ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 5, May 2014

# A DCT Domain Robust Image Watermarking Based on Luminance Parameters

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**Abstract**: Embedding a digital signal with information which cannot be removed easily is called 'Digital watermarking'. In visible watermarking of images, a secondary image is embedded in a primary image such that watermark is intentionally perceptible to human observer.The present work aims at visible watermarking algorithm based on luminance parameters in DCT domain. Visible watermarking is a type of digital watermarking used for protection of publicly available images. The growth of computer networks has boosted the growth of the information technology sector to a greater extent. There is a trend to move from conventional libraries to digital libraries. Visible watermarking is a type of digital watermarking used for protection of publicly available images. In this paper, the proposed work consists of visible watermarking scheme that is applied into the host image in the DCT domain. The algorithm will be implemented on MATLAB platform.

**Keywords:** luminance based watermarking, Discrete Cosine Transform, Just Noticeable Difference, Robustness

## I. INTRODUCTION

An efficient method to protect digital images is called Digital Image Watermarking. A signal is embedded directly in the image to be protected without altering it significantly, this signal (watermark) is imperceptible usually, but it can be detected or extracted by specific algorithm, even after some manipulations to the watermarked data.The embedded data (watermark) may be either visible or invisible.

In visible watermarking of images, the watermark is embedded in a host image such that watermark is intentionally perceptible to a human observer where as in the case of invisible watermarking the embedded data is not perceptible, but may be extracted detected by a computer program.

Some of the desired characteristics of visible watermarks are listed below [4][5].

- A visible watermark should be obvious in both color and monochrome images.
- The watermark should be spread in a large or important area of the image in order to prevent its deletion by clipping.
- The watermark should be visible yet must not significantly obscure the image details beneath it.
- The watermark must be difficult to remove; removing a watermark should be more costly and labor intensive than purchasing the image from the owner.
- The watermark should be applied automatically with little

There are very few visible watermarking techniques available in current literature. Kankanhalli have proposed a visible watermarking technique in DCT domain. They divide the image into different blocks, classify the blocks by perceptual methods proposed in [5] and modify the DCT coefficients of host image as follows.

$$C_{ij}(n)=\alpha_n C_{ij}(n)+\beta_n W_{ij}(n) \qquad n=1, 2... \qquad (1)$$

The $\alpha_n$ and $\beta_n$ coefficients are for block n. The $C_{ij}$ (n) are the DCT coefficients of the host image block and $W_{ij}$ (n) are the DCT coefficients of the watermark image block. In this paper, we propose a visible watermarking technique that modifies the DCT coefficients of the host image. We call $\alpha_n$ as the scaling factor and $\beta_n$ as the embedding factor. We have also proposed a modification to make the watermark more robust.

## II. CALCULATING SCALING AND EMBEDDING FACTOR

While calculating the scaling factors *($\alpha_n$)* and embedding factors *($\beta_n$)*, mean and variance are considered so that the quality of the watermarked image is not degraded.

- The distortion visibility is low when the background has strong texture. In a highly textured block, energy tends to be more evenly distributed among the different AC DCT coefficients. That means AC DCT coefficients of
highly textured blocks have small variances and
we can add more to those blocks. So for convenience, we assume $\alpha_n$ to be directly proportional to variance ($\sigma_n$) and $\beta_n$ to be inversely proportional to variance ($\sigma_n$)
- Let us denote the mean gray value of each image block as $\mu_n$ and that of the image as $\mu$. The blocks with mid-intensity values ($\mu_n$=$\mu$) are more sensitive to noise than that of low intensity blocks ($\mu_n<\mu$) as well as high intensity blocks ($\mu_n>\mu$). This means that $\alpha_n$ should increase

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
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with $\mu_n$ as long as ($\mu_n<\mu$) and should decrease with $\mu_n$ as long as ($\mu_n>\mu$).The variation of $\beta_n$ with respect to $\mu_n$ is the reverse of that of $\alpha_n$. The mean gray value of each block is given by its DC DCT coefficient.

For confirmation the above requirements, we have chosen $\alpha_n$ and $\beta_n$ as follows

- For edge blocks $\alpha_n$ and $\beta_n$ are taken to be $\alpha_{max}$ and $\beta_{min}$ respectively.
- For non-edge blocks αn and βn are computed as:

$$\alpha_n = \sigma'_n \exp .\left(-(\mu'_n - \mu')^2\right) \qquad (2)$$

$$\beta_n = (1/\sigma'_n)\left(1 - \exp .\left(-(\mu'_n - \mu')^2\right)\right) \qquad (3)$$

where and are the normalized values of μn and μ respectively, and $\sigma'_n$ is normalized logarithm of $\sigma_n$.

