Reversible Watermarking Based on Prediction Error Expansion and Pixel Selection on Color Image

G.S.Raman, C.Surya, R.Balaji Ganesh

Abstract- ***Reversible watermarking enables embedding of valuable information in a host signal with no loss of host information. The conventional PEE exploit the similar inherent in the neighborhood of pixel that the difference expansion scheme. In our proposed system, the PEE technique is further investigated and an resourceful reversible watermarking scheme is deduced by incorporating in PEE two new techniques, namely, adaptive embedding and pixel selection. PEE technique embeds data consistently, using Embedded Zerotree Wavelet (EZW), Bit-plan Complexity Segmentation (BPCS) based embedding is applied to embed on natural images. This avoids expanding pixels with huge prediction errors likewise it also reduces embedding impact by diminishing the maximum modification to pixel values. We as well put forward to selecting pixels of smooth area for data embedding and leave the rough pixels unchanged. In our method a more penetratingly effective method for data embedding and a better visual quality of watermarked image is observed.***

Keywords-Pixel selection, Prediction error expansion, EZW, BPCS, Reversible watermarking

1. INTRODUCTION

Reversible watermarks are used to restore the original cover content completely after the extraction of watermark. As a basic requirement, the quality degradation on the digital content after data embedding should be low. When the information is embedded into images, the pixel value in the image will be changed, and thus the image quality is degraded. Since the altered pixels cannot be recovered into their original state after the secret messages has been extracted, permanent distortion will occur. Distortion for some application is unacceptable, for example chest X-ray images.

For this purpose reversible data hiding is necessary. A aspect of reversible data embedding is the reversibility, specifically, when the digital content has been authenticated, one can eradicate the embedded data to restore the original content. The motivation of reversible data embedding is distortion free data embedding. In susceptible images such as military and medical images, every bit of information is most important. Reversible data embedding method will provide the original data when the digital content is authenticated. Reversible watermarking is a lossless data compression technique. Reversible watermarking is used to embed the useful information into a digital work such as audio, video, image.

Manuscript Received on April 2013.

G.S.Raman, Associate Professor Department of Information Technology, KLN College of Information Technology, Sivangangai, India
C.Surya, PG Scholar, Department of Information Technology, KLN College of Information Technology, Sivagangai, India
R.Balaji Ganesh, CITE Research Scholar, MS University Thirunelveli, India

It is used for copyright protection, authentication. In application reversible watermarking is used in military, medical and source tracking. This enable the decoder extract the watermarking image and reconstruct the original host image from the watermarked image.

In our proposed method the image is divided into two parts called flat region and rough region by selecting the region of interest. The selected region was grown according to the adaptive threshold value then the grown region was masked with the original image to identify the flat region then the flat region was cropped to embed the watermark. Finally the watermark signal was generate by using the two techniques called Bit-plane Complex Segmentation (BPCS) and Embedded Zerotree Wavelet (EZW).

2. LITERATURE REVIEW

There are varieties of reversible watermarking method is proposed in this literature. Difference expansion of a vector of several pixels [13] achieve larger capacity. These approaches are simple and efficient but do not make an efficient trade off with respect to imperceptibility. Reversible watermarking scheme using integer wavelet transform and threshold embedding [13] have used a fixed threshold for all of the coefficients in different sub-bands of integer wavelet transform. A new research direction is prediction-error expansion (PE) embedding technique [5]. Comparing with the DE-based method [12], one of the advantages of the PE technique is that it significantly adds the number of the feature elements that expanded for data embedding. PE embedding technique provided the maximal capacity up to 1bpp in a single pass. Prediction-error expansion (PE) embedding is a technique to expand a prediction error to create a vacant position and insert a bit into the vacant position, generally at the least significant bit (LSB). The PE- based scheme was originally was later improved by marking the present pixel and its context for reducing the embedding distortion.

In [1] the PEE technique is further investigated and an efficient watermarking scheme is proposed by incorporation adaptive embedding and pixel selection. It also proposed to adaptively embed 1 or 2 bit into expandable pixels according to the local complexity. in [2] the histogram shifting technique was proposed as an alternative to embedding a location map. This technique improves the distortion performance at low emedding capacities and mitigates the capacity control problem. In [3] was proposed the histogram of prediction errors to prepare vacant positions for data embedding.

