Available Online at www.ijcsmc.com

International Journal of Computer Science and Mobile Computing

A Monthly Journal of Computer Science and Information Technology

ISSN 2320–088X
IMPACT FACTOR: 6.017

IJCSMC, Vol. 7, Issue. 12, December 2018, pg.257 – 265

A NOVEL DOUBLE ENCODING SCHEME FOR LOW DISTORTION ADAPTIVE REVERSIBLE WATERMARKING

Nidhin Sani[1], Agath Martin[2], Nishanth.R[3]
[1]Assistant Professor/IT & CUSAT, Kerala, India
[2]Assistant Professor/IT & CUSAT, Kerala, India
[3]Assistant Professor/ECE & CUSAT, Kerala, India
[1] mail2nidhinsani@gmail.com; [2] agath.bethel@gmail.com; [3] nishanth.jino@gmail.com

***Abstract-* This paper proposes a low-distortion transform for prediction- error expansion reversible watermarking. The transform is derived by taking a simple linear predictor and by embedding the expanded prediction error not only into the present pixel as well as into its expectation setting. The inserting guarantees the minimization of the square error introduced by the watermarking. The proposed transform introduces less mutilation than the established forecast error development for complex indicators, for example, median edge detector or the gradient-adjusted predictor. Reversible watermarking algorithms dependent on the proposed transform is to be examined. Experimental results are given.**

***Keywords-* linear predictor, watermarking, median edge detector, gradient adjusted predictor, peak signal to nose ratio (PSNR).**

1. INTRODUCTION

The basic principle of our approach is to reduce the distortion introduced by the watermarking by embedding not only into the current pixel but also into its prediction context. The minimization of the square error is considered. We shall consider one of the linear predictors used in JPEG lossless coding, namely, the fourth predictor (JPEG4). Let n,w and nw be the north, west, and north-west neighbors of pixel n, respectively. Pixel w is estimated. The basic principle of our approach is to reduce the distortion introduced by the watermarking by embedding not only into the current pixel but also into its prediction context. The minimization of the square error is considered. We shall consider one of the linear predictors used in JPEG lossless coding, namely, the fourth predictor (JPEG4). Let n, w, and nw be the north, west, and north-west neighbors of pixel n, respectively. Pixel x is estimated.

© 2018, IJCSMC All Rights Reserved

A. The Digital Watermark

Digital watermarking is a technology for embedding various types of information in digital content. In general, information for protecting copyrights and proving the validity of data is embedded as a watermark. A digital watermark is a digital signal or pattern inserted into digital content. The digital content could be a still image, an audio clip, a video clip, a text document, or some form of digital data that the creator or owner would like to protect. The main purpose of the watermark is to identify who the owner of the digital data is, but it can also identify the intended recipient. All the information handled on the Internet is provided as digital content. Such digital content can be easily copied in a way that makes the new file indistinguishable from the original. Then the content can be reproduced in large quantities.

For example, if paper bank notes or stock certificates could be easily copied and used, trust in their authenticity would greatly be reduced, resulting in a big loss. To prevent this, currencies and stock certificates contain watermarks. These watermarks are one of the methods for preventing counterfeit and illegal use.

Digital watermarks apply a similar method to digital content. Watermarked content can prove its origin, thereby protecting copyright. A watermark also discourages piracy by silently and psychologically deterring criminals from making illegal copies.

II. RELATED WORKS

The concept of reversible watermark firstly appeared in the patent owned by Eastman Kodak [1]. Honsinger et al. [1] utilized a robust spatial additive watermark combined with modulo additions to achieve reversible data embedding. Goljan et al. [2] proposed a two cycles flipping permutation to assign a watermarking bit in each pixel group. Celik et al. [3] presented a high capacity, reversible data embedding algorithm with low distortion by compressing quantization residues. Tian [4] presented a reversible data embedding approach based on expanding the pixel value difference between neighboring pixels, which will not overflow or underflow after expansion. Thodi and Rodrguez exploited the inherent correlation among the neighboring pixels in an image region using a predictor. Xuan et al. [5] embedded data into high-frequency coefficients of integer wavelet transforms with the companding technique, and utilised histogram modification as a preprocessing step to prevent overflow or underflow caused by the modification of wavelet coefficients. The earliest reference to reversible data embedding we could find is the Barton patent [8], filed in 1994. In his invention, the bits to be overlayed will be compressed and added to the bitstring, which will be embedded into the data block. Honsinger et al. [9], reconstruct the payload from an embedded image, and then subtract the payload from the embedded image to lossless recover the original image. Macq [10] proposes an extension to the patchwork algorithm to achieve reversible data embedding. Fridrich et al. [1], develop a high capacity reversible data-embedding technique based on embedding message on bits in the status of group of pixels. They also describe two reversible data-embedding techniques for lossy image format JPEG. De Vleeschouwer et al. [11], propose a reversible data-embedding algorithm by circular interpretation of objective transformations. Kalker et al. [12], provide some theoretical capacity limits of lossless data compression based reversible data embedding [6] and give a practical code construction. Celik et al. [13], [14], present a high capacity, low distortion reversible data embedding algorithm by compressing quantization residues.