- $\alpha_n$ and $\beta_n$ are then scaled to the ranges and respectively, where $\alpha_{min}$ and $\alpha_{max}$ are the minimum and maximum values of the scaling factor, and $\beta_{min}$ and $\beta_{max}$ are the minimum and maximum values of the embedding factor. These are the parameters determining the extent of watermark insertion.

We divide the host image I into 8x8 blocks and find the DCT coefficients of each block. Let us denote the DCT coefficients of block n by, $C_{ij}(n)$ = 1, 2… N, where n represents the position of block in image I. N is the total number of 8x8 blocks in the image and given by (row x column)/64, "row" is the number of rows and "colum" is the number of columns of the image. The norn mean gray value of block n is found out using eq. (4

$$\mu'_n = C_{00}(n) / C_{00(\max)} \qquad (4)$$

Where, $C_{00max}$ is the maximum value of $C_{00}(n)$.

The normalized mean gray value of image I is calculated using eq. (5):

$$\mu' = (1/N)\sum_{n=1}^{N} C_{00(n)} \qquad (5)$$

The variance of AC DCT coefficients of block $n$ is computed using eq. (6)

$$\sigma_n = \frac{1}{63}\sum_i \sum_j \left(C_{ij} - \mu_n^{AC}\right)^2 \qquad (6)$$

Where $\mu_n^{AC}$ is the mean of the AC DCT coeffi

The normalized variance of AC DCT coefficients n is of the value given by (7)

$$\sigma'_n = \sigma^*_n / \sigma^*_{\max} \qquad (7)$$

Where $\sigma^*_{max}$ is the maximum value of $\sigma^*_n$

## III. EMBEDDING OF WATERMARK

The steps for watermark insertion are discussed now.

- The host image I and watermark image W each are 256*256 gray scale images.
- The host image I (to be watermarked) and the watermark image W are divided into blocks of size 8x8.
- The DCT coefficients for each block of the host image are found out. These are 64 coefficients.
- For each block of the host image I, the normalized mean gray value $\mu'_n$ is computed using eq. (4) and are scaled to the range 0.1-1.0.
- The normalized image mean gray value μ is found out using eq. (5).
- The variance of AC DCT coefficients of block $n$ is computed using eq. (6).
- For the AC DCT coefficients, the normalized variances $\sigma'_n$ are computed using eq. (7) and scaled to the range 0.1- 1.0
- The edge blocks are identified using the Canny edge operator and no watermark is embedded in these blocks.
- For non edge blocks – The $\alpha_n$ and $\beta_n$ are found by using eq. (2) and (3).
- The DCT of watermark image blocks are found out.
- The $n^{th}$ block DCT coefficient of host image I is modified using eq. (1).
- The IDCT of this image (in DCT domain) gives watermarked image in spatial domain.

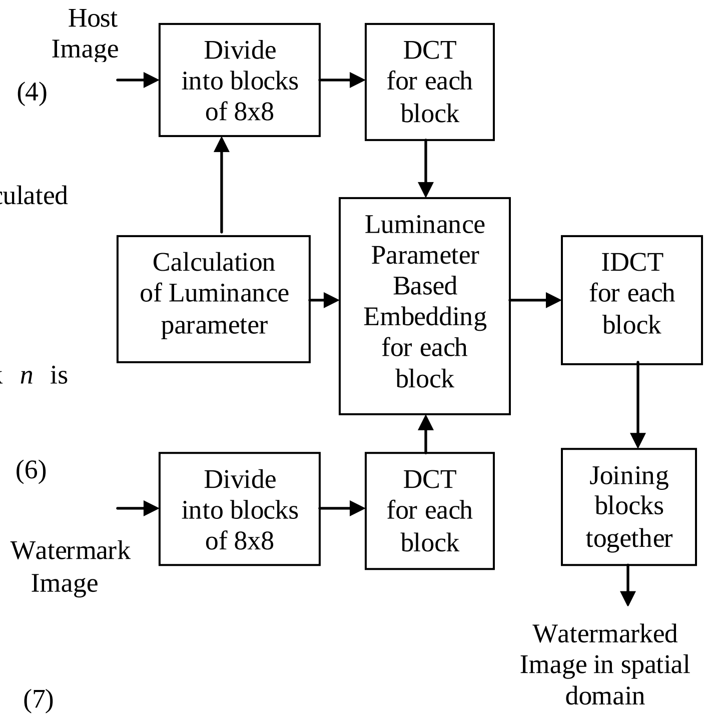


FIG.1. WATERMARK EMBEDDING PROCESS

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

*International Journal of Advanced Research in Computer and Communication Engineering*
*Vol. 3, Issue 5, May 2014*

## IV. MODIFICATIONS TO MAKE THE WATERMARK MORE ROBUST

To check the robustness of watermarked image, attacks are performed on watermarked image. These attacks are jpeg compression, Median Filter, Laplace of Gaussian filter, salt & pepper and gaussian noise respectively.

