Comparison Of Wavelets To Watermarking Applications

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Abstract

Healthcare infrastructure depends on Hospital Information Systems (HIS), Radiology Information Systems (RIS),Picture archiving and Communication Systems (PACS) as these provide new ways to store, access and distribute medical data . It reduces the security risk. Conversely, these developments have introduced new risks for unsuitable deployment of medical information flowing in open networks, provided the effortlessness with which digital content can be manipulated. Watermarking is a budding technology to overcome these drawbacks. In the proposed work a block based error correction code to improve the quality of watermark image. The watermark is done in all types of wavelets and a comparison is given. When the image is watermarked using different wavelets the wavelets give somewhat similar results. In the proposed method peak signal to noise ratio, structural similarity index measure and correlation are calculated. It is compared with the existing method and found to be effective.

1. Introduction

Due to the development of technology, digital watermarking or Steganography, an invisible signal is usually embedded into a digital medium. It may be an image, audio, or video data to protect it from unauthorized use and alteration, so that the content of information and the source can be authenticated. The lossless data embedding is called as reversible data embedding. It embeds invisible data called payload into a digital medium. Such an image in a reversible fashion so that the original image and the payload is lossless recovered. The most important requirement of lossless watermarking is that any distortion between the original image and the watermarked image should be perceptually invisible. The human visual system (HVS)[1] is the perceptual phenomenon that can be exploited to achieve this requirement. The data hiding technologies for digital data like digital watermarking have attracted enormous attention recently [2].

A watermark is put into the media and cannot be removed or altered easily. The watermarking process introduces irreversible degradation of the original medium. Even though the degradation is less, it may not be acceptable to certain applications, like military and medical use .So there is a need for a reversible watermark which completely recovers the original image. If the embedding algorithm and embedding parameters are available, it is possible to detect the watermark from the marked medium to recover the original medium. But most watermarking algorithms apply some non-linearity to optimize the performance of the algorithm. Therefore, a reversible watermark must be designed such that it can be removed to restore the original medium without any reference to information beyond what is available in the watermarked medium .

The proposed scheme divides an input image into non overlapping blocks of a given size and Integer wavelet transform is taken for each small block and then data is embedded into the high-frequency wavelet coefficients of each block. Various block sizes and their performance are studied in it. A lossless data hiding method using integer wavelet transform is given by [3]. In that small coefficients of the high frequency sub band are modified to embed data. The histogram modification is done to prepare enough space for data hiding . Weng [4] proposes the reversible integer transform using the correlations among four pixels in a quad. Data embedding is done by expanding the differences between one pixel and each of its three neighbouring pixels. To improve the hiding capacity, difference expansion and companding technique is used in the embedding process. [5] Kim Proposes a difference expansion method with simplified location map and better embedding capacity can be achieved with new expandability .

2. Types of Wavelets

2.1Discrete wavelet transform

Wavelets can be described as functions defined over a finite interval and having an average value of zero. The fundamental idea of the wavelet transform is to denote any arbitrary function as a superposition of a set of such wavelets or basis functions [6]. These wavelets are acquired from a single mother wavelet through multiplicative scaling and translational shifts. The large number of known wavelet families and functions provides a rich space in a variety of applications. Biorthogonal, Coiflet, Haar, Symmlet, Daubechies wavelets [7] and the like, are some of the wavelet families.

2.1.Coiflet Wavelets

Coiflets are designed by Ingrid Daubechie. The wavelet is symmetric having scaling function and wavelet function. Is it considered the scaling function as low pass filter and wavelet function as high pass filter after normalization. Each scaling and wavelet function has particular coefficient value.

2.2.Daubauchie wavelets

The daubechie wavelets are of orthogonal wavelets. It defines a discrete wavelet transform and characterized by a maximal number of vanishing moments. The father wavelet generates the orthogonal multi resolution analysis. The vanishing moment limits the wavelets' ability to represent polynomial behaviour or information in a signal. All types of Daubechie wavelets are analyzed.

2.3.Haar Wavelet

Harr wavelet is a sequence of square-shaped wavelet function. It is represented in terms of an orthonormal basis function. It is similar to Fourier analysis. It is also known as D2 wavelet.

