RESEARCH ARTICLE OPEN ACCESS

Difference Expansion Reversible Image Watermarking Schemes Using Integer Wavelet Transform Based Approach

Subhanya R.J (1), Anjani Dayanandh N (2)
(1) PG Scholar, Arunachala College of Engineering for Women
Subhanyarj@gmail.com

ABSTRACT
Digital contents show great advantages in terms of storage and processing. Furthermore, they can be reproduced without loss of quality, and allow for easy and imperceptible modifications. However, this will have its problems. In fact, intellectual properties are becoming harder to protect and so are original contents. That's why we need techniques to be developed such are image watermarking. In this project, we present a new scheme of image watermarking to guard intellectual properties and to secure the content of digital images. It is an effective way to protect the copyright by image watermarking. The work concerns with the watermarking algorithm that embeds image/ text data invisibly into a video based on Integer Wavelet Transform and to minimize the mean square distortion between the original and watermarked image and also to increase Peak signal to noise ratio. This is a blind watermark algorithm to confirm the copyright without the original video and the watermark is a meaningful image / text. The watermarks are invisible and robust against noise and commonly image processing methods.
Keywords:Difference Expansion, Embedding capacity, Integer wavelet Transform, PSNR, Reversible Watermarking.

I. INTRODUCTION:

Watermarking is the process of hiding information.Reversible in the sense to restore the exact original image. Digital Watermarking (also known as Multimedia data Embedding, Steganography) protect the copyright of digital image. Reversible watermarking or Lossless Data embedding has to meet the requirements are Robustness, imperceptibility, embedding and retrieving, high embedding capacity.Usually Watermarking process introduces irreversible degradation of the original medium. Even a very slight change in pixel values may not be acceptable for military, medical data and also multimedia archiving of valuable original works. By embedding its message authentication code, Reversible data embedding provide True self authentication scheme. Dinucoltuc [1], develop a low distortion transform for reversible watermarking and also minimizes the Mean Square Error. If noise like signal can be added to image, audio, video Steganography [2] protect it from alteration and authenticate its content. Fridrich, et al.[3]presented the RS scheme to embed watermark bits into the status group of pixels**.**Fredrich also extended the technique to GIF and PNG images. Celik, et al.[4] enhanced fridrich’s approach and develop a low distortion Reversible watermark that is capable of embedding 0.7 bits per pixel. Generalization of LSB [5] based on the scheme by applying data compression. Tian’s DE [6] creates space by expanding difference. Data and auxiliary information are added to the expanded difference and embedded into the image. Expanded difference is the one between adjacent pixels[6]-[8], original and predicted pixels[9]. Tian’s algorithm divides the image into pairs of pixels and embeds one bit into the difference of the pixels of each pair from those pairs are not expected to cause an over/underflow. Alattar[7] has extended Tian’s work by Generalizing the DE Technique for any Integer Transform. Reversible Contrast mapping [8] is a simple integer transform that applies to pairs of pixels. The scheme does not need additional compression, and in terms of mathematical complexity. Compared to Difference Expansion RCM provides almost similar embedding bit-rates.MED uses JPEG-LS, and GAP uses CALIC [11], GAP Provide better results than MED. Simplified GAP and Low Distortion transform out performs Tian[6] and classical MED-GAP prediction error expansion [9]. X.Wu [11] presents a lossless Image compression of continuous tone images. Xuan et al. [15], reversibly embed bits into the middle and high frequency integer wavelet coefficients.

This paper aims to develop a DE Reversible watermarking technique using Integer waveletTransform and to achieve low distortion. The outline of this paper is as follows: Section 2 provides a general overview of the related work. Section 3 discusses the proposed methodology in detail.

Experimental results provided in section 4. Finally we conclude our paper in section 5.