Here we have five Host Images and five Watermark Images. For any experiments we perform all combinations of Host images with Watermark images, this gives 25 sub experiments. Average PSNR and average Correlation are calculated for 25 sub experiments.

Fig.2. Host image "Lena"

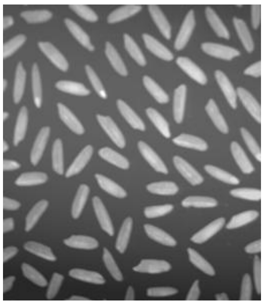

Fig.3.Watermark Image "Rice"

Fig.4. Watermarked Image

Fig.5. Recovered image

"Lena" is used as host image and "Rice" is used as watermark image are shown in fig.2 and 3 respectively are used for all experiments in a paper. After watermarking process we are getting the watermarked image and recovered image as shown in fig. 4 and 5 respectively. This is the result for no attack of one sub experiment like this we are performed for all remaining images.

Table I. Result for No Attack

| Sr. No | H+W | No Attack | | | |
|---|---|---|---|---|---|
| | | Simple Watermarking | | Proposed Method | |
| | | PSNR | Correlation | PSNR | Correlation |
| 01 | L+R | 38.11 | 1 | 39.22 | 1 |
| 02 | B+R | 37.94 | 1 | 40.72 | 1 |
| 03 | P +R | 37.54 | 1 | 38.28 | 1 |
| 04 | F +R | 34.73 | 1 | 35.07 | 1 |
| 05 | G+R | 36.81 | 1 | 37.80 | 1 |
| 06 | L+P | 36.11 | 1 | 37.59 | 1 |
| 07 | B+P | 36.65 | 1 | 39.88 | 1 |
| 08 | P+P | 36.19 | 1 | 37.19 | 1 |
| 09 | F+P | 34.94 | 1 | 35.53 | 1 |
| 10 | G+P | 34.03 | 1 | 35.08 | 1 |

The above table shows, the result for No Attack, total 25 sub experiments are done for each experiment i.e. nothing but for each attack. But here we have shown the result only for 10 sub experiments. After each experiment, we have calculated PSNR and Correlation, and then we have compared the results of both.

Fig.6.Compression Attacked Image.

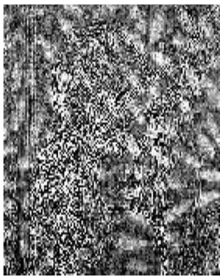

Fig.7.Recovered Image

Table II. Result for Jpeg Compression Attack

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

IJARCCE

*International Journal of Advanced Research in Computer and Communication Engineering*
*Vol. 3, Issue 5, May 2014*

| Sr. No. | H+W | JPEG Compression | | | |
|---|---|---|---|---|---|
| | | Simple Watermarking | | Proposed Method | |
| | | **PSNR** | **Corr.** | **PSNR** | **Corr.** |
| 01 | L+R | 29.69 | 0.34 | 29.45 | 0.4 |
| 02 | B+R | 23.53 | 0.16 | 29.03 | 0.23 |
| 03 | P+R | 32.89 | 0.46 | 32.38 | 0.53 |
| 04 | F+R | 28.76 | 0.36 | 31.23 | 0.35 |
| 05 | G+R | 32.28 | 0.44 | 28.64 | 0.32 |

Fig.8.LOG Filter Attacked Image

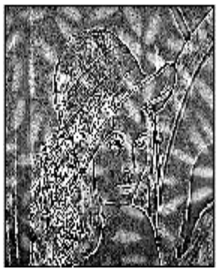

Fig.9.RecoveredImage

Table III. Result for LOG Filter Attack

| Sr. No. | H+W | LOG Filter | | | |
|---|---|---|---|---|---|
| | | **Simple Watermarking** | | **Proposed Method** | |
| | | **PSNR** | **Corr.** | **PSNR** | **Corr.** |
| 01 | L+R | 26.84 | 0.37 | 31.23 | 0.4 |
| 02 | B+R | 20.75 | 0.15 | 22.45 | 0.31 |
| 03 | P+R | 28.96 | 0.53 | 29.76 | 0.57 |
| 04 | F+R | 24.66 | 0.39 | 28.34 | 0.36 |
| 05 | G+R | 30.72 | 0.49 | 26.08 | 0.4 |

The table II and III shows the result of jpeg compression, Log Filter attacks respectively for simple watermarking and luminance based watermarking. For each attack we are performed 25 sub experiments. Validating and comparing performance of above two methods using suitable metrics like PSNR and Correlation and then compare the average values of these parameters.