III. SYSTEM ANALYSIS

A. Problem Definition

Early reversible algorithms often have small embedding capacity. Poor image quality. Classical method been used. Anyone property to be done clearly either the image or the message or the information.

B. Problem Evaluation

A very low distortion transform for prediction error reversible watermarking Has been proposed. The proposed transform has been obtained by considering a simple linear predictor i.e., JPEG4 together with an optimized embedding procedure. The proposed transform introduces low distortions than the based high Performance predictors such as MED and GAP.

C. Existing System

Difference expansion (DE) reversible watermarking, introduced by Tian, creates space by expanding a difference. It is known that the difference between adjacent pixels or, more generally, the difference between pixels and their predicted values (i.e., the prediction error) is modeled by the Laplacian distribution. In order to minimize such differences, the watermarking schemes are built on high-performance predictors. Thus, the median edge detector (MED) predictor used in JPEG-LS was introduced, instead of the simple difference between adjacent pixels. The gradient-adjusted predictor (GAP) used in context-based adaptive lossless image coding algorithm. This paper presents a novel high-capacity reversible data hiding algorithm called shifted gradient-adjusted prediction error (SGAPE) which is based on shift differences between cover image pixels and their predictions. Large capacity of embedded data (15-140 kb for a 512 × 512 grayscale image), very high PSNR, applicability to almost all types of images, simplicity and short execution time are key features of this algorithm. Therefore, SGAPE method has advantages to the methods reported in [2] and [4] where used algorithms are considered as among the best methods in lossless data hiding. The disadvantages of this method are, at low difference values, no over-flow/underflow appears, and consequently, high embedding capacity can be entailed. It has high-complexity predictor.

D. Proposed System

So as to limit such contrasts, the watermarking schemes are based on elite indicators. Therefore, the Median Edge Detector (MED) indicator utilized in JPEG-LS was presented, rather than the basic contrast between neighboring pixels. The gradient-adjusted predictor (GAP) utilized in setting based versatile lossless picture coding calculation seemed to give preferable outcomes over the MED indicator in watermarking plans. The enhancement is gotten at the expense of an expansion in the scientific unpredictability. Other complex indicators have been considered also. This paper goes for lessening the bending presented by the watermarking. Rather than searching for a high-intricacy indicator, we think about a straightforward direct indicator and enhance the information implanting technique. The improved watermarking change seems to present low mutilation. It outflanks the fundamental DE change of Tian and the established MED– GAP forecast blunder development changes. In light of this change, low mutilation watermarking plans are researched.

© 2018, IJCSMC All Rights Reserved

Advantages:

1. The proposed transform gives very good results only at very low capacity.
2. This can be applied in application areas include low bit-rate image annotation for captioning and labeling.
3. High attack resistance

***1.)* Proposed Algorithm**

The proposed algorithm utilizes usually high spatial correlation among adjacent pixel values in grayscale images. It predicts the grayscale value of a pixel from those of its adjacent pixels and the watermark bits are embedded into the prediction errors. Depending on the order of prediction, the pixels are divided into four classes as follows:

1. The pixels of the cover image whose values remain unchanged during the watermarking process are termed base pixels.
2. From the base pixels, the first set of predicted pixel values is derived.
3. Further, the second and third sets of predicted pixel values are derived from the base pixels and first set of predicted pixel values. Fig. 2 shows the flowchart of our watermark embedding algorithm. Our watermark embedding algorithm consists of four broad steps: (a) selection of base pixels; (b) predicting other pixels from the base pixels; (c) computing the prediction errors, and (d) embedding watermark bits into the errors. We next describe the above steps in detail.

