Research Article

iMedPub Journals
http://www.imedpub.com/

American Journal of Computer Science and Information Technology

2017
Vol.5 No.1:1

DOI: 10.21767/2349-3917.100001

Utilization of Edge Position for Digital Image Watermarking using Discriminant Analysis

Rajeev Raghuwanshi[1*], Pankaj Kumar Sahu[2] and Sanjiv Sharma[3]

[1]Samrat Ashok Technological Institute, Vidisha, Madhya Pradesh, India

[2]School Of Information Technology, RGPV, Bhopal, Madhya Pradesh, India

[3]School Of Information Technology, RGPV, Bhopal, Madhya Pradesh, India

[*]**Corresponding author:** Rajeev Raghuwanshi, Samrat Ashok Technological Institute, Vidisha, Madhya Pradesh, India E-mail: rajeev.raghuwanshi.mtit@gmail.com

Received date: November 28, 2016; **Accepted date:** December 08, 2016; **Published date:** December 19, 2016

Citation: Rajeev R, Pankaj KS, Sanjiv S (2016) Utilization of edge position for digital image watermarking using discriminant analysis. Am J Compt Sci Inform Technol 5: 1. doi: 10.21767/2349-3917.100001

Abstract

A low complexity, pixel based watermarking technique has been used in this paper on the edge areas of an image to improve the quality and security of an image. The method proposed in this paper while maintaining robustness against smoothing and compression, improves the quality of the different types of images. To evaluate the quality of the image after applying the proposed technique the parameters such as Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index (SSIM) has been computed. The watermark is embedded into selected Channels of pixel. The proposed method supports high watermark embedding capacity. The robustness of the image is also evaluated against the Gaussian filtering and JPEG compression parameters adapting noise. After performing all the computations the results has been obtained which shows better quality and security of the image as compared to the techniques applies and implemented in the previously performed researches.

Keywords: Watermarking; Between-class variance; Discriminated analysis method Image processing

Introduction

Watermarking is a branch of information hiding which is used to hide proprietary information in digital media like photographs, digital music, or digital video. The ease with which digital content can be exchanged over the Internet has created copyright infringement issues. Copyrighted material can be easily exchanged over peer-to-peer networks, and this has caused major concerns to those content providers who produce these digital contents. The major point of digital watermarking is to find the balance among the aspects such as robustness to various attacks, security and invisibility. The invisibleness of watermarking technique is based on the intensity of embedding watermark. Better invisibleness is achieved for less intensity watermark. So, we must select the optimum intensity to embed watermark. In general there is a little trade-off between the embedding strength (the watermark robustness) and quality (the watermark invisibility). Increased robustness requires a stronger embedding, which in turn increases the visual degradation of the images. For a watermark to be effective, it should satisfy the following features Unobtrusive, Robustness, Unambiguous, Loyalty, and Computational Cost.

Digitization and new coding formats, together with the development of the Web, have led to a world where electronic distribution of image, video and audio to end users has become a reality. This reality however has at the same time led to increased concern about the protection of the rights of owners of the content that is distributed in electronic form. Digital Right Management (DRM) is the term for commercial, legal, and technical measures that can be taken to ensure that rights of owners of digital content are respected [1]. One approach to address the problems of DRM is watermarking technique. The Digital watermarking has been proposed as a way to identify the source of creator, and distributor of image [2]. The process of watermarking involves the modification of original information data to embed watermark information. Various watermarking techniques have been developed. However, these techniques can be grouped into two classes: spatial domain and frequency domain. The spatial domain methods are to embed the watermark by directly modifying the pixel values of the original image. Class variance embedding is one of algorithm that uses spatial domain. When class variance is in the spatial or temporal domains, these approached modify the host data. The invisibility of the watermark is achieved on the assumption that the data are visually insignificant [3]. The watermark is generally recovered using knowledge of the PN sequence (and perhaps other secret keys, like watermark location) and the statistical properties of the embedding process. In the literature, there are many techniques. In [4], the watermark is inserted in to image pixels which are located in the vicinity of image. In [5], author describes choosing randomly 'n' pair of image points (ai, bi) and increases the ai by one, while decreases the bi by one. (The detection was performed by comparing the sum of the difference of ai and bi of the 'n' pairs of the points with 2n. In [6], watermark is embedded in colour image using the biological colour model). But it uses the combination of both frequency and spatial domain. Many of these techniques suffer from the image processing operations like filtering, cropping, sharpening etc. In addition to these, in many methods supports less embedding capacity. To resolve these problems, we a propose a novel technique in this paper; we developed a low-complexity, pixel-based blind watermarking method using the Discriminated Analysis Method (DAM) which is known as a linearization method of grey-level images [7]. We utilized DAM to identify the optimal edge area of an image for the embedding of information. The information is embedded by controlling Between-Class Variance (BCV) which can be obtained during the process of DAM. Visible distortion of the watermarked image is relatively small because our method effectively utilizes edges in the image where the human eye is unlikely to notice changes. We evaluated the quality of the watermarked image as well as the robustness of the watermark against JPEG compression and Gaussian filtering and adaptive noise.

