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A Blind and Robust Video Water Marking Technique in DCT Domain

D.Niranjan babu, D.Jagadeesh

*Abstract: In this paper, we present a blind video watermarking algorithm that can resist noise attacks, frame removal, and frame averaging, compression attacks and filtering attacks. Each video frame is divided into non-overlapping 8*8 blocks. Each block is transformed 2D-DCT. After performing the same transformation to all the blocks and frames, 1D DCT is applied to each coefficient on time domain. Now, the quantization is applied to embed the secret logo. Embedding is performed in to DCT intermediate frequency coefficients of the video frame.The DCT intermediate coefficients are adjusted by using a controlling parameter k which is a tradeoff between the perceptual quality and resilience to the attacks.*

Index Terms— **Discrete Cosine Transform, SQM, Resistance to Attacks.**

I. INTRODUCTION

Due to the rapid growth of network technologies digital video is becoming more popular and it is very easy to transmit and distribute data. So, there is a demand for techniques to protect the data and prevent unauthorized duplication. Digital watermarking protects the illegal copying of data. The fact that an unlimited number of perfect copies of text, audio and video data can be illegally produced and distributed requires studying ways of embedding copyright information and serial numbers in audio and video data. Steganography and watermarking bring a variety of very important techniques how to hide important information in an undetectable and/or irremovable way in audio and video data. Steganography and watermarking are main parts of the fast developing area of information hiding. There are so many video watermarking algorithms, but the issue is to resist the attacks. Our technique resists the attacks like filtering noise and compression attacks and preserves the quality. In general, there are two types of watermarking

i) Visible watermarking

ii) Invisible watermarking.

Based on the type of detection methods watermarking methods are classified in to three types.

i) Blind watermarking

ii) Semi-Blind watermarking

iii) Non-blind watermarking. If the watermarking scheme does not require the original image or any other data, then it is called Blind watermarking Technique. The watermarking scheme requires the use of the original image, and then it is called Non-Blind watermarking technique. The watermarking scheme requires the watermark data and/or the parameters used to embed the data, then it is called Semi-Blind watermarking. In this paper, we present an invisible watermarking technique. The watermarking logo is embedding is transform domain. There are so many transformation techniques (DCT, DWT, DFT, DHT etc). There are so many video watermarking techniques available based on simple 2D DCT [2, 5, 6] and DWT [9, 10]. We use a pseudo 3D discrete cosine transform and standard quantization matrix (SQM). Huang et al method [1] used the pseudo 3D DCT technique and quantization index modulation, but their technique is limited to monochrome videos. The Proposed method is also applicable to the colour videos.

DCT

The Discrete Cosine Transform is similar to the Fourier Transform in that it transforms a signal from the spatial or time domain to the frequency domain, as in if preparing an image for compression. Just as the Fourier Transform can be completed in a smaller amount of calculations by use of the FFT, the complexity of calculations needed to use the DCT also can be reduced. A method called the Fast Cosine Transform, or FCT, can be used when $N = 2^q$, where N is the number of vectors to be transformed and q is an element of the integers, and the complexity is reduced, just as with the FFT, from N^2 calculations to a number of calculations on the order of Nlog2N. The FFT is actually the foundation for calculating the FCT. The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. (The name comes from the working group that developed the standard: the Joint Photographic Experts Group). DCT domain watermarking can be classified into Global DCT watermarking and Block based DCT watermarking. In this paper block based DCT watermarking is used. In this method, a 2D-DCT and 1D DCT is applied to the frames. Each frame is divided in to non- overlapping 8*8 blocks. 2D-DCT is applied to each block and the same is repeated to each frame. Using the following the equation 4. 1D-DCT is applied to the 2D-DCT coefficients by using equation.

