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Performance Evaluation of Image Watermark System using selected Discrete Cosine Transform

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ABSTRACT

In recent days the computer communication and the usage of multimedia data is enormous over the Internet that may be easily copied & distributed from one to another. So protection of these data is very important. A robust watermarking embedding system must be developed with high PSNR Values. In this paper, a watermarking system using DCT transformation technique with image padding and selector is proposed. The results assure that the proposed algorithm gives high PSNR value and least MSE value.

Keywords: Image, Image Watermarking, DCT, embedding, Peak Signal to Noise Ratio.

INTRODUCTION

There has been a tremendous hike in the amount of information being used from the Internet. This has led to an increase in the amount of information being available on the Internet. Due to this ever growing usage of multimedia content on the Internet, serious issues have been marked.

Counterfeiting, forgery, fraud, and pirating of this content are most common amongst these issues. Consequently, copyright abuse is taking a toll among multimedia users who are rarely caught. Copy protection is a serious issue. This copy protection is the motivating factor in developing new technologies like digital image watermarking. Image watermarking deals with the watermarking process for Images. A need for image watermarking arose due to the fact that most of the information these days is in the form of images as well. Now a day, it is necessary to have a technique which will embed watermark on an Image. Various image & video watermarking methodologies were presented in (Pik-Wah, 2004).

The proposed method serves the purpose of providing copy protection of images using watermark. The proposed algorithm is watermark being embedded into an image in an invisible manner. It proves efficient technique with high PSNR values of the watermarked images (Pik-Wah, 2004).

There are many different types of digital watermarking, with different goals, and many schemes to accomplish those types of watermarking. Digital watermarking is the process of embedding information into an image that can identify where the image came from or who has rights to it. In some watermarking schemes, a watermarked image has a logo or some other information embedded into the image so that it is readily visible, however these watermarks can be easily corrupted or removed using simple image processing techniques. Most watermarking schemes use invisible watermarking, in which the information is virtually invisible after it is embedded. Watermark embedding can be achieved in a number of different ways. Some techniques embed a binary pattern into the spatial domain of an image. Usually, the information can be embedded while taking into account which areas of the original image can hold more information while remaining undetectable (Huang and chang, 2005)-(Maity and Kundu, 2005). The watermark is embedded by directly modifying pixel values in the spatial domain. However, other watermarking schemes are achieved by embedding the information in the transform domain of an image, either the Discrete Wavelet Transform (DWT) domain or the Discrete Cosine Transform (DCT) domain (Huang and chang, 2005), (lee and lee, 2005- (Kaewkamnerd and Rao, 2000). These schemes usually convert the image into one of the transform domains and then embed the watermark information by adjusting the transform domain coefficients. The image is then transformed back into the spatial domain.
DCT based watermarking techniques are more robust as compared to spatial domain watermarking techniques. This algorithm is robust against simple image processing operations like low pass filtering, contrast and brightness adjustment, etc. However, they are difficult to implement and are computationally more costly. And also they are weak against geometric attacks like scaling, rotation and cropping etc. DCT watermarking can be classified into Block based DCT watermarking and Global DCT watermarking One of the first algorithms presented by Cox *et al*., (1997) used global DCT to embed a robust watermark in the perceptually significant portion of the Human Visual System (HVS). Embed the watermark in the perceptually significant portion of the image has many advantage because most compression algorithms remove the perceptually insignificant portion of the image. It represents the LSB in spatial domain however it represents the high frequency components (Su, 2001; kundur and hatzinakos, 1998; Jun, Guo-hua, and Yi-jia, 2006; Ahmidi and Safabakhsh, 2004; Rao and Yip, 1990; Discrete Cosine Transformation www.cs.cf.ac.uk/Dave/Multimedia/node231.html) in the frequency domain.

This paper focuses on embedding watermarks into gray scale images using DCT domain. This paper describes Image watermarking schemes using DCT coefficient to improve the performance of the system.

PROPOSED METHOD

In this paper, a watermarking system using DCT transformation technique with image padding and selector is proposed. In the proposed method watermark is embedded in the cover image using selected DCT coefficient.

