DCT Based Watermark embedding into mid frequency of DCT coefficients Using Luminance Component

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Abstract- The main purpose of the digital watermarking is to provide information security and copyright protection. video watermarking algorithm using DCT (discrete cosine transform). Discrete Cosine Transform middle band of the luminance (Y) component is used for watermarking processes. Each bit of the binary watermark is embedded in a different Discrete Cosine Transform block. In this proposed algorithm cover video is divided into frames and watermark is inserted into selected frames. For selected video frames two-dimensional 8×8 discrete cosine transform is carried out on luminance component. Finally Experimental results shows that the proposed algorithm is imperceptible as well as robust against wide variety of signal and video processing attacks like Gaussian noise, Salt –pepper noise, Gaussian filter, Median filter, Histogram Equalization etc. The technique is fairly acceptable and watermarked video is of good quality, achieves high PSNR and extraction of watermark with NC value of the retrieved watermark as 1.

Keywords: DCT (Discrete Cosine Transform), Luminance (Y component), MSE (Mean Square Error), Normalized Correlation (NC), PSNR (Peak Signal to Noise)

1. Introduction

Now a day's people are highly dependent on internet technology, the users of networks especially over the Internet are increasing enormously. The increased importance of digital content invites new challenges for securing the distribution of digital media content. This copyright misuse is the motivating factor in developing new watermarking techniques. Watermarking [1-6] can be used for copyright protection. There is a need for video watermarking [1, 2] as most of the information on Internet these days is in the form of videos as well. Video watermarking is a technology in which there is embedding of various copyright information in video frames [3, 6, 7]. Digital watermarking algorithms are classified into frequency domain and spatial domain algorithms. Spatial domain algorithms embeds watermark by directly modifying pixels of carrier signal [8, 9] while Frequency domain algorithms embeds watermark by modifying frequency bands [10, 11]. Frequency domain watermarking is more secure and robust as compare to spatial domain watermarking. We are developing an algorithm for video watermarking in frequency domain using DCT which embeds binary watermark in video frames. Each bit of binary watermark is embedded into different 8×8 sized DCT block of Y (Luminance) channel of selected frame. Proposed method is blind and invisible as well as robust against variety of video processing attacks.

In literature DCT transform has been successfully used for digital watermarking. In the proposed algorithm DCT is used for video watermarking in frequency domain. DCT divides carrier signal into low, middle, and high frequency bands [10]. DCT watermarking is classified into two types: Global DCT watermarking and Block-based DCT watermarking. In the Global DCT watermarking, the DCT computation is performed on the whole image, while in the Block-based DCT the image is divided into non-overlapping blocks and DCT computation is performed on each block separately to obtain low-frequency, mid-frequency and high-frequency sub-bands . J. R. Hemandez, M. Amado have proposed image watermarking in DCT domain [11]. Masoumi, M., Amiri, have Proposed video watermarking in YCbCr color space [12]. S. Feng, D. Lin, S. C. Shie and J. Y. Guo proposed a DCT-based technique they converted RGB space to YUV space and embedded watermark in Y component [15]. Jaya Jeswani and Tanuja Sarode have proposed a blind image watermarking using DCT in RGB color space by modifying middle frequency coefficients DCT(4,3) and DCT(5,2) [17].

The paper is organized as follows: Section 1 presents introduction. An introduction to DCT transform is given in section 2. Section 3 describes proposed algorithm with DCT coefficients selection, watermark embedding and extraction algorithms. Experimental results before and after applications of attacks are given in section 4. Finally conclusion of proposed algorithm is given in section 5.

2. Introduction to DCT transform

DCT(Discrete Cosine Transform)is a popular frequency domain watermarking technique [17]. DCT divides carrier signal into three frequency bands namely low, middle, and high frequency bands. It is frequency domain watermarking technique as watermark is embedded into one of these three bands, carrier signal pixels are not modified directly. Fig. 1 below shows three DCT Regions, is used to denote the lowest frequency components of the block, is used to denote the middle frequency components, is used to denote the higher frequency components

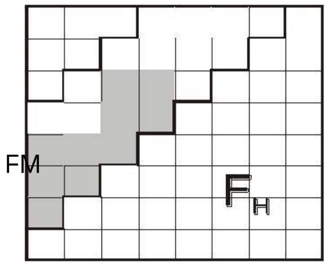

Fig:1 DCT Regions

The definition of 2-D DCT can be given as follows: The general equation for a 2D (*N* by *M* image) DCT is defined by the following equation:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1}\sum_{j=0}^{M-1} \Lambda(i).\Lambda(j).cos\left[\frac{\pi.u}{2.N}(2i+1)\right] cos\left[\frac{\pi.v}{2.M}(2j+1)\right].f(i,j)$$

The DCT-II implies the boundary conditions: x_n is even around n=-1/2 and even around n=N-1/2; X_k is even around k=0 and odd around k=N.In this paper for watermark embedding middle frequency bands are selected because moreof the video energy lies on low-frequency sub-band which contains the most important visual contents of video which effects quality of watermarked video, high frequency sub-band is usually removed through noise attacks.

3. Proposed Method

DCT Coefficients Selection

For watermark embedding DCT coefficients DCT (4,3) and DCT(5,2) have been selected because both are middle frequency components and in JPEG quantization table both are having same value as 22. The choice in selecting the two locations is dependent on the content of the JPEG quantization table given below in table I.