Compression attacked image, recovered image and LOG filter attacked, recovered image are shown in fig. 6 to 9 respectively. The experiment was performed for other attacks also such as Median filter, Salt & pepper and Gaussian Noise. The results of all attacks are shown in Table IV.

Table IV. Comparison of Simple and Luminance based watermarking for different attacks

| Sr. No. | Attacks | Simple Watermarking | | Luminance Based Watermarking | |
|---|---|---|---|---|---|
| | | **PSNR** | **Corr.** | **PSNR** | **Corr.** |
| 01 | No Attack | 36.36 | 1 | 37.70 | 1 |
| 02 | Compression | 29.28 | 0.33 | 30.47 | 0.37 |
| 03 | Median Filter | 28.64 | 0.47 | 30.01 | 0.49 |
| 04 | LOG Filter | 26.32 | 0.36 | 28.14 | 0.39 |
| 05 | Salt & Pepper | 32.62 | 0.99 | 35.29 | 0.99 |
| 06 | Gaussian noise | 26.49 | 0.18 | 27.31 | 0.21 |

The above table shows the difference between the average values of PSNR and Correlation for both methods. The relation between PSNR and correlation is compliment to each other but here with the proposed method both are increasing**.**

## V. CONCLUSION

This paper aims at developing a digital image watermarking method using luminance parameters. Host image set and watermark image sets include five gray scale images each and all combinations of host and watermark images are verified. The proposed method is validated using metrics like PSNR and correlation. The proposed luminance based method improves both PSNR and correlation compared to simple watermarking scheme.

It is concluded that both PSNR and correlation increased with the proposed method for 5 different attacks. Hence Luminance based watermarking method is robust.

## REFERENCES

[1] A DCT domain Visible Watermarking Technique for Images, by Sanju P. Mohanty, K.R. Ramakrishna, Mohan S. Kankankalli.

[2] An Improved Method of Content Based Image Watermarking, by Arvind Kumar Parthasarathy and Subhash Kak

**[3]** Digital Watermarking : A Tutorial Review, Saraju P. Mohanty, Dept of Comp Sc and Eng, University of South Florida Tampa, FL 33620, smohanty@csee.usf.edu

[4] Fan Zhang et al, "Digital image watermarking capacity and detection error rate", pattern recognition letters, 28(2007), 1-10

[5] Digital watermarking: A tutorial review, Saraju P. Mohanty, Dept of comp science and engg university of South Floorida Tampa, FL 33621.

[6] Yeung M.M., "Digital Watermarking for High- Quality Imaging", Proc. of IEEE First Workshop on Multimedia Signal Processing, Princeton, NJ, pp. 357-362, June 1997.

[7] Mintzer F, "Effective and Ineffective Digital Watermarks", Proc. IEEE International Conference on Image Processing ICIP-97, vo1.3, pp. 9-12, 1997.

[8] Mintzer F, "Towards Online Worldwide Access to Vatican Library Materials", IBM Journal of Research and Development, V01.40, No.2, pp.139-162, Mar. 1996.

[9] Kankanhalli M.S., "Adaptive Visible Watermarking of Images", appeared in Proc. of ICMCS'99, Florence, Italy, and June 1999.

[10] Tao B. and Dickinson B., "Adaptive Watermarking in DCT Domain", Processing of IEEE International Con$ on Acoustics, Speech and Signal Processing, ICASSP-97, Vo1.4, pp. 1985- 2988, 1997.

[11] Granrath D.J., "The Role of Human Visual Models in Image Processing", Processing, IEEE, Vo1.69, No. 5, pp. 552- 561, May 1981.

[12] Kankanhalli M.S., "Content Based Watermarking for Images", Proc. of 6th ACM International Multimedia Conference, ACM-MM 98, Bristol, UK, pp.61-70, Sep.1998.

[13] Braudaway G. W., Magerlein K. A. and Mintzer F.,"Protecting Publicly Available Images with a Visible Image Watermark", Proc. of International Conference on Image Processing, 1997, Vol. 1, pp. 524 -527

[14] Ingemar J. Cox and Matt L., "A review of watermarking and the Importance of perceptual modelling", Proceedings of Electronic Imaging, February 1997.