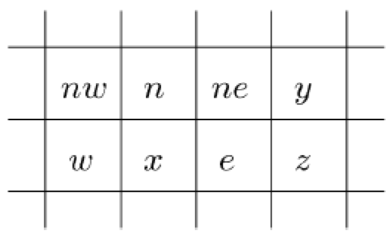


Fig. 1. Pixels and their context for prediction.

The optimized watermarking transform appears to introduce very low distortion. It outperforms the basic DE transform of Tian [1] and the classical MED–GAP prediction-error expansion transforms [5], [11]. Based on this transform, low distortion watermarking schemes are investigated.

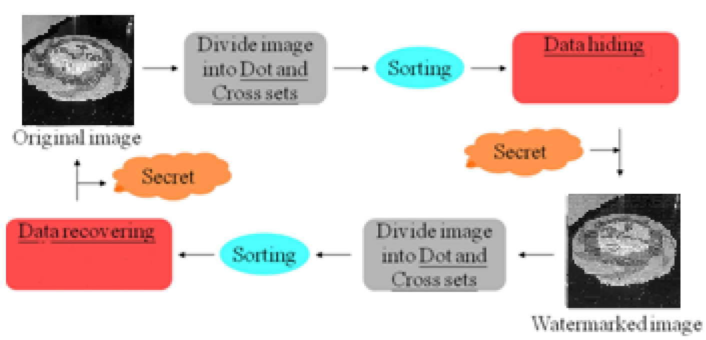


Fig 2. Proposed Block diagram

***2.)* Detailed Design**

Encoder and Decoder

This section describes the encoding and decoding processes in detail and uses ideas all described above. Fig. 7 presents a simple block diagram representing the embedding and decoding processes. Before data embedding, all pixels should be divided into two sets: either Cross set or Dot set (see arrows with “Cross” and “Dot,” respectively, in the left hand side of the encoder in Fig. 3). Payloads for the Cross and Dot embedding schemes are *P*Cross and *P*Dot, respectively. For recovering data, threshold values *Tn*Cross and *Tp*Cross, and actual payload size |*P*Dot| (for Dot embedding scheme) or |*P*Cross| (for Cross embedding scheme) should be sent to the decoder. The LSB values of the first 34 prediction errors from *d*sort are replaced with threshold values *Tn*Cross (7 bits) and *Tp*Cross (7 bits), payload size |*P*Dot| (20 bits), or |*P*Cross| (20 bits). Original 34 LSB values should be collected to a set of collected LSB values *SLSB*, and included to the payload.