Watermarking Method Using Between-Class Variance

Embedding Watermark

Figure 1 shows the overview of the proposed method. In the first step, an image is divided into fixed-size blocks in the first step. Then to each block DAM is applied then BCV of the block is obtained. DAM classifies the pixels in the block into two classes: C_0 is a class whose pixel values are small and C_1 is a class whose pixel values are large. BCV σ_b^2 is defined as follows:

$$\sigma_b^2 = \frac{\omega_0\omega_1}{\omega^2}(\mu_0 - \mu_1)^2 \rightarrow (1)$$

Where ω_0 and ω_1 are the number of pixels in C_0 and C_1, and μ_0 and μ_1 is the mean luminance of pixels in C_0 and C_1, respectively. The total number of pixels in the block is denoted as ω. If edge is present in the block, the block distribution is pixel level becomes bi-modal and two peaks appear in the distribution. We named C_0 as "low peak class" and C_1 as "high peak class". Then in this method we compare the value σ_b^2 with the value of threshold and adjudicate whether edge is present or not in block. We use edge blocks for embedding purpose because the human visual system is insensitive to luminance change in the edge area [9]. Then after that watermark embedding process is start information is an embedded in each edge block by changing the luminance of edge pixels until the value of a σ_b^2 is greater than the value threshold which exposit the threshold T condition and the rule for σ_b^2 in section 2.2 and 2.3, respectively. How to change the luminance of edge pixels while satisfying these rules is shown in the section in 2.4.

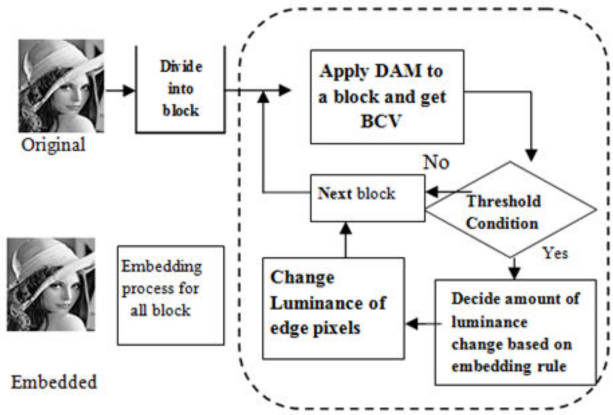

Figure 1: Overview of proposed method.

Edge block detection using DAM

In DAM, each block pixels are classified into two classes. BCV of the block depends on the luminance distribution. If the block is flat, the luminance distribution is unimodal and σ_b^2 becomes small. On the other hand, if the block includes an edge, the luminance distribution is bi-modal and σ_b^2 is large. To determine whether the block includes an edge, we set a threshold condition as follows:

$$\sigma_b^2 > T \rightarrow (2)$$

Where T is the threshold.

Figure 3 shows the detection of the edge boundary. First, the pixels in the edge block are binaries by using DAM. Then, the pixels on the edge boundary are detected by scanning the binaries block horizontally, vertically and diagonally.

Let the block size be m × n pixels and the pixel luminance at the position (i, j) in the binaries block be B(i, j) (0 ≤ i ≤ m 1, 0 ≤ j ≤ n 1). If B(i, j) satisfies the following conditions (7) or (8) or (9), the pixel is assumed as an edge boundary pixel. If not, it is assumed as a flat pixel.