An image of size 256×256 is considered as a cover image. To convert the original image into 8×8 block, block processing of 8×8 size is applied using Discre Cosine Ttransform. Most of the energy of image is in the upper left corner of the resultant matrix. These coefficients are selected for the embedding process. Watermark is embedded into the selected coefficient of cover image after multiply it by a multiplying factor. To view watermarked image, IDCT Block with zero image pad is to be used. A zero pad 4×4 submatrix block is reconverts the image to its original 8×8 size.

Algorithm

Image Watermarking using Discrete Cosine Transform:

1. Take an Original Image.
2. Resize the image into 256×256 pixels.
3. Apply block processing & divide the image in the blocks of 8×8 pixels.
4. Apply the Discrete Cosine Transformation (DCT) technique to the blocked image.
5. Take the watermark gray image/colour image of size 256×2564; using colour space conversion
6. Colour space conversion converts RGB to Intensity

7. Watermark vector W is multiplied by a gain factor ‘α’.
8. Embedding process is applied by using image pad & selector block.
9. Apply the Inverse Discrete Cosine Transformation to get the watermarked image.

Experimental Results and Performance Analysis

In the experiment shown below the original images are of size 256×256 pixel & 512×512 gray image and the watermark images are of size 256×256, 128×128, 64×64 & 32×32 binary image. In order to quantitatively analyze the invisibility of the algorithm, four guide lines are employed: one is peak signal- noise ratio, PSNR (unit’s dB), which is used to measure the invisibility of the water mark. Others are Mean Square Error (MSE), Root Mean Square Error, and Absolute Mean Error.

Experimental Results

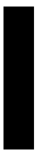
Table 1: Embedding of same watermark image with different Cover Images

S.No.	Cover Image	Watermark Image	Watermarked Image
1.			
3.			
4.			

Table 2: Embedding of different size watermark image with different Cover Images

S. No.	Cover Image(Different size)	Watermark Image(Different size)	Watermarked Image
1.			
2.			
3.			
4.			

Table 3: Embedding of different size watermark image with same Cover Image

S. No.	Cover Image	Watermark Image	Watermarked Image
1.			
2.			
3.			
4.			

Performance Analysis

After applying the embedding process on different images, results and all the relative changes are tabulated in respective tables with their PSNR, Mean Square Error, Normalized Mean Square Error, Root Mean Square Error, Absolute Mean Error values. To evaluate the degradation between the original image and the watermark image, peak-signal-to-noise ratio (PSNR) is used. Mathematically it is represented as:

$$\mathbf{PSRN} = 10 \log 10 \frac{2552}{\mathbf{MSE}}$$

Peak Signal to Noise Ratio depends on the value of MSE. Mathematically MSE is given by:

$$\mathbf{MSE} = \frac{1 \; M \; N}{M \; N \; i=1 \; j=1} \sum\sum \{((I(i, j) - I'(i, j))2\}$$

Normalized Mean Square Error is given by:

$$\mathbf{NMSE} = \frac{\mathbf{MSE}(x, y)}{\mathbf{MSE}(x, 0)}$$

Root Mean Square Error is given by,

Root MSE = sqrt MSE

Absolute Mean Error is given by,

$$\mathbf{AME} = \frac{\mathbf{Root\ MSE}}{\mathbf{MSE}(x, 0)}$$

Table 4: Performance Evaluation for different images with same watermark image (256×256 Size)

S.No.	Input Image / Size	watermark image / Size	PSNR (dB)	MSE	NMSE	Root MSE	AME
1.	Cameraman.tif 512 × 512	watermark2.bmp 256 × 256	36.77	13.679	0.05343	3.6985	0.01445.
2.	lena_gray_256.tif 256 × 256	watermark2.bmp 256 × 256	29.44	73.974	0.28896	8.6008	0.03359
3.	lena_gray_512.tif 512 × 512	watermark2.bmp 256 × 256	34.72	21.932	0.0885672	4.6832	0.01829
4.	Womandarkhair.tif 512 × 512	watermark2.bmp 256 × 256	41.68	4.4165	0.01725	2.1015	0.00821
5.	Woman blond.tif 512 × 512	watermark2.bmp 256 × 256	35.28	19.279	0.07531	4.391	0.01715