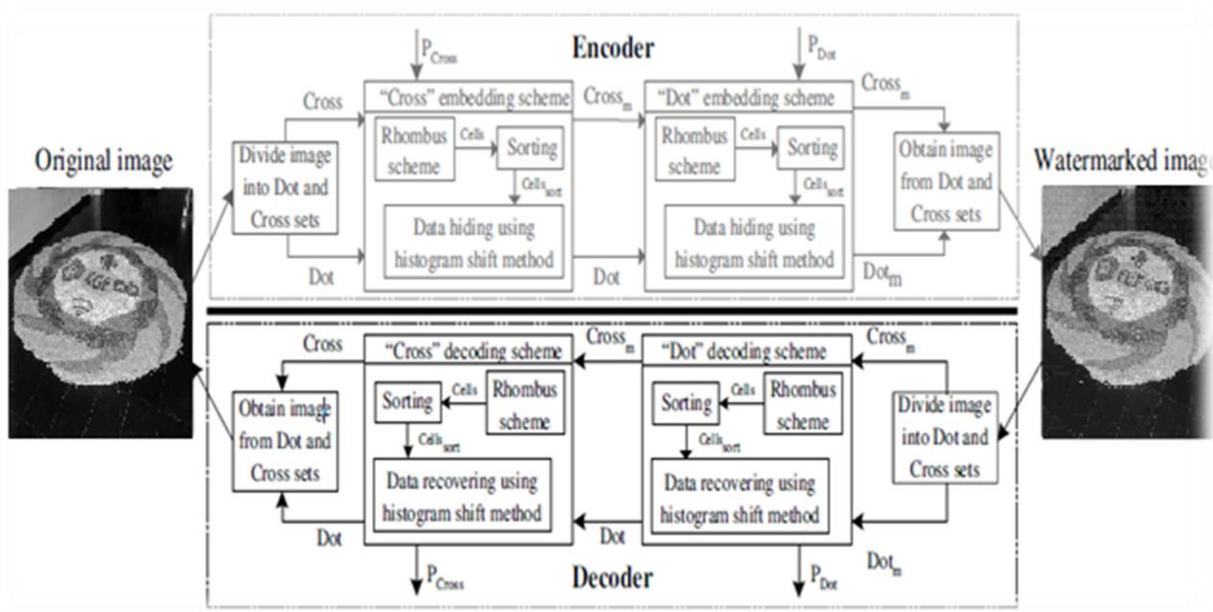


Fig.3. Double Encoding and Decoding

The Dot embedding scheme uses the modified pixels from the Cross set for computing predicted values and original pixels from the Dot set (see Fig. 3) for embedding data. The output result of the Dot embedding scheme is the modified Dot and Cross sets (see arrows with accompanying words “Dot*m*” and “Cross*m*” in the right-hand side of the encoder part in Fig. 3), which is the watermarked image. Dot*m* is a modified Dot set, and Cross*m* a modified Cross set.

IV. Experimental Setup

Through experiments we aim to study the distortion characteristics of the original image and the watermark, when transmitted through a noisy channel with high packet error rate (PER) p. Here, p refers to the percentage of pixels, distorted in each frame. One representative watermarking scheme, for each of the algorithms described in the Section 2, was implemented in MATLAB. A noisy communication channel with a given PER was simulated in MATLAB by inducing random bit-flipping of the pixels within the data packets, so that the percentage of pixels distorted in each data packet, transmitted over the channel, is equal to the given PER. The simulations were carried out on six 256X256 grayscale image. A random bit stream of size 630 bits was selected as the watermark. The maximum watermark embedding capacity varies with each scheme as well as with each cover image. To make the comparisons fair we have selected a uniform watermark for all watermarking algorithms, and for both images. Size of the watermark was selected to be 630 bits, since this length is the maximum that could be embedded into each image, using any of the algorithms analyzed.

Our experiment consisted of the following steps:

1) The watermark was embedded in the cover image to produce the watermarked image.

2) The watermarked image was broken down into data frames containing 223 (grayscale) pixels.

3) Each frame was appended with 32 redundant unsigned 8-bit integers, for error detection and correction at the receiver side.

4) Each encoded frame was transmitted through the simulated noisy channel. We have varied the PER of the channel, from 0% to 25%.

5) At the receiver side, each frame was decoded using Reed–Solomon decoder to retrieve a 223 grayscale pixels frame, and then the watermarked image was restored by combining those frames received.

6) Finally, the original cover image was retrieved and the watermark extracted, from the watermarked image.

A. Selection of Base Pixels

One out of every four pixels in the original cover image is chosen as a base pixel in our algorithm, such that they are uniformly distributed throughout the image. The positions of the base pixels we selected in an image are marked with '0's in Fig. 1.

B. Predicting Three Sets of Pixels

The first set of pixels (marked with '1's in Fig. 1) are predicted from the base pixels whereas the second and third sets of pixels (marked with '2's and '3's respectively in Fig. 1) are predicted from the base pixels as well as the predicted first set of pixels. All predictions are done utilizing CLOs according to the definition of the function f. Predicted value of each first-set pixel depends on the four base pixels surrounding it on its four corners. Therefore those four base pixels constitute the set of four neighbors { N1,N2,N3,N4 } for a first-set pixel. The prediction formula for a first-set pixel p(i, j) is given by:

$$\lambda(p(i, j)) = f(p(i-1, j-1), p(i-1, j+1), p(i+1, j-1), p(i+1, j+1)) \quad \ldots\ldots\ldots(1)$$

Next the second set of pixels is predicted. Each second-set pixel is surrounded on its top and bottom by two base pixels and on its left and right by two first-set pixels. In this case the prediction formula is:

$$\lambda(p(i, j)) = f(p(i-1, j), \lambda(p(i, j-1)), \lambda(p(i, j+1)), p(i+1, j)) \quad \ldots\ldots\ldots\ldots(2)$$

© 2018, IJCSMC All Rights Reserved

For each third-set pixel prediction, we use the two base pixels located on its left and right, and the two first-set pixels on its top and bottom. Here the prediction formula is given by:

$\lambda(p(i, j)) = f(\lambda (p(i-1, j)), p(i, j-1), p(i, j+1), \lambda (p(i+1, j)))$ ……….……(3)

C. Computing Prediction Errors

Prediction error is given by the difference between an original pixel value p and its predicted value $\lambda(p)$. For each predicted pixel we compute prediction error using the following integer transformation:

$e = \lambda(p) - p$ ……….…..(4)

Due to high correlation of adjacent pixels, in practice, usually the errors are small integers, close to zero.