3. Discrete Cosine Transform

The Discrete Cosine Transform is a renowned coding technique employed in image and video compression algorithms. It is capable of carrying out decorrelation of the input signal in a data-independent manner [8]. The DCT is a methodology for the transformation of a signal into elementary frequency components. The sequences of n real numbers $x_1,\cdots,x_n$ are converted into the sequence of n complex numbers $f_1,\cdots,f_n$ by the DCT [9] in accordance with the following formula:

$$f_j = \sum_{k=0}^{n-1} x_k \cos\left[\frac{\pi}{n} j\left(k+\frac{1}{2}\right)\right] \qquad (1)$$

4. Performance metrics

4.1 Mean Square Error

Mean Square Error (MSE) for two P×Q monochrome images (G and R) where one of the images is considered a noisy approximation of the other is defined as:

$$MSE = \frac{1}{PQ}\sum_{m=0}^{P-1}\sum_{n=0}^{Q-1}[G(m,n) - R(m,n)]^2 \qquad (2)$$

4.2 Peak Signal to Noise Ratio

The PSNR is most commonly used as a measure of the quality of despeckled image. The PSNR is defined as:

$$PSNR = 20.\log_{10}\left(\frac{MAX_i}{\sqrt{MSE}}\right) \qquad (3)$$

where MAX_i^2 is the maximum intensity in the unfiltered image. A higher PSNR would normally indicate that the reconstruction is of higher quality.

4.3 Structural Similarity Index Measure

This SSIM is defined as:

$$\mathrm{SSIM}(x,y) = \frac{(2\mu x\,\mu y + c1)(2\sigma xy + c2)}{(\mu x^2 + \mu y^2 + c1)(\sigma x^2 + \sigma y^2 + c2)} \qquad (4)$$

4.4 Normalized Correlation

For image-processing applications in which the brightness of the image and template can vary due to lighting and exposure conditions, the images can be first normalized. This is typically done at every step by subtracting the mean and dividing by the standard deviation.

$$\mathrm{corr} = \frac{\sum_i\sum_j (C_{ij}-\overline{C})(Y_{ij}-\overline{Y})}{\sqrt{\left(\sum_i\sum_j (C_{ij}-\overline{C})^2\right)\left(\sum_i\sum_j (Y_{ij}-\overline{Y})^2\right)}} \qquad (5)$$

5. Experimental Results and Comparison

The experimental results of the proposed effective watermarking scheme for checking the integrity and authenticating medical images using hybrid transform (DCT-DWT). The proposed watermarking scheme is programmed in Matlab (Matlab7.9) and tested with different types of wavelets. The proposed watermarking scheme discussed in this paper effectively embedded the watermark image into the original image and extracted it back from the watermarked image. The watermarked images possess superior Peak Signal to Noise Ratio (PSNR), Structural similarity Index Measure(SSIM) and visual quality. The watermark and watermarked images of different original CT (Computed tomography) medical images are shown in Table 1,2,3,4 and 5 along with the PSNR values

Table 1: For CT Images

Types of Wavelets	MSE	PSNR	SSIM	CORRELATION
Db6	7.2699	39.5155	0.7269	0.9999
Db8	7.2721	39.5142	0.7277	0.9999
Db10	7.2744	39.5128	0.7293	0.9999
Db12	7.2641	39.5190	0.7209	0.9999
Db14	7.2357	39.5360	0.7225	0.9999
Db16	7.1971	39.5562	0.7242	0.9999
Haar	7.2907	39.5031	0.7244	0.9999
Coif1	7.2621	39.5202	0.7259	0.9999
Ciof2	7.2648	39.5185	0.7265	0.9999
Coif3	7.2733	39.5135	0.7262	0.9999

Table 2 :FOR MRI IMAGE

Types of Wavelets	MSE	PSNR	SSIM	CORRELATION
Db6	7.9354	39.1352	0.9960	0.9998
Db8	7.9470	39.1288	0.9960	0.9998
Db10	7.9568	39.1283	0.9960	0.9998
Db12	7.9479	39.1447	0.9960	0.9998
Db14	7.8815	39.1647	0.9960	0.9998
Db16	7.9348	39.1335	0.9960	0.9998
Haar	7.9125	39.1476	0.9960	0.9998
Coif1	7.9229	39.1419	0.9960	0.9998
Ciof2	7.9385	39.1334	0.9960	0.9998
Coif3	7.9425	39.1312	0.9960	0.9998