The major drawbacks of [1] low embedding capacity and inability to control the capacity, by embedding secret message bits into errors value. In [4] a novel reversible watermarking scheme using an interpolation technique was proposed, which can embed a large amount of covert data into images with imperceptible modification. They utilize the difference between interpolation value and corresponding pixel value, to embed bit "1" or "0" by expanding it additively or leaving it unchanged. Due to slight modification of pixels, high image quality is preserved. In [5] was proposed new embedding schemes that help us construct an efficient payload-dependent overflow location map. Under the same image quality, the proposed algorithm often has larger embedding capacity.

3. PROPOSED SYSTEM

In the proposed system the PEE technique is further investigated and an efficient reversible watermarking is produced by incorporating PEE in two new strategies, namely, adaptive embedding and pixel selection. Our proposed method has two stages of embedding they are EZW (Embedded Zerotree Wavelet), BPCS (Bit-Plane Complexity Segmentation).

Before embedding the image was firs split into two regions namely flat region and rough region. Then the flat region was chose to embed the watermark signal. For select the flat region and rough region we use the ROI. The region was grown according to the adaptive threshold value. Then the grown region was masked with the original image to indentify flat region then the flat region was cropped for used for the further operations.

Then apply the BPCS and EZW techniques were used to embed the water mark. Then the histogram was calculated for both the original image and Embedded image to identify the distortion between them.