Average PSNR = **35.78 dB**
Average Normalized Mean Square Error = **0.1047034**
Average Mean Absolute Error = **0.18338**

Table 5: Performance Evaluation for different images with same watermark image (32 × 32 Size)

S. No.	Input Image / Size	watermrk image (Size 32 × 32)	PSNR (dB)	MSE	NMSE	Root MSE	AME
1.	lena_gray_256.tif 256 × 256	sscet 32 gray.bmp	29.44	73.974	0.2889	8.6007	0.03359
2.	lena_gray_512.tif 512 × 512	sscet 32 gray.bmp	34.72	21.932	0.0856	4.6831	0.01829
3.	woman_darkhair.tif 512 × 512	sscet 32 gray.bmp	41.68	4.416	0.0172	2.1015	0.00821

Average PSNR = **35.28 dB**
Average Normalized Mean Square Error = **0.1306**
Average Mean Absolute Error = **0.01993**

Table 6: Performance Evaluation using different parameters for same cover images with different size watermark image

S.No.	Input Image / Size	watermark image / Size	PSNR (dB)	MSE	NMSE	Root MSE	MAE
1.	lena_gray_256.tif	watermark2.bmp 256 × 256	29.44	73.974	0.28896	8.601	0.0336
2.	lena_gray_256.tif	Watermark3128.bmp 128 × 128	29.44	73.974	0.28896	8.601	0.0336
3.	lena_gray_256.tif	I32gray.bmp 32 × 32	29.44	73.974	0.28896	8.601	0.0336
4.	lena_gray_256.tif	Watermark64.bmp 64 × 64	29.44	73.974	0.28896	8.601	0.0336
5.	lena_gray_256.tif	Watermark.bmp 256 × 256	29.44	73.974	0.28896	8.601	0.0336
Average Values			**29.44**	**73.974**	**0.28896**	**8.601**	**0.0336**

Average PSNR = **29.44 dB**
Average Normalized Mean Square Error = **0.28896**
Average Mean Absolute Error = **0.0336**

Table 7: PSNR & MSE Values for different images with same watermark image (32×32 pixel size)

S. No.	Input Image	watermrk image (32 × 32)	PSNR	MSE	NMSE	Root MSE	MAE
1.	lena_gray_256.tif (256 × 256)	sscet 32 gray.bmp	29.44	73.127	0.2856	8.5514	0.0334
2.	lena_gray_512.tif (512 × 512)	sscet 32 gray.bmp	34.72	21.932	0.0856	4.6831	0.0182
3.	woman_darkhair.tif (512 × 512)	sscet 32 gray.bmp	41.68	4.41	0.0172	2.1	0.0082

Average PSNR = **35.28 dB**
Average Normalized Mean Square Error = **0.1294**
Average Mean Absolute Error = **0.01993**

CONCLUSION

This paper proposed a watermarking algorithm which is based on block processing. The proposed algorithms embedded watermark message using selected DCT coefficient.

Here proposed technique for embedding image into the gray-scale images may find applications in the intellectual property protection such as copy protection and anonymous. The results shows that the embedding algorithm gives high PSNR value for the input image size 512×512 as compare to input image size 256 × 256. It also shows that for different cover images with same watermark image (256×256 Size) gives average PSNR 35.28 & Average Normalized Mean Square Error 0.1306, Average Mean Absolute Error value 0.01993. Experimental result shows that the average PSNR, MSE & MAE for for same cover images with different size watermark image are 29.44, 0.28896 & 0.0336. Therefore different results assures that the proposed algorithm gives high PSNR value and least normalized MSE value.

It is to be noted that the algorithm presented in primary stage only works for gray-level images. It can be further enhanced for color images and video sequence.

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