II. RELATED WORK

Chang D.Yoo et al. (2007), explains high capacity and low distortion reversible image watermarking using integer to integer wavelet transform (IWT) and this conditions to avoid overflow/underflow in the spatial domain are derived for an arbitrary wavelet and blocksize. Sachnev et al. (2009) describes the most popular method of watermarking which includes spread spectrum such as additive and multiplicative spread spectrum. Vleeschouwer, et al. (2003) proposed lossless watermarking based on a circular interpretation of ofbijective transformations. Tian (2003), gave one of the first few development of reversible watermarking. Yang et al. (2004) proposed a reversible watermarking technique based on Discrete Cosine Transform. Thodi and Rodriguez (2007) adopted the histogram shifting technique to embed the location map that the DE scheme required. They then proposed a PEE method to embed watermarks. Lihong Cui et al. (2011) presents multibit, multiplicative, spread spectrum watermarking using the discrete multiwavelet. Arsalan et al. (2012) proposed a reversible watermarking method in medical and defense imagery with the combination of IWT and Genetic algorithm. They describe another popular class of reversible watermarking algorithm is based on the hybrid IWT. IWT based adaptive data hiding scheme is to protect medical images. Veen et al. (2003) applied the companding technique to reversibly embed a large amount of data into an audio signal. Yang et al. (2004) proposed a reversible watermarking scheme based on Integer DCT. Ning bi et al. (2007) develops a blind image watermarking based on multiband wavelet transform and the empirical mode decomposition. The scheme is robust against JPEG compression, Gaussian noise, salt and pepper noise. Histogram modification is another important technique in RWM.Serdean et al. (2007) compares wavelet and multiwavelet domain watermarking under a variety of attacks. Furthermore, they describe both wavelet style and multi wavelet style watermarking under multiwavelet domain watermarking. Multiwavelets offer better visual quality than scalar wavelets. El safy et al. (2009) used an adaptive steganographic technique based on IWT, which improves the embedding capacity and PSNR compared to DWT technique by B. Lai and L. Chang (2006)

III. PROPOSED METHOD

In this proposed method, message bits (image) are (is) hidden into gray/color images. The size of secret data/image is smaller than cover image. To transfer the secret image/text confidentiality, the secret image/text itself is not hidden, keys are generated for each gray/color component and the IWT is used to hide the keys in the corresponding gray/color component of the cover image. The following subsections describe the IWT algorithm, embedding and extracting process.

A. Integer Wavelet Transform (IWT)

Conventional wavelet transform is not applicable to the reversible watermarking scheme since it does not guarantee the reversibility. For example, suppose that an image block consisting of integer-valued pixels is transformed into a wavelet domain using floating-point wavelet transform. If the values of the wavelet coefficients are changed during watermark embedding, the corresponding watermarked image block is no longer guaranteed to have integer values. Any truncation of the floating point values of the pixels may result in a loss of information and may ultimately lead to the failure of the reversible watermarking systems, which the original image cannot be reconstructed from the watermarked image. Furthermore, the conventional wavelet transform is, in practice implemented as a floating-point transform followed by truncation or rounding since it is impossible to represent transform coefficients in their full accuracy: information can potentially be lost through forward and inverse transforms. To avoid this problem and to eliminate more redundancy to embed more data while avoiding round-off error, we propose to use the second generation wavelet transform such as IWT. Compared to DWT, IWT appears to be a close copy with smaller scale of the original image.The block diagrams of our proposed lossless data embedding and extracting algorithm areshown in fig 1 and 2.