Table 3:FOR ULTRA IMAGE

Types of Wavelets	MSE	PSNR	SSIM	CORRELATION
Db6	7.9401	39.1325	0.9641	0.9997
Db8	7.9516	39.1262	0.9645	0.9997
Db10	7.9615	39.1208	0.9654	0.9997
Db12	7.9526	39.1257	0.9665	0.9997
Db14	7.9225	39.1442	0.9678	0.9997
Db16	7.8864	39.1620	0.9689	0.9997
Haar	7.9399	39.1327	0.9645	0.9997
Coif1	7.9173	39.1450	0.9646	0.9997
Ciof2	7.9280	39.1391	0.9643	0.9997
Coif3	7.9435	39.1307	0.9644	0.9997

Table 4: FOR LENA IMAGE

Types of Wavelets	MSE	PSNR	SSIM	CORRELATION
Db6	7.9401	39.1325	0.9990	0.9999
Db8	7.9516	39.1262	0.9990	0.9998
Db10	7.9615	39.1208	0.9989	0.9998
Db12	7.9526	39.1257	0.9989	0.9998
Db14	7.9225	39.1442	0.9988	0.9997
Db16	7.8864	39.1620	0.9988	0.9997
Haar	7.9396	39.1328	0.9992	0.9999
Coif1	7.9177	39.1448	0.9992	0.9999
Ciof2	7.9280	39.1391	0.9991	0.9999
Coif3	7.9435	39.1307	0.9990	0.9999

Table 5: COMPARISON WITH EXISTING METHOD

	EXISTING METHOD ref 7	PROPOSED METHOD
haar	31.48	39.1328
Db1	31.48	-
Db2	31.12	-
Db3	30.67	-
Db6	-	39.1325
Db8	-	39.1262
Db10	-	39.1208
DB12	-	39.1257
DB14	-	39.1422
DB16	-	39.1620
Cdf1.1	31.48	-
Cdf1.3	31.48	-
Cdf1.5	31.35	-
Cdf2.2	33.20	-
Cdf2.4	33.15	-
Cdf2.6	33.19	-
Cdf4.2	28.91	-
Cdf4.4	30.01	-
Cdf4.6	30.28	-
Cdf6.2	22.82	-
Cdf6.4	24.88	-
Cdf6.6	25.57	-
Coif1	-	39.1448
Coif2	-	39.1391
Coif3	-	39.1307

6. Conclusion

On comparing the medical images and lena image using MATLAM 7.9 version it is observed that the PSNR is almost same in all the wavelet families except with the fractional part. With this result we can go for the optimization of watermarking method which will be helpful for the future research on the enhancement of the software.

7. References

[1] Foriš P., and Levický D., "Implementations Of HVS Models In Digital Image Watermarking", *Journal of Radio engineering*, Vol. 16, No. 1, pp. 45-50, April 2007.

[2] Prabhishek Singh, and R S Chadha .,"A Survey of Digital Watermarking Techniques, Applications and Attacks ", *International Journal of Engineering and Innovative Technology*,Vol.2 Issue 9,2013

[3] Yousefi, S. Rabiee, H.R.Yousefi, E.Ghanbari, M. Sharif," Reversible Date Hiding Using Histogram Sorting and Integer Wavelet Transform Univ. of Technol.", *Tehran Digital Eco Inaugural* ,IEEE-IES Volume , Issue , 21-23 Feb. 2007 Page(s):487 – 490

[4]Shaowei Weng; Yao Zhao; Jeng-Shyang Pan;Rongrong Ni ,"A Novel Reversible Watermarking Based on an Integer Transform Image Processing", 2007. ICIP 2007. IEEE International Conference on Volume 3, Issue ,Sept. 16 2007-Oct.19 2007 Page(s):III - 241 - III – 244.

[5] Hyoung Joong Kim, Member, IEEE, Vasiliy Sachnev, Yun Qing Shi, Fellow, IEEE, Jeho Nam, SeniorMember, IEEE, and Hyon-Gon Choo "A Novel Difference Expansion Transform for Reversible Data

Embedding" *IEEE Transactions on Information Forensics and Security*, vol. 3, no. 3, September 2008 pages456-465.

[6] L. Kamstra and H. J. A. M. Heijmans, "Reversible data embedding into images using wavelet techniques and sorting,"IEEE Trans. Image Process., vol. 14, no. 12, pp. 2082–2090, Dec. 2005.

[7]Daubechies, I., "Ten Lectures on Wavelets", SIAM, Philadelphia, 1992.

[8]Christopher Bennett, "DFT, DCT, and DWT", University of Miami, 2005

[9]Ms.Rekha D.Patil1, Mr.A.R.Nigavekar, Reversible Image Watermarking Using Lifting Wavelet Transform And Arithmetic Coding", International Journal of Engineering Research & Technology vol 2 issue 2 2013.