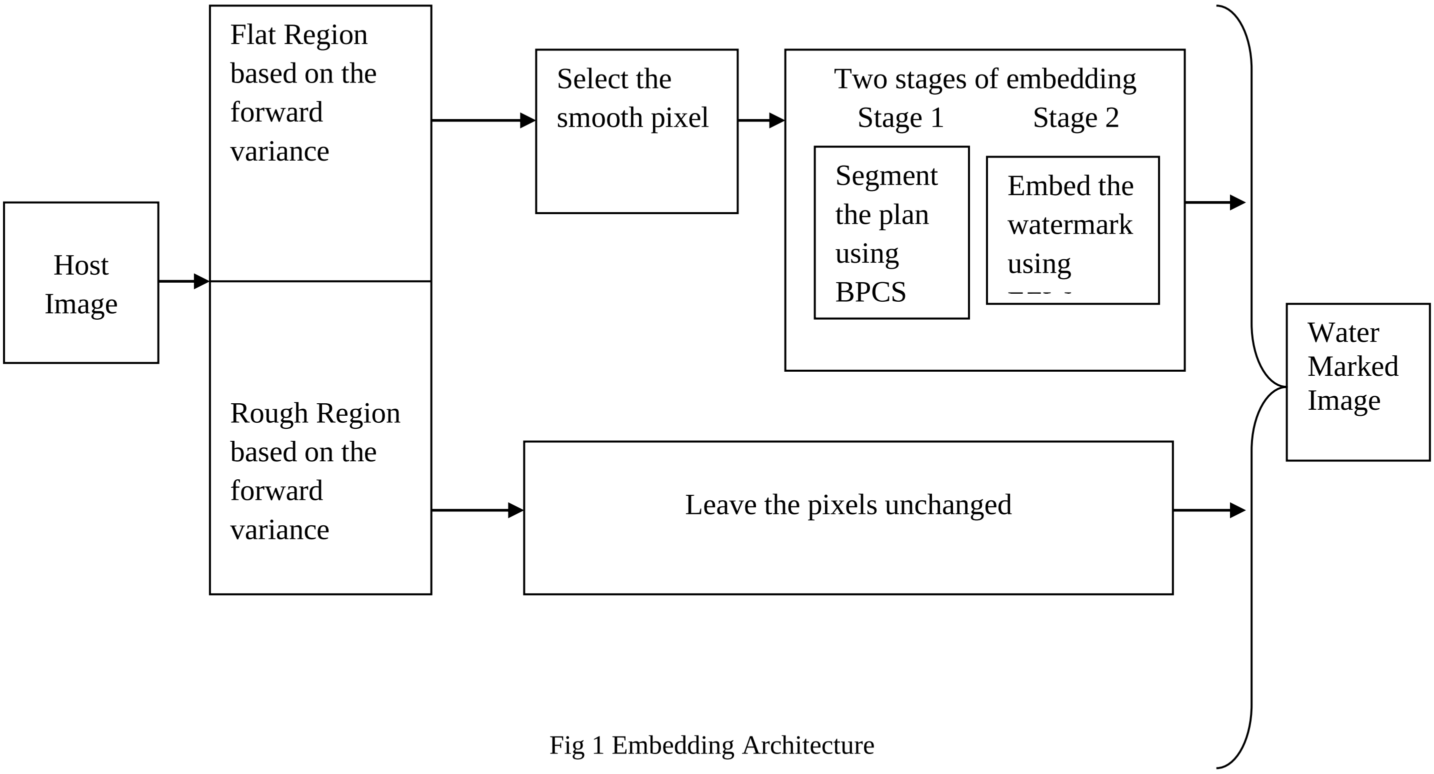


Fig 1 Embedding Architecture

4. EMBEDDING PROCEDURE

Before embedding the watermark into an we define region of interest (ROI) by taking the smallest area around an image. This border will be used for our watermark embedding later. The watermark generated from hashing the area of interest. The embedding region is measured to be outside the region of interest as to preserve the area for distortion as a result from watermarking. In an image, the embedding region's pixel value is 0. This feature will be exploited to create a reversible or invertible watermarking.

A. First Stage

a) Bit-Plane Complex Segmentation Principle

In BPCS, a multi valued image consisting of n-bit pixels can be decomposed into set of n-binary pictures. Ordinary image data is represented by a pure binary code system which is commonly used in image processing. In BPCS each bit plane can be segmented into "informative" and "noise" region. In BPCS, we replace each noise-looking region with another noise-looking pattern without changing the overall image quality.

b) Bit-Plan Decomposition of Multi-Valued Image

A multi-valued image (P) consisting of n-bit pixels can be decomposed into a set of n binary pictures.

For examples, if the image is an n-bit gray image, it is shown as,

$P = (P1,P2,\ldots\ldots Pn)$

In case the image is Red, Green, Blue color picture, it is shown by,

$P=(PR1,PR2,\ldots\ldots PRn,PG1,PG2,\ldots.PGn,PB1,PB2,\ldots\ldots\ldots PBn)$

where PR1,PG1,PB1 are the most significant bit-planes(MSB), while PRn,PGn,PBn are the least significant

ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013

planes (LSB). Canonical Gray Code (CGC) is better for BPCS-Stenography.

c) Nature of the human vision system and information embedding

Each bit-plane can be segmented into "shape-informative" and "noise-looking" region. A shape-informative region consists of simple patterns, as a noise-looking region consists of complex patterns. That two regions can be segmented by using a "black-and-white boarder length" based complexity measure. Then we can replace each noise-looking region with another noise-looking pattern without changing the overall image quality.

d) Bit-Plan Segmentation *Algorithm*

Step 1 Consider the color image as vessel image
Step 2 Convert the vessel image into gray image
Step 3 Perform the bit plane slicing on vessel image
Step 4 Calculate the complexity measure α for each block of each bit plane
Step 5 Perform embedding on vessel image

B) Second Stage

a) Embedded Zerotree Wavelet (EZW)

The EZW algorithm is a easy and it is incredible effective image compression algorithm. The EZW have property of the bits in the bit stream are generated and it has provided a completely embedded code. By means of an embedded coding algorithm, an encoder can finish the encoding at any point so allowing a target rate or target distortion metric to be met accurately. Also given a bit stream, the decoder can cease decoding at any point in the bit stream and still produced exactly the same image that would have been encoded at the bit rate corresponding to the reduced stream. Additionally to producing a entirely embedded bit stream, EZW over and over again produces compression results that aggressive with almost all known compression algorithms.

The EZW algorithm is based on four key concepts that are Discrete Wavelet transform i.e hierarchical subband decomposition and prediction of the absence of significant information across scales by exploiting the self-similarity inherent in images, then entropy-coded successive approximation quantization, finally "Universal" lossless data compression which is achieved via adaptive arithmetic coding. The EZW encoding scheme is designed to operate on images or in a broader sense, on 2-D signals. The coding process is based on embedded encoding to compress an image into a bit stream with increasing accuracy. One important advantage of EZW coding over other methods is the scalability that provides, which can lead to a "layer-by-layer" decoding which provides the end-user with the ability to choose, for each time segment, the level of reconstruction quality desires.

b) Embedded Zerotree Wavelet algorithm:

Step 1 Sequence of Decreasing Thresholds
Step 2 Maintain Dominant List
Step 3 Maintain Subordinate List
Step 4 Perform Dominant pass
Step 5 Perform Subordinate pass

e) Description of EZW algorithm

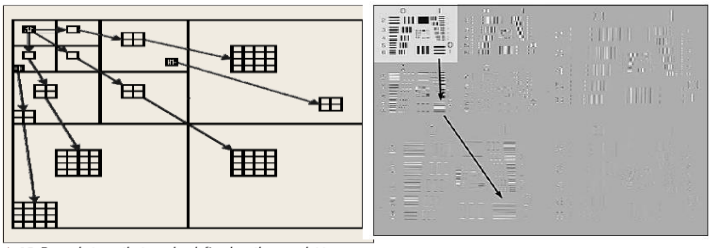
Step 1 Sequence of Decreasing Threshold
T0,T1,…….Tn-1 with Ti-Ti-1/2 and |Coefficients|<2T0
Step 2 Maintain Dominant List
Dominant list is the co-ordinates of coefficients, not yet found significant
Step 3 Maintain Subordinate List
Subordinate list is the magnitude of coefficients, already found to be significant

Step 4 Perform Dominant pass

For each threshold perform dominant pass the coefficient on dominant list is compared to T0 and the resulting significance map is zero tree coded. The code significance using four symbols they are Zerootree Root (ZRT), Isolated Zero (IZ), Positive Significant (POS), Negative Significant (NOS). Then put its magnitude on the subordinate list and remove from its dominant list

Step 5 Perform Subordinate pass

Provide the next lower significance on the magnitude of each coefficient on subordinate list. Halve the quantizer cells to get the next finer quantizer. If the magnitude of coefficients is in upper half of old cell, provide "1" or if the magnitude of coefficients is in lower half of old cell, provide "0". The entropy code sequence of refinement bits using an



▲ 15. Example trees that can be defined on the wavelet transform. The roots of the three trees, indicated by shading, originate in the LL_3, LH_3, and HL_3 subbands.

a adaptive AC. Now repeat the next lower threshold and stop when total bit budget is exhausted. Now encoded stream is an embedded stream.

f) Zerotree Coding

From B.E Usevitech, A Tutorial on Modam Lossy Wavelet Image Compression:Foundation of JPEG 2000, IEEE SP Mag Sept.2001

Every wavelet coefficient at a given scale can be related to a set of coefficients at the next finer scale of similar orientation. The Zero Tree Root (ZTR) is low scale "zero-valued" coefficient for which all the related higher-scale coefficients are also "zero-valued". Specifying a ZTR allows the decoder to "trackdown" and zero out all the related higher-scale coefficient.

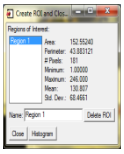
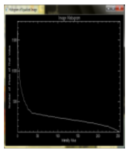
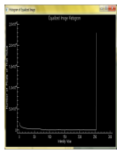
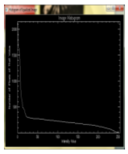
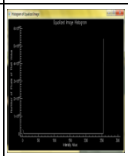
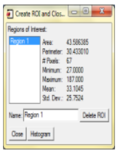
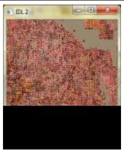
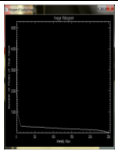
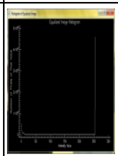
Original Image	**Create ROI**	**Region Growing Using Threshold**	**Mask Region**	**Crop the Mask**	**Water marked Image**	**Histogram of Original image**	**Histogram of watermark ed image**
							
							
							

Table 1 Result analysis for various images

5. EXPERIMENTAL RESULT

In our propose method the color image data set was collected and the region was choosing to embed the watermark. The growing region is based on the adaptive threshold value. Then the capacity parameter was decided. Our method is compare with the other recent work [15] and the experimental results are shown in Table 1 for various butterfly images. For our method the error rate was reduced with the previous work and also we increase the embedding capacity. In our method the ER rate is vary from 0.1 BPP with maximum step size of 0.1. From the fig the observation is that our methods provide the high image quality.