B (i,j) ≠ B (i+1, j) → (3)

B (i,j) ≠ B (i, j+1) → (4)

B (i,j) ≠ B (i+1, j+1) → (5)

The amount of the luminance change for the edge block is determined as follows. Assume a certain class C_x (x : 0 or 1). Let δ_{xedge} be the amount of the change for each pixel on the edge boundary of C_x , and let δ_{xflat} be the amount of the change for each pixel in the flat area of C_x. The number of Pixels in the class x is as follows:

→(6)

Where ω_{x_edge} is the number of pixels on the edge boundary and ω_{x_flat} is that of the flat area. The amount of the change δ_{x_edge} and δ_{x_flat} are given as follows:

This article is available from: https://doi.org/10.21767/2349-3917.100001

$$\delta_{x\_edge} = \frac{p\omega_x\beta_x}{\omega_{x\_edge}} \rightarrow (7)$$

$$\delta_{x\_flat} = \frac{(1-p)\omega_x\beta_x}{\omega_{x\_flat}} \rightarrow (8)$$

Where β_x is the amount of the luminance change for each class shown in (11) or (12). The amount of change in (7) and (8) is added according to each pixel detected.

Condition (9) shows the range of a parameter p that adjusts the luminance change in the edge boundary. The larger p becomes, the more the edge boundary is enhanced.

$$\frac{\omega_{x\_edge}}{\omega_x} < p \leq 1 \rightarrow (9)$$

In this paper, we used $p = \omega_{x\_edge} / \omega_x + 0.1$ for the simulation.

Embedding rules

In this developed algorithm, to decide the embedding sequence and perceptual similarity between original image and watermarked image, we consider the intensity of pixel as a parameter. Based on intensity of pixels the channels of pixels are selected dynamically for embedding the watermark. Thus the algorithm embeds the watermark of size is equivalent to colour image. The extraction algorithm uses the intensity value of the pixel as a parameter to select the channels for extraction and the watermark bits are extracted from the channels. In this, the watermark is embedded by controlling σ b2. The horizontal line denotes σ b2. In Figure 2, the areas '1' and '0' are associated with the watermark bit '1' and '0', respectively. α is a parameter related to the image quality of the watermarked image and the robustness of the watermark. In addition, the Dead Zone (DZ) area is assigned between the areas of '1' and '0'. DZ is an area that is not associated with the watermark bit and thus reduces the risk of changes to the embedded information by some attack. After embedding, BCVs of all embedded blocks are within the ranges of '1' or '0' as shown in Figure 2. For example, if the current value of σ b2 is in DZ and we want to embed '1' in that block, σ b2 is increased until it becomes a value within the area '1' by changing the pixel luminance of the current block.

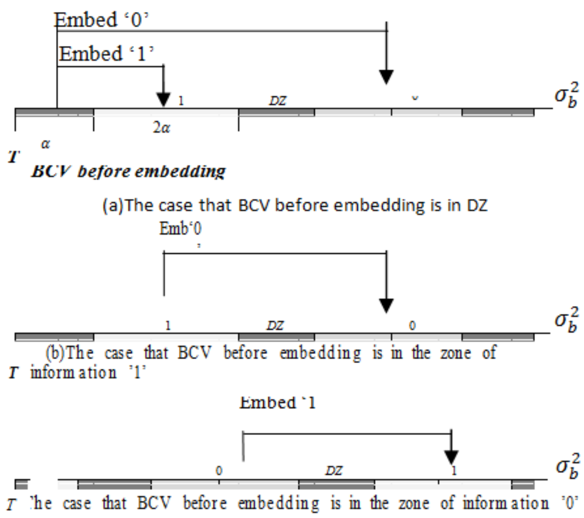

Figure 2: Embedding to Water Marking.

To change σ b2 according to the rules in Figure 2, it is necessary to decide the amount of the luminance change. In this study, we set constraints on the following three values and keep them constant before and after the embedding process.

The number of pixels in each class ω_0, ω_1.

The position of the pixel that belongs to each class.

The mean luminance of the block.

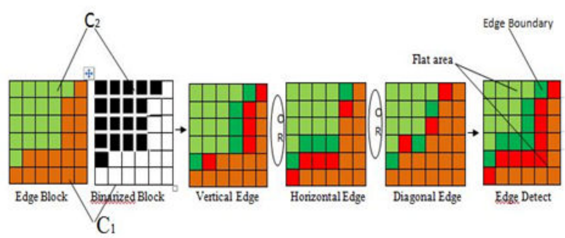

Figure 3: Showing luminance of the block.

