. The wavelet rbio3.1 gives the lowest CR in the threshold range 5 to 40 and dmey gives the lowest CR in the threshold range 50 to 500.

The curves of THR vs CR for competing members of wavelet family have been calculated and depicted in Figure 2 and Figure 3 for level 2 and level 5 respectively.

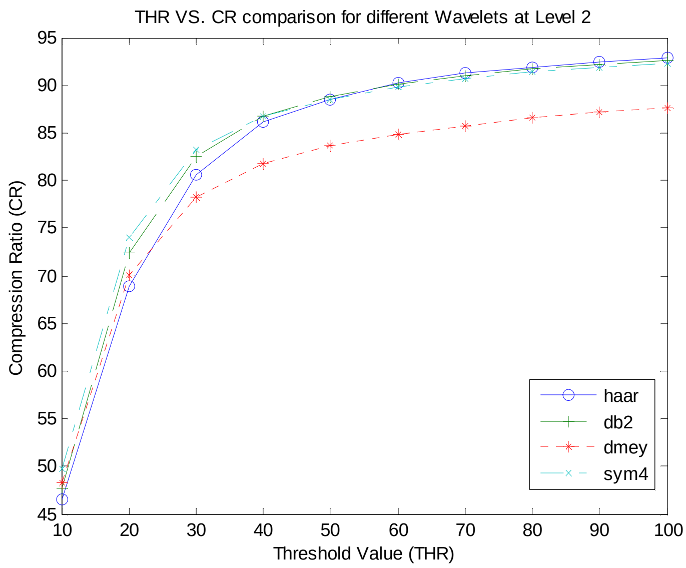


Figure 2: Simulation Results of THR vs. CR for different Wavelets at Level 2.

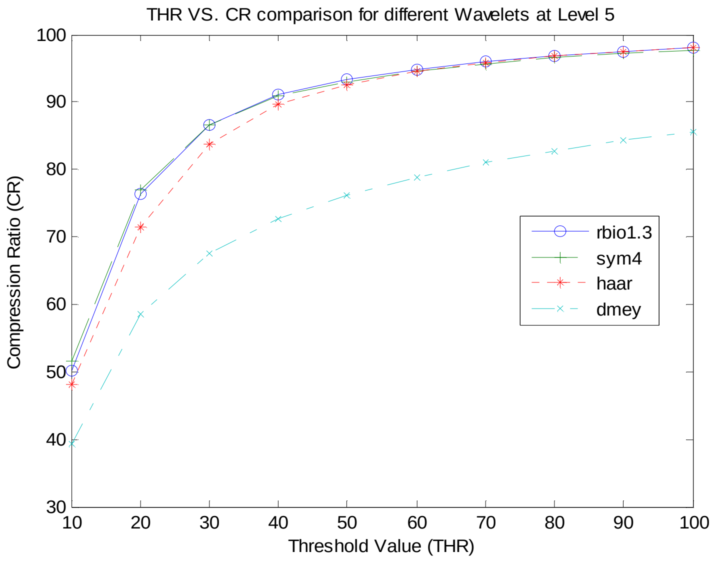
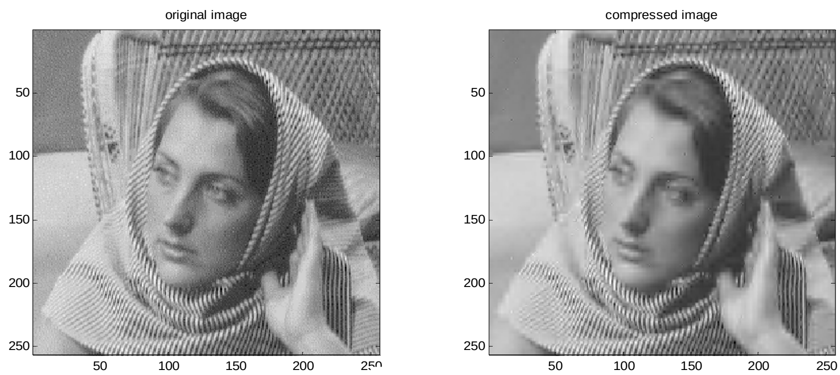


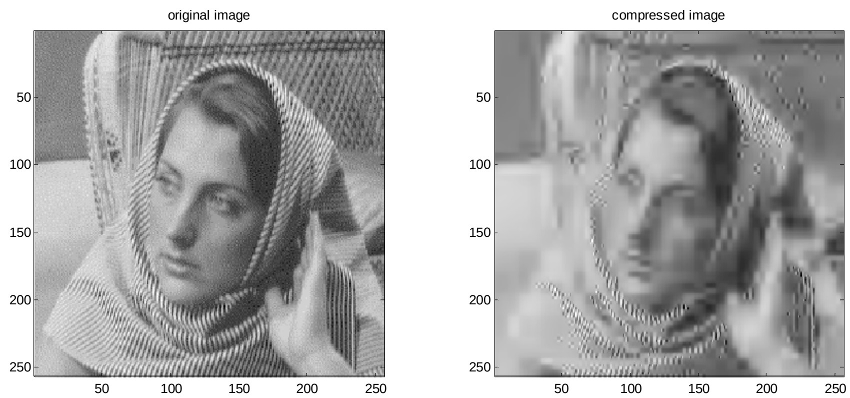
Figure 3: Simulation Results of THR vs. CR for different Wavelets at Level 5.

Conclusion

Higher CRs can be achieved at the expense of the quality of the image by quantizing the image coarsely or by using a higher threshold value or by increasing the decomposition level. At level 2, inspite of having highest CR in the higher THR range, wavelet haar cannot be used for image compression. For image compression, db2 is preferred in the higher THR range as the image degradation is within the tolerable limit as depicted in Figure 4 (a). For level 5, the wavelet rbio1.3 is preferred for image compression in the lower threshold range. The image degrades for higher threshold values as shown in Figure 4 (b). The decomposition level has been increased up to 5 because above this level the image degradation will be beyond the tolerable limit.



(a)



(b)

Figure 4: (a): Image Compression using Wavelet db2 at THR 60 for Level 2
(b): Image Compression using Wavelet rbio1.3 at THR 100 for Level 5.

Acknowledgement
The author would like to thank his guide Er. Tripatjot Singh and friends for their companionship and insight into the work summarized in paper.

References

[1] Lotfi A. A., Hazrati M. M., Sharei M., Saeb Azhang (2005),” CDF(2,2) Wavelet Lossy Image Compression on Primitive FPGA”, IEEE ,pp. 445-448
[2] Uytterhoeven G. (1999), “Wavelets: Software and Applications”, K.U. Leuven Celestijnenlaan, Department of Computer Science, Belgium.
[3] Rioul O. and Vetterli (1991), “Wavelets and Signal Processing,” IEEE Signal Processing Magazine, Vol.91, pp. 14-34.
[4] Thong Nguyen and Dadang Gunawan (1994), “Wavelets and Wavelets-Design Issues”, IEEE, ICCS Singapore, pp. 188-194.

[5] Rao R. and Bopardika A. S. (2002), “Wavelet Transform, Introduction to Theory and Applications,” Pearson Education Asia.
[6] Young R. K. (1993) “Wavelet theory and its applications “, Kluwer Academic Publishers; Boston/Dordrecht/London.
[7] Kulbir Singh, Rajiv Saini and Rajiv Saxena (2009),” Performance of Wavelet, Fractional Fourier and Fractional Cosine Transform in Image Compression,” International Journal of Recent Trends in Engineering, Vol. 2, No. 7.