B. Block Diagrams

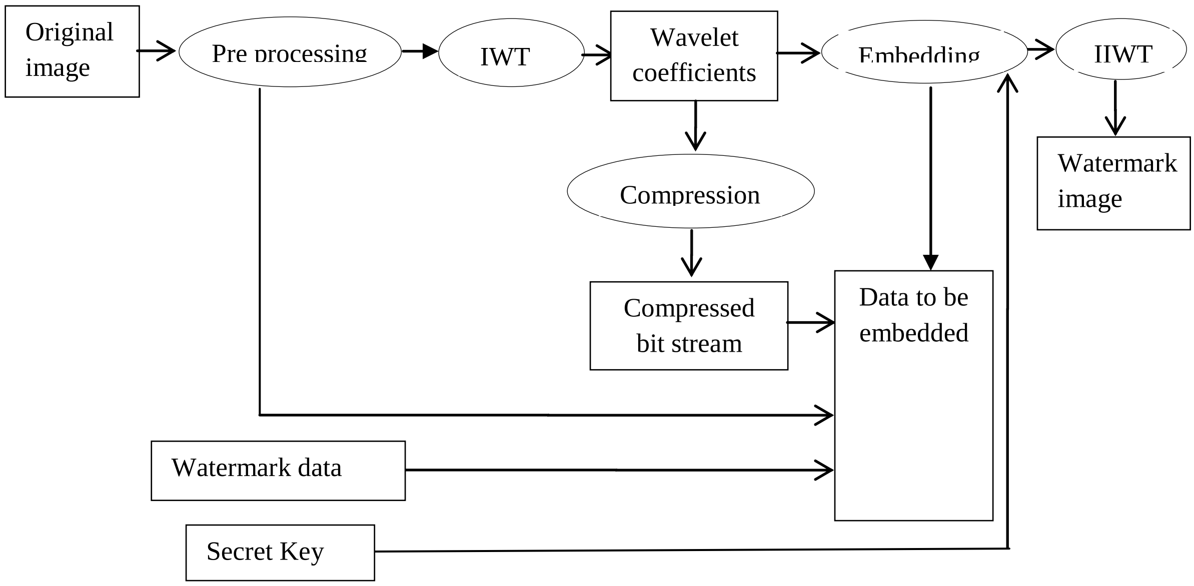

Fig1: Data embedding algorithm (IWT denoting integer discrete wavelet transform IIWT inverseIWT)

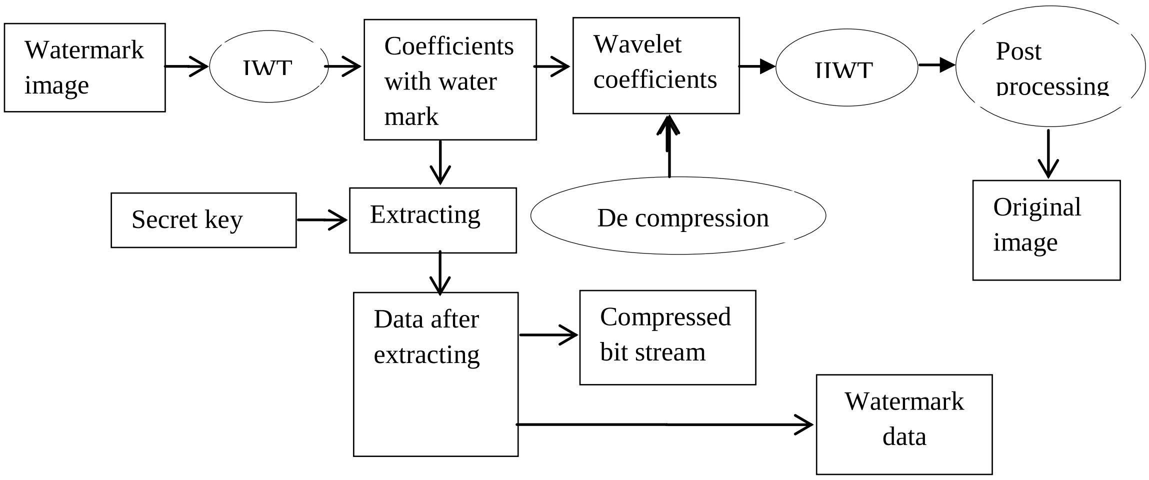

Fig 2: Data extracting algorithm (IWT denoting integer discrete wavelet transform, IIWT inverse IWT)

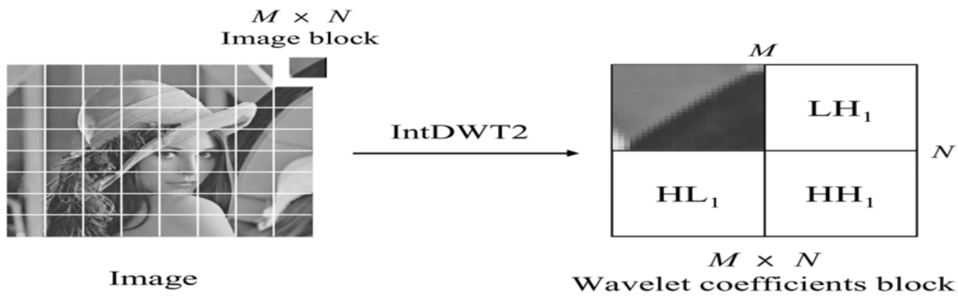

Fig 3: Watermark is embedded into high frequency wavelet subbands such asHL_1, LH_1, HH_1. IntDWT2(.) represents a 2D integer to integer transform.