D. Embedding Watermark Bits

Prediction errors which are close to zero are used to embed the watermark bits, leading to achievement of high embedding capacity, since the number of errors close to zero is usually large. To define closeness to zero, we adopt an error threshold k (≥ 0). Only those pixels with prediction errors $|e| \leq k$ are used for embedding watermark bits. A watermark bit is embedded into an error, by multiplying the error by 2 and adding the watermark bit to the result. For pixels with $|e| > k$, a constant shift of magnitude (k+1) is applied to the absolute prediction error values to avoid overlap with pixels in which watermark bits have been embedded.

E. Combining Modified Errors with Predicted Pixels

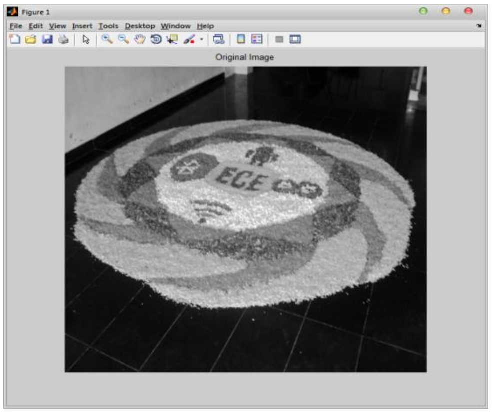
Each predicted pixel, combined with its corresponding modified (watermark bit embedded) prediction error, produces a watermarked pixel. We combine a predicted pixel with a modified error using the following integer transformation: $pwm = \lambda(p) - \lambda(e)$ ……….. (5)

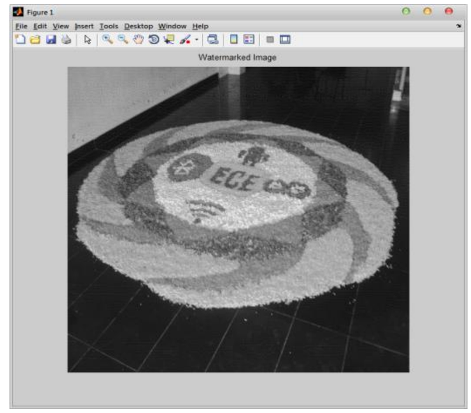
where pwm is the watermarked pixel and $\lambda(e)$ is the corresponding modified (watermark bit embedded) prediction error. Note that, transformation (5) is the reverse of transformation (4). The watermark extraction works in just the reverse way of watermark embedding procedure and is trivial. So we do not discuss it here explicitly.

V. RESULTS & DISCUSSION

In Distortion_Less_Data_Hiding_Embedding is,
Original CH Bits Length = 65536 ------ Compressed CH Bits Length = 9105
Original CV Bits Length = 65536 ------ Compressed CV Bits Length = 17334
Original CD Bits Length = 65536 ------ Compressed CD Bits Length = 5074
Payload(bpp) = 0.343262 -- Embedded Data(Header+Original Bits+Watermark) = 121753 bits -- Watermark Length = 90000 bits
PSNR = 34.043554

© 2018, IJCSMC All Rights Reserved





VI. CONCLUSION

The proposed transform presents bring down distortions than the ones dependent on elite indicators, for example, MED and GAP. The proposed strategy beats a delegate earlier specialty of Tian's DE change, and it is demonstrated that Tian's change is equal to a forecast mistake extension of a straightforward direct indicator with enhanced inserting. A low twisting change for forecast error extension reversible watermarking has been proposed. The proposed change has been acquired by thinking about a straightforward direct indicator, i.e., JPEG4, together with an enhanced installing strategy. Reasonable reversible watermarking calculations dependent on the proposed change have been examined. The proper application areas incorporate low bit rate picture explanation for subtitling and naming. The proposed method gives and PSNR of 34.043554 and this method will give a better result for the low bit rate images.

REFERENCES

[1] Honsinger, C.W., Jones, P., Rabbani, M., and Stoffel, J.C.: 'Lossless recovery of an original image containing embedded data'. US patent no. 6278791, 2001.

[2] Goljan, M., Fridrich, J., and Du, R.: 'Distortion-free data embedding for images'. 4th Information Hiding Workshop, LNCS, vol. 2137, (Springer-Verlag, New York, 2001, pp. 27–41.