PSNR (db)	Embedding Rate for existing method	Embedding Rate for proposed method
25	0.2	0.5
30	0.4	0.6
35	0.6	0.7
40	0.8	0.8
45	1	0.9
50	1.2	1

Table 2 Embedding rate for existing and propose system

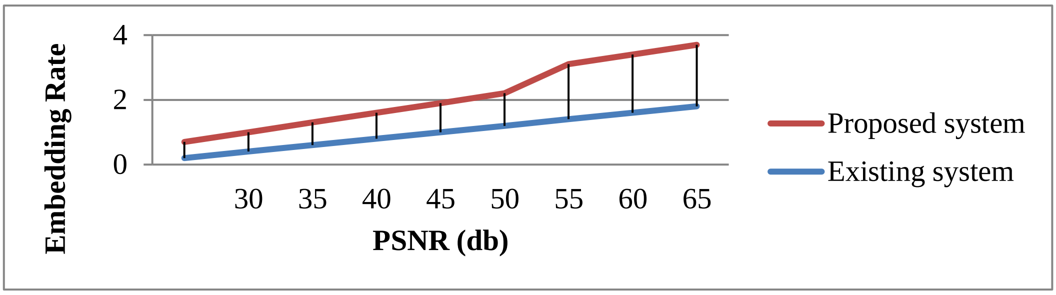


Fig 2 Embedding rate between proposed system and existing system

6. CONCLUSION

In this work, we propose the reversible watermarking based on prediction error expansion and pixel selection on color images. In our proposed system we focus on the flat region to embed the watermark. We propose the BPCS and EZW technique to embed watermark we select the smooth pixel for embedding thereby we reduce the spatial redundancy and we reduce the distortion. Compare with the conventional PEE, our method reduce the ER by .098. In our method we increase the embedding capacity and image quality practically.

REFERENCES

1. Xiaolong Li, Bin Yang Tienyong Zeng "Efficient Reversible Watermarking Based on Adaptive Prediction-error Expansion and pixel selection" IEEE Tans.on image processing, vol.20,No.12,December.2011
2. L.Luo,Z.Chen,M.Chen,X.Zeng and Z. Xiong "Reversible image watermarking using interpolation thechique",IEEE Trans.Inf.Foren-sics Security, vol1.5,No.1,pp.187-193,Mar.2010.
3. Y.Hu.H.K.Lee and J,Li,"DE based reversible data hiding with improved overflow location map",IEEE Trans.Circuits Syst,Video Technol., vol.19, no.2, pp.250-260,Feb.2009.
4. W.Hong, T.S.Chen, and C.W.Shiu, "Reversible data hiding for high quality images using modification of prediction errors",J.Syst.Softw.vol. 82, N0.11, pp.1833-1842,Nov.2009.
5. D.M.Thodi and J.J.Rodriguez,"Expansion embedding techniques for reversible watermarking "IEEE Trans.Image Process., vol.16,No.3.pp.721-730,Mar.2000
6. J.Hwag, J.Kim and J.Choi,"A Reversible watermarking based on histogram shifting",in proc.IWDW,2006.vol.4283,pp.1321-1324.
7. S.K.Lee, Y.H.Suh and Y.S.Ho,"Reversible image authentication based on watermarking," in proc.IEEE ICME,20006,pp.132-1324
8. Nambakhsh, M.S and Ghaamim M.;Dilmaghani, R.S.;Karimi-Farod,S."A Novel Bild Watermarking of ECG Singnals on Medical Images Using EZW Algorithm" Engineering in Medicine and BiologySociety, 2006.EMBS'06,28thAnnual International Conference of IEEE.
9. A.M.Alattar,"Reversible watermak using the difference expansion of a generalized integer transform",IEEE Trans.Image Process.,vol.13,no.8,pp.1147-1156,aug.2004
10. Jerome M.Shapiro "Embedded image coding using Zerotrees of wavelet coeffiecents",IEEE Trans. Signal Process.vol.14.No.20.Dec 1993
11. Shrikant S.Khaire and Dr.Sanjay L.Nalbalwar "Review: Steganography-Bit Plane Complexity
12. Segmentation (BPCS) Technique" Shrikant Khaire et.al/International Journal of Engineering Science and Technology vol.2(9),2010,4860-4868.
13. J.Tain, "Reversible data embedding using a difference expansion" IEEE Trans.Circuits Syst. Video Technol.,vol.13,no.8,pp.890-896, Aug.2003.
14. W.Hong,T.S Chen, and C.W.Shiu,"Reversible data hiding for high quality images using modification of prediction errors",J.Syst.Softw.,vol82,no.11,pp.1833-1842,Nov.2009