In order to have the watermarked image perceptually the same as the original image, we choose to hide data in a "middle" bit-plane in the IWT domain. To let the watermarked image have a PSNR, we embed data only in the high frequency subbands, specifically in theHL_1, LH_1, HH_1 (refer to fig 3). Hence one(multiple) middle bit-plane(s) in the high frequency subbands is chosen to hide the data.

In the chosen bit plane(s) of the high frequency subbands, the arithmetic coding is chosen to losslessly compress binary 0s and 1s because of its high coding efficiency. The block diagrams of our proposed lossless data embedding algorithm are shown in fig 1 and 2. Secret key is used to make the hidden data remaining in secret even after the algorithm is known to the public.

C. Preventing possible "Overflow"

Gray scale values of some pixels in the watermarked image may exceed the upperbound (255 for an eight-bit grayscale image) and/or the lower bound (0 for an eight-bit grayscale image). This is possibly caused by changes taking place in the chosen bitplane of the high frequency IWT coefficients when data are embedded. Inorder to prevent overflow the blocks of "pre-processing" and "post-processing" are designed and included in the above block diagrams. For instance, either histogram modification or gray scale mapping can be used to prevent overflow.

D. Difference Expansion (DE)

DE algorithm generates small values to represent the features of original image. The generated values are expanded. Then the watermarked information can be embedded in the LSB parts of the expanded values. Finally reconstruct the watermarked image by using modified values.

IV. EXPERIMENTAL RESULTS

We present results of the performance of the proposed system where we assume there are no attacks against the embedded watermarks. Watermark length and strength are the two factors are considered to evaluate the performance of the proposed watermarking system.

Table 1: Average PSNRs and MSEs for various watermark length and strength

Watermark length	PSNR	MSE	Watermark strength	PSNR	MSE
30	47.9660	1.0387	0.2	58.3103	0.0960
45	48.0175	1.0264	0.6	48.7678	0.8636
70	48.1197	1.0025	1.0	44.3309	2.3988

Fig5: Curve between embed capacity vs PSNR

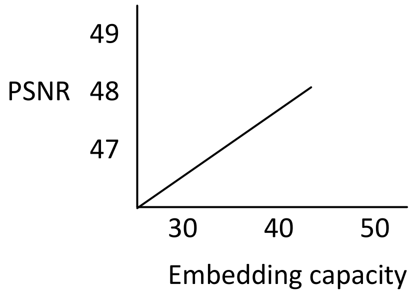

Fig 5: Original image

Fig6: DWT 1st level approximation coefficients

Fig 7: DWT 1st level decompositioncoefficients

Fig 8: DWT 2nd level approximation coefficients

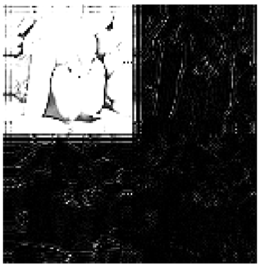

Fig9: DWT 2nd level decompositioncoefficients

Watermark added - "College of Engineering"

Fig10: watermarked image
Extracted watermark,
Z = "College of Engineering"
PSNR = 47.9660,MSE = 1.0387

Fig 11: Recovered image

Same technique can be used to hide images into video also.

V. CONCLUSION AND FUTURE SCOPE

During the last decade, digital watermarking has been one of the most active research fields in the signal / image processing area, as witnessed by the number of works on watermarking and related topics presented at all the major conferences all over the world. Such an interest was motivated by the fact that watermarking was seen as a feasible option of copyright protection of multimedia contents. A very low distortion transform for prediction-error expansion reversible watermarking has beenproposed. The experimental results show that our proposed model can improve the quality of the watermarked image and give more robustness of the watermark and also increasing PSNR and minimizing MSE as compared with a variety of state-of-the-art algorithms. In future this work can also be extended for inserting watermark on videos. Important progress has been made recently that makes the future of watermarking brighter than it seemed a couple of years ago.Watermark technology also will soon be embedded in packages for medicines and other health care products.