[3] Celik, M.U., Sharma, G., Tekalp, A.M., and Saber, E.: 'Reversible data hiding'. Proc. ICIP, 2002, vol. 2, pp. 157–160

[4] Tian, J.: 'Reversible data embedding using a difference expansion', IEEE Trans. Circuits Syst. Video Technol., 2003,13, (8), pp. 890–896.

[5] Xuan, G.R., Yang, C.Y., Zhen, Y.Z., and Shi, Y.Q.: 'Reversible data hiding using integer wavelet transform and companding technique'.Proc. IWDW, 2004

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

[7] J. Tian, "Wavelet-based reversible watermarking for authentication," in Security and Watermarking of Multimedia Contents IV—Proc. SPIE, E. J. Delp III and P. W. Wong, Eds.,Jan. 2002, vol. 4675, pp. 679–690.

[8] J. M. Barton, "Method and Apparatus for Embedding Authentication Information Within Digital Data," U.S. Patent 5 646 997, 1997.

[9] C. W. Honsinger, P. W. Jones, M. Rabbani, and J. C. Stoffel, "Lossless recovery of an original image containing embedded data," U.S. Patent 6 278 791, 2001.

[10] B. Macq, "Lossless multiresolution transform for image authenticating watermarking," in Proc. EUSIPCO, Sept. 2000, pp. 533–536.

[11] C. De Vleeschouwer, J. F. Delaigle, and B. Macq, "Circular interpretation of bijective transformations in lossless International Journal of Computer Science and Telecommunications [Volume 2, Issue 3, June 2011] 50 watermarking for media asset management," IEEE Tran. Multimedia, vol. 5, pp. 97–105, March 2003.

[12] T. Kalker and F. M. J. Willems, "Capacity bounds and constructions for reversible data hiding," in Proc. 14th Int. Conf. Digital Signal Processing, vol. 1, July 2002, pp. 71–76.

[13] M. U. Celik, G. Sharma, A. M. Tekalp, and E. Saber, "Reversible data hiding," in Proc. Int. Conf. Image Processing, vol. II, Sept. 2002, pp.157–160.

[14] "Lossless generalized-LSB data embedding," IEEE Trans. Image Processing, submitted for publication.

[15] D. Coltuc and J. M. Chassery, "Very fast watermarking by reversible contrast mapping," IEEE Signal Process. Lett., vol.14, no. 4, pp. 255–258, Apr. 2007.

© 2018, IJCSMC All Rights Reserved

[16] S.W. Weng, Y. Zhao and J.-S. "Pan Reversible watermarking resistant to cropping attack", IET Inf. Secur., 2007, 1, (2), pp.91–95

[17] C. De Vleeschouwer, J. F. Delaigle, and B. Macq, "Circular interpretation on histogram for reversible watermarking," in IEEE Int. Multimedia Signal Process. Workshop, France, Oct. 2001, pp. 345–350.

[18] G. Xuan, J. Zhu, J. Chen, Y. Q. Shi, Z. Ni, and W. Su, "Distortionless data hiding based on integer wavelet transform," in Proc. IEEE Int. Workshop Multimedia Signal Process., St. Thomas, U.S. Virgin Islands, Dec. 2002, vol. 38, no. 25, pp. 1646–1648.

[19] Craver, S.; Memon, N.; Boon-Lock Yeo; Yeung, M.M.; "On the invertibility of invisible watermarking techniques," Proceedings of International Conference on Image Processing, Oct 1997, Volume: 1Pages: 540 -543.

[20] Juan R. Hern´andez, Fernando P´erez-Gonz´alez, Jos´e ManuelRodrıguez, and GustavoNietoA, "Performance Analysis of a 2-D-Multipulse Amplitude Modulation Scheme for Data Hiding and Watermarking of Still Images", IEEE transaction, MAY 1998.

[21] Aweke NegashLemma,JavierAprea,WernerOomen,and Leon van de Kerkhof, "A Temporal Domain Audio Watermarking Technique", IEEE transaction,APRIL 2003.

[22] Xiangyang Wang, Jun Wu, and Panpan Niu, "A New Digital Image Watermarking Algorithm Resilient to Desynchronization Attacks", IEEE transaction,DEC 2007.

[23] Mandeep Kaur, Gurinderbir Kaur Sidhu, "Effect of quantization on robustness of DCT digital watermarking techniques", International Conference on Information and Multimedia Technology, 2009.

© 2018, IJCSMC All Rights Reserved