How to change luminance of edge pixels

The amount of the luminance change that satisfies the above three constraints can be written as follows:

$$\beta_0 = \frac{\omega_1}{\omega}(\mu_1 - \mu_0) - \sqrt{\frac{\omega_1}{\omega_0}}\gamma \rightarrow (10)$$

$$\beta_1 = -\frac{\omega_0}{\omega}(\mu_1 - \mu_0) + \sqrt{\frac{\omega_0}{\omega_1}}\gamma \rightarrow (11)$$

Where β_0 and β_1 are the amount of change for pixels belonging to C_0 and C_1, respectively. γ is BCV decided by the embedding rules. To embed a watermark bit, the mean luminance in each class is changed as follows:

μ_0^'=μ_0+β_0→ (12)

μ_1^'=μ_1+β_1→ (13)

Where μ'_0 and μ'_1 are the mean luminance of C_0 and C_1 after embedding.

Extracting watermark

For extracting the watermark, the watermarked image is divided into fixed-size blocks as done in the embedding process. Then, BCV is calculated by applying DAM for each block. If BCV is larger than a threshold T, the extraction process is applied for the block. Theoretically, there are no blocks where BCV is within the range of DZ after embedding because the proposed method uses the embedding rules shown in Figure 2. However, when the watermarked image is attacked, BCV of the watermarked image may be within the range of DZ. If a block where BCV is in DZ is detected in the extracting process, then we can judge that the image has been attacked. In this case, the BCV in the DZ is compared with a threshold T' given by (14) to estimate whether the BCV was in '0' or '1' before the attack and extract the embedded bit. α' is the parameter denoting the width of the area for extraction as shown in and is defined by (15).

$$T' = T + \frac{\alpha}{2} \rightarrow (14)$$

α'=3α → (15)

Experimental Results

To verify the effectiveness of the proposed method, a series of experiments were conducted. In these experiments, set of original images of size 256 × 256, with 8 bit colour representation is used. Figure 1 shows colour images of Lena, House, Girl, mandrill, Barbara and Peppers, which are used in our experiments. The watermark used is a monochrome image of size 256 × 256. Figure 2 shows the watermarked colour images obtained by our algorithm. To measure the distortion incorporated by the watermarking algorithm we have used Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR). Structural Similarity Index (SSIM) is a method for the evolution; we compared our method with the method by class variance method.

PSNR is most easily defined via the mean squared error (MSE). Given a noise-free m × n monochrome image I and its noisy approximation K, MSE is defined as:

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Here, m and n are the height and width of image respectively. I (i, j) and I'(i, j) are the (i, j)th pixel value of the original image and modified image respectively.

The PSNR is defined as:

$$PSNR = 10.log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample SSIM.

The SSIM metric is calculated on various windows of an image. The measure between two windows and of common size N×N

The SSIM is defined as

$$SSIM\ (x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

Where, μ_x the average of x, μ_y the average of y, $\sigma^2_x$the variance of x, σ^2_y the variance of y, σ_{xy} the covariance of x and y, $c_1=(K_1L)^2$ and $c_2=(K_2L)^2$ Two variables to stabilize the division with weak denominator; L the dynamic range of the pixel-values.K_1=0.01 and K_2=0.03.

Figure 4: Original Image and Number of Embedded Bits.

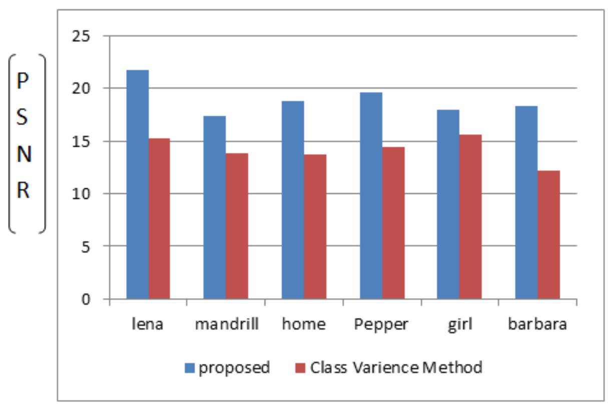

Figure 5: PSNR comparison between our proposed algorithm and result in class variance method.

This article is available from: https://doi.org/10.21767/2349-3917.100001

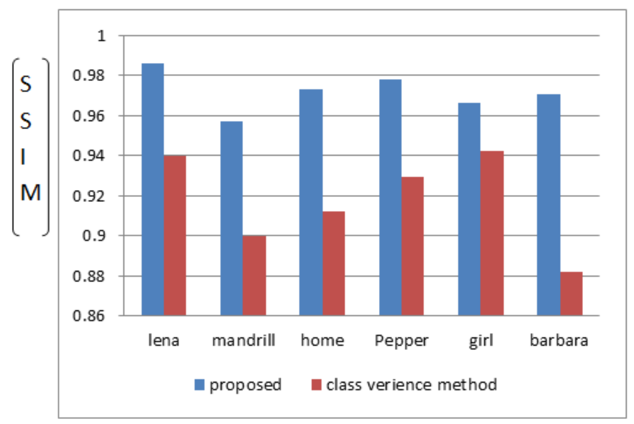

Figure 6: SSIM comparison between our proposed algorithm and result in class variance method.