A. Mathematical Representation

The 1-D discrete cosine transform (DCT) is defined as

$$C(u) = \alpha(u)\sum_{x=0}^{N-1} f(x)\cos\left[\frac{(2x+1)u\pi}{2N}\right] \quad \textbf{(Eq 1)}$$

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For u = 0, 1, 2… N-1, similarly, the inverse DCT is defined as

$$f(x) = \sum_{u=0}^{N-1} \alpha(u) C(u) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \quad \textbf{(Eq 2)}$$

For x = 0, 1, 2… N-1. In both the equations (2.17) and (2.18), α is

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}} & for\, u = 0 \\ \sqrt{\frac{2}{N}} & for\, u = 1,2,\ldots\ldots N-1 \end{cases}$$

The corresponding 2-D DCT pair is

$$C(u,v) = \alpha(u)\alpha(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y) \cos\left[\frac{(2x+1)u\pi}{2N}\right]$$

$$\cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad \textbf{(Eq 3)}$$

For u, v = 0, 1, 2… N-1 and the values $C(u, v)$ are called the DCT coefficients *of* $f(x, y)$.

Similarly the inverse 2-D DCT is defined as

$$f(x,y) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} \alpha(u)\alpha(v) C(u,v) \cos\left[\frac{(2x+1)u\pi}{2N}\right]$$

$$\cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad \textbf{(Eq 4)}$$

For x, y = 0, 1, 2… N-1, where α is given as

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}} & for\, u = 0 \\ \sqrt{\frac{2}{N}} & for\, u = 1,2,\ldots\ldots N-1 \end{cases}$$

And $$\alpha(v) = \begin{cases} \sqrt{\frac{1}{N}} & for\, v = 0 \\ \sqrt{\frac{2}{N}} & for\, v = 1,2,\ldots\ldots N-1 \end{cases}$$

II. QUANTIZATION

In this paper, Quantization is performed after dividing the DCT transformed coefficients with standard quantization matrix. Two different quantizes are used. One for embedding the watermark bit '1'; other is for embedding '0'. The quantization is performed based on adjacent coefficients. Adjacent coefficients are compared. Here, the embedding is performed in the compressed domain to resist the attacks.

III. PROPOSED SCHEME

Pseudo-3-D DCT Technique:

The DCT transformation is taken twice here. The first-performed DCT is a 2-D transformation applied to the image plane. The second-performed DCT can be regarded as a 1-D transformation. Based on this relationship, we regard the proposed embedding method as a pseudo-3-D DCT Huang et al method [1]. The main advantage of the pseudo-3-D DCT is that it can reduce the computational cost more than the traditional 3-D DCT does. A video is divided in to group of frames. The RGB video is divided in to luminance and chroma components. The video is embedded in luminance component. Our eye is less sensitive to the luminance components and more sensitive to the color components. In this the transformation is performed in two steps. In the first step, each frame is divided in to non overlapping 8*8 blocks. Each block is transformed in to DCT domain by using two dimensional discrete cosine transform equation. In the second step, one dimensional discrete cosine transform is applied on time axis. I.e. The corresponding pixels of each frame are transformed using one dimensional DCT.

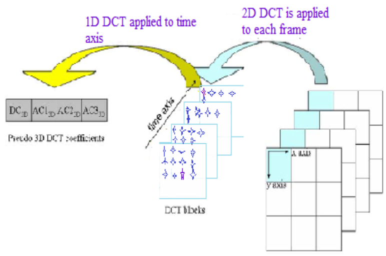

Fig .1 Illustration of the Proposed DCT Method

Watermark embedding and extracting:

Watermark embedding:

1. Divide the video in to frames
2. Dive the each frame from RGB to Y Cb Cr.
3. Each frame is divided into 8*8 blocks
4. Apply 2D-DCT to each block. Repeat this to all the frames.
5. Apply 1D-DCT to (1, 1) coefficient of first block of each frame.
6. Perform the same to (1, 2) coefficient of first block of each frame.
7. Repeat the same till (8, 8) coefficient is reached.
8. Repeat the steps 4, 5 and 6 till all the blocks are finished.

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9. Now, divide the each block of first frame with standard quantization matrix.