Table 1: JPEG Quantization Table

16	11	10	26	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	31	56	68	109	103	77
24	35	55	64	81	104	113	92
37	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

A. Watermark Embedding Process

Inputs: Color video frames and binary watermark
Outputs: Watermarked video frames

1. Take cover video of size M×N and select some video frames where watermark is to be embedded. Binary watermarkof size n×n is also taken as an input.
2. Selected frames are decompose into 3 components: Y, U and V.
3. Select Luminance component for watermark embedding and divide it into 8×8 sized blocks.
4. Determine watermark size based on cover image and block size by :
   watermark_size=M×N
5. Check watermark size if it is less than the watermark size calculated by equation 4 than pad the watermark out to the watermark size with ones.
6. Transform each block using DCT.
7. Embeds watermark bit=0 when DCT (5,2) is greater than or equal to DCT(4,3) and embeds watermark bit=1 when DCT (5,2) is less than DCT (4,3).
8. If watermark bit=0, then DCT(5, 2) should be greater than or equals to DCT(4, 3) and if DCT(5, 2) less than DCT(4, 3) then swap these two values .
9. If watermark bit=1, then DCT(5, 2) should be less than DCT (4, 3) and if DCT (5, 2) greater DCT (4, 3) then swap these two values.
10. Adjust difference between DCT(5, 2) and DCT (4, 3) such that their difference = k.
11. Transform block back into spatial domain by IDCT which gives watermarked frame.
12. Combine modified Y and U, V components to create watermarked video frame.
13. Repeat the same procedure till all the selected frames are watermarked.

B. Watermark Extraction Process

Input: Watermarked Video Frames
Output: Binary watermarks extracted from all Watermarked Frames

Steps:
1. Take watermarked video frames of size M×N as an input.
2. Each watermarked video frame and decompose into 3 components: Y, U and V.
3. Two-dimensional 8×8 discrete cosine transform is carried out on luminance component.
4. If DCT (5, 2) greater than or equal to coefficient of DCT (4, 3), make watermark bit=0 else watermark bit=1.
5. Reshape the recovered watermark image into
6. n×n.
7. Repeat the procedure till all the watermarks are extracted from the watermarked video frames.

Experimental Results

The proposed video watermarking algorithm is implemented on Intel Core i5-3210M, 1.8 GHz, 4GB RAM machine and Matlab R2011b.The proposed method is tested on different videos like News, Ice, Crew, Soccer of size 256×256 and binary watermark (8.bmp) of size 32×32 is used as watermark. For evaluating the performance of proposed algorithm Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE) and Normalized correlation (NC) performance evaluators are used.

$$MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} \left[I(i,j) - I'(I,J) \right]^2$$

Where, M, N = size of the original video frame,
I(i, j) = pixel values at location (i, j) of the original video frame,
I'(i, j) = pixel values at location (i, j) of watermarked video frame

$$PSNR = 10 \log_{10} \left(\frac{255}{MSE} \right)^2$$

$$NC = \frac{\sum_i \sum_j w(i,j)\, w'(i,j)}{\sum_i \sum_j w(i,j)^2}$$

W(i,j) = pixel values at location (i, j) of the original watermark,
W'(i,j) =pixel values at location (i, j) of the extracted watermark

Fig 2. Cover Video and watermarked image

Quality Factor K	PSNR					Average
1	45.3948	46.3186	46.3031	46.2931	46.2757	46.1745
2	45.3635	46.2812	46.2674	46.2568	46.2459	46.1388
3	45.3108	46.2112	46.1992	46.1906	46.1806	46.0725
4	45.2826	46.1478	46.1346	46.1273	46.1077	46.0144
5	45.2291	46.0679	46.0665	46.0364	46.0269	45.9364

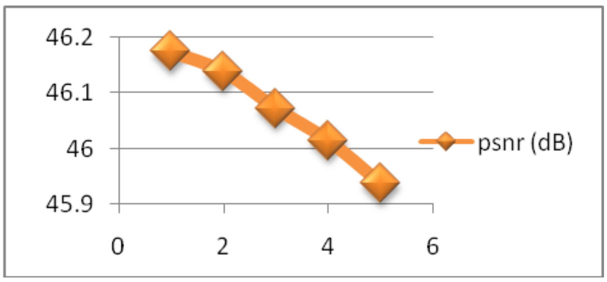

Fig.3: Peak Signal to Noise Ratio Chart at different Values of k

It can be concluded that as the value of k increases PSNR of watermarked frames decreases. Fig.3 shows Peak Signal to Noise Ratio chart at different values of k. Here k indicates minimum

Test Carrier Videos	News
Average PSNR of Watermarked Frames	46.0135
MSE of Watermarked Frames	1.6425
Average NC of Extracted watermarks	1

Conclusion

Various video watermarking algorithms have been proposed in spatial and frequency domains but very few algorithms are proposed for color videos. In this paper a frequency domain color video watermarking is proposed by using DCT. Proposed algorithm is blind video watermarking algorithm so at the time of watermark extraction original video frames are not required and recovery of watermark is lossless and having NC value as 1 without any attack. Proposed method is robust and secure because watermark is inserted in only Y component and chrominance component that is u and v are untouched. The proposed method is fairly acceptable and can be used as a non-blind video watermarking algorithm. The performance of proposed algorithm is measured by computing the Peak Signal to Noise Ratio (PSNR) and Normalized correlation (NC). The proposed method achieves average PSNR as 45.98 dB and NC as 1. Experimental results show that proposed method is imperceptible as well as robust against variety of attacks like salt- pepper noise, Gaussian noise, Speckle noise and filtering attacks like Median filter, Gaussian filter etc. Thus, proposed can be used as a non-blind video watermarking algorithm.

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