Result of attack on watermarking

Images that were watermarked and then attack along with their extraction rate value given in the following experimental result to show resulting damage. In general the lower extractions rate the more damage in the image. In practice the image is proceeds and store using jpeg compression quality that the proposed method can resist is adopted as the measure of effectiveness of watermarking method to resist attack. The extraction rate η is define as follow,

$$\eta = \frac{\eta_c}{\eta_a} \times 100$$

Where, n_c is the number of correctly extracted bits, and n_a is the total number of embedded bits in order to equalize the image quality of the watermarked images of both methods in terms of SSIM and PSNR.

JPEG Compression

JPEG compression is one of the most important attack that watermark should be resistant to jpeg compression is applied to the watermarked image for different quality factor value of extraction rate of the corrupted image are compressed to result from Table 1. According to Table 1 our proposed algorithm has better transparency and robustness. Result of Table 1'can be pointed out that the proposed method considerably robust against image compression and watermark can be well detected for all image of facing jpeg compression. In other words, due to the use of ridge let transform, better performance Proposed Method will be achieved for images with more curved edges. Lena images and extraction rate of Lena image of different quality parameter (QP) are also displayed in Table 1.

Table 1: Extraction rate calculate between the proposed and existing work under jpeg compression attack with different quality parameter for Lena image.

IMAGES	PROPOSED METHOD	CLASS VARIANCE METHOD
Mandrill	94.18	93.35
Lena	93.61	93.2
Barbara	93.9	93.58
Home	94.23	90.25
Girl	92.21	91.45
Elaina	90	87.05

Gaussian filtering

Robustness of proposed watermarking algorithm Gaussian filtering attacks in terms of transparency. In Table 2 result of detecting the watermark in the presence of Gaussian filter with Robustness of proposed watermarking algorithm is evaluate and filter size of 3 × 3 and variable variance is presented. Results show acted against median filtering attack. Have been faced Gaussian filtering that our proposed algorithm can considerably detect the water mark. In normalized correlation filtering attack with different image with watermarked Barbara, Mandrill, Home, Pepper of extracted watermark as a robustness parameter for some host image, extraction rate watermark in Table 2 Home image has more smooth area than other image, normalized correlation of extracted watermark for images, it is more robust against attacks like Gaussian and median some host images. The Gaussian filtering can be seen in Table 2. Barbara image, however, has the worst Performance in the filtering attack and has the least effect on home image and watermark presence of Gaussian filtering attacks because of having is substantially detected. In table 2, we compare our results with exiting method results in the face of Gaussian filtering to show the robustness of proposed method.

Table 2: Extraction rate calculate between the proposed and existing work under Gaussian filtering attack.

IMAGES	PROPOSED METHOD	CLASS VARIANCE METHOD
Barbara	67.09	64.53
Mandrill	67.5	66.21
Home	76.28	62.91
Peppper	67.3	65.25
Girl	62.21	31.45
Elaina	70	67.05

Gaussian noise

In Table 3, the robustness of proposed algorithm in the presence of Gaussian noise for Lena, Barbara and Pepper image is compared to methods with exiting class variance method. The mean of the additive Gaussian noise is considered to be zero and its variance is variable. This comparison clearly demonstrates that our watermarking method outperforms the method in under Gaussian noise attack. For low noise variances our proposed method is as robust as method in. However, there are more difference between our proposed method and exiting class variance method, in case of extraction rate for our proposed method extraction rate more. The extraction rate watermark images obtained using proposed method are shown in Table 3 after adding Gaussian noise with different variances. Although there are more attacks that can be tested, the results presented here give a good indication of the capabilities of the proposed method. Since the proposed watermarking algorithm takes advantage of ridge let transform and spread spectrum technique simultaneously, the extracted watermark are more robust against all mentioned attacks. Consequently, both PSNR values and SSIM value of watermarked images and the robustness against attacks show considerable improvement using the proposed algorithm.

Table 3: Extraction rate calculate between the proposed and existing work under Gaussian noise attack.