10. One bit of watermark is to be embedded in each block.

11. Choose any two mid frequency coefficient resultant matrix and modify the coefficients according to the following condition.

```
if   w(k)==1
          A' (4, 4, 1) = (A(4, 4, 1)  + k);
end

if   w(k)==0
          A ' (4, 4, 1) = (A (4, 4, 1) - k);
End
```

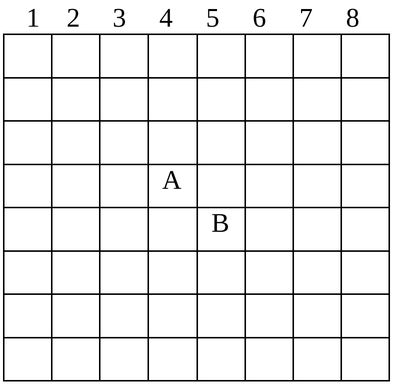

Fig. 2 Selected DCT Coefficients

Multiply the modified blocks with standard quantization matrix.

12. Apply the inverse 1D IDCT along the time axis.

13. Apply the block based inverse 2D IDCT to each frame.

14. Convert the each frame from Y Cb Cr to RGB.

15. Write the all the frames in to the AVI format.

Watermark extraction:

1. Divide the watermarked video in to a number of frames and converted RGB to YCbCr.

2. Apply the 2D-DCT and 1D-DCT to as mentioned above in the embedding process. (i.e. steps 2 to 7 of embedding process).

```
if ((A_ex(5,5,1)))>=A_ex(4,4,1)
      w_e(k)=0;
else
      w_e(k)=1;
end
```

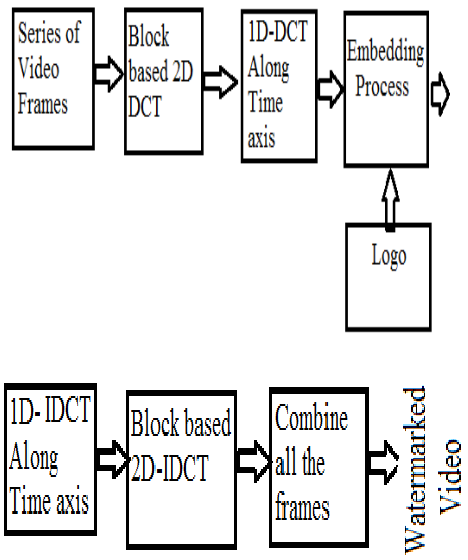

Fig .3 Block diagrams of Embedding Technique

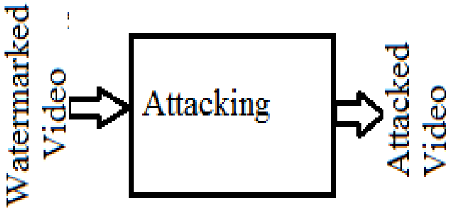

Fig. 4 Public Channel

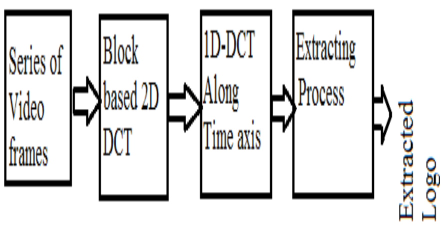

Fig.5 Block diagram of Extraction Technique

IV. EXPERIMENTAL RESULTS

The experiment is performed on a video of size 240*320 and the number of frames are 60.The secret logo size is 64*64.The controlling parameter **k** value 0.5 is selected. The experiment is performed in MATLAB 2012a.
The PSNR of proposed method is 43.05db.

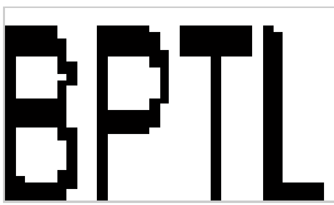

Fig. 6 Original Watermark logo

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Fig. 7 Original video

Fig. 8 Watermarked Video

Fig.9 Extracted Logo

Table 1

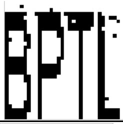
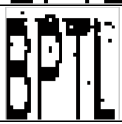