VI. Acknowledgement

Apart from my effort, the success of any work depends on the support and guidelines of others. I take this opportunity to express my gratitude to the people who have been supported me in the successful completion of this work. I owe a sincere prayer to the LORD ALMIGTHTY for his kind blessings without which this would not have been possible. I wish to take this opportunity to express my gratitude to all who have helped me directly or indirectly to complete this paper.

References

[1] Dinu Coltuc, "Low Distortion Transform for Reversible Watermarking" *IEEE Trans. Image Process.*, vol.21, no. 1, Aug. 2004.

[2] I. J. Cox, M. L. Miller, J. A. Bloom, Digital Watermarking, Morgan Kaufmann Publishers, San Francisco, CA, 2001.

[3] J. Fridrich, M. Goljan, and R. Du, "Lossless data embedding—new paradigm in digital watermarking," EURASIP Journal on Applied Signal Processing, vol. 2002, no. 2, pp. 185-196, Feb. 2002.

[4] M. U. Celik, G. Sharma, A. M. Tekalp, and E. Saber, "Reversible data hiding," in Proc. of the IEEE International Conference on Image Processing, vol. II, Sept. 2002, pp. 157-160.

[5] M. U. Celik, G. Sharma, A. M. Tekalp, and E. Saber,"Lossless generalized-lsb data embedding," IEEETransactions on Image Processing, vol. 14, no. 2,pp. 253–266, Feb. 2005.

[6] J. Tian, "Reversible data embedding using a difference expansion," *IEEE Trans. Circuits Syst. Video Technol.*, vol.13, no. 8,pp.890–896, Aug.2003.

[7] A. M. Alattar, "Reversible watermark using the difference expansion of ageneralize dinteger transform, "*IEEE Trans. Image Process.*, vol.13,no.8,pp.1147–1156,Aug.2004.

[8] D.ColtucandJ.-M. Chassery, "Very fast watermarking by reversible contrast mapping, "*IEEE Signal Process. Lett.*, vol.14, no.4, pp.255–258, Apr.2007.

[9] D.M. ThodiandJ. J. Rodriguez, "Expansion embedding techniques forreversible watermarking," *IEEE Trans. Image Process.*, vol.16, no.3, pp. 721–730, Mar. 2007.

[10] B. Macq and F. Deweyand, "Trusted headers for medical images," *DFG VIII-D II Watermarking Workshop*, Erlangen, Germany, Oct. 1999.

[11] X. Wu and N. Memon, "Context-based,adaptive,lossless image coding,"*IEEETrans.Commun.*,vol.45,no.4,pp.437–444,Apr.1997.

[12] Lihong Cui and Wenguo Li "Adaptive Multiwavelet-Based Watermarking Through JPW Masking" IEEE Transactions on image processing, vol. 20, no. 4, April 2011.

[13] B. Yang, M. Schmucker, W. Funk, C. Busch, and S. Sun, "Integer DCT-based reversible watermarking for images using companding technique," in *Proc. SPIE,* Security, Steganography, andWatermarking of Multimedia Contents, San Jose, CA, Jan. 2004, pp. 405–415.

[14] C. De Vleeschouwer, J. F. Delaigle, and J. F. B. Macq, "Circular interpretationof bijective transformations in lossless watermarking formedia asset management," *IEEE Trans Multimedia*, vol. 5, no. 1, pp.97–105, Mar. 2003.

[15] G. Xuan, Y. Q. Shi, Q. Yao, Z. Ni, C. Yang, J. Gao, and P. Chai, "Lossless data hiding using histogram shifting method based on integer wavelets," presented at the LNCS, Int. Workshop Digital Watermarking, Jeju Island, Korea, Nov. 2006.

[16] A. R. Calderbank, I. Daubechies, W.Sweldens and B.Yeo, "Wavelet transforms hat map integers to integers,"*Applied and Computational Harmonic Analysis*, vol.5, no.3,pp.332-369, 1998.

[17] I. Daubechies and W. Sweldens, "Factoring wavelettransforms into lifting steps," *J. Fourier Anal. Appl.*, vol.4, pp.247-269, 1998.

[18] Y. Q. Shi and H. Sun, *Image and video Compression for Multimedia Engineering*, Boca Raton, FL: CRC, 1999.