IMAGES	PROPOSED METHOD	CLASS VARIANCE METHOD
Barbara	88.54	84.64
Lena	97.74	85.11
Pepper	71.17	90.84
Home	94.23	91.45
Girl	93.51	90.45
Elaina	92	88.76

Brightness and Contrast Attacks

We change to brightness and Contrast of the test image to test to resistance of the proposed watermarking to these kinds of attacks. Watermark was shown to resist the brightness and Contrast attack. Result for the Lena, Barbara, Pepper and home are shown in the Table 4.

Table 4: Extraction rate calculate between the proposed and existing work under Brightness and Contrast Attacks.

Images	PROPOSED METHOD	CLASS VARIANCE METHOD
Barbara	40.82	14.63
Lena	83.29	54.26
Pepper	52.68	14.36
Home	86.3	72.99
Girl	72.91	68.4
Elaina	81.9	74.06

Conclusion

We proposed a new approach for watermarking in this paper. We developed a low-complexity pixel-based watermarking method that utilizes the edge areas in an image to decrease the visual degradation, PSNR and SSIM of the proposed method are better than exiting class variance method that is shown by Experimental results. In the scanning of the binary block diagonally we detect the edge boundary size is more as compare to exiting class variance method. From these we able to embedding large size of water mark. The proposed method is suitable for marking image as military database or as fingerprint database to avoid fraudulent tempering in general with application commerce, law, defence, journalism this method is suitable for this image authentication if image contain of large area texture than we found that our method is robust for this smoothing. Robustness of the algorithm is tested against different type of attacks. The last one is the case in which it part of it. Although a number of work have been already done in the field of digital image watermarking. A number of approaches already have given so it is not possible to implement a different approach of digital image watermarking. But we modified previous method and give a direction for new research work. There are number of benefits of these approaches and people can further work in the field of digital image watermarking by using different methods.

References

1. Jonker W, Linnartz JP (2004) Digital rights management in consumer electronics products. IEEE Signal Processing Magazine 21: 82-91.
2. Ingemar JC and Matt L (2002) The first 50 years of Electronic Watermarking, EURASIP Journal on Applied Signal Processing 2: 126-132.
3. Ingemar JC, Matthew LM, Bloom A, Jassica F, Tan Kalker (2008) Digital watermarking and steganography.
4. Macq BM and Quisquater JJ (1995) Cryptology for digital TV Broadcasting. Proceedings of IEEE 8: 944-957.
5. Bender WD, Gruhl N, Mormoto N, Lu A (2003) Techniques for data hiding. IBM Systems J. 35: 313-336.
6. Nino DA, Haramo MB (2006) Dual Domain Watermarking in the Biological Color Model. IEEE International Conference on Information and Automation (ICIA).
7. Otsu N (1979) A Threshold Selection Method from Gray-Level Histograms. IEEE Trans. on System, Man, and Cybernetics SMC-9 1: 62-66.
8. Dorairangaswamy MA (2009) A robust blind image watermarking scheme in spatial domain IJET13: 249-255.
9. Kutter M, Petitcolas F (1999) Electronic Imaging security and watermarking of multimedia contents: A fair benchmark for image watermarking systems. Proc. SPIE IS&T/SPIE's 11th Annu. Symp. 3: 65-67.
10. Wang Z (2004) Image quality assessment: From error visibility to structural similarity. IEEE Trans. Image Processing 13: 600-612.
11. Guo JM (2008) Variance-classified capacity watermarking using discrete cosine transform. ProcIIH-MSP 9: 77-80.
12. Echizen I (2000) Maintaining image quality in digital watermarking based on contour preserving. IPSJ 41: 1828-1839.
13. Adhipathi RA, Chatterji BN (2003) Wavelet based robust logo watermarking scheme. In: Internat. Conf. on Advances in Pattern Recognition.
14. Barni M, Bartolini F, Piva A (2001) Improved wavelet based watermarking through pixel wise masking. IEEE Trans. Image Process. 10: 783-791.

This article is available from: https://doi.org/10.21767/2349-3917.100001

15. Broadway GW (1997) Protecting publicly-available images with an invisible image watermark. In: Internet Conf. on Image Process. 1: 524-527.

16. James R, Long M, Newcomb D, Renesse RLV, (2004) Designing Security holograms. Proc SPIE Optical Security and Counterfeit Deterrence Techniques V 7: 264-274.

17. Souparis H (2002) Achromatic feature and DID. Proc. Beijing Int. Conf. Advanced Anti-Counterfeiting Technologies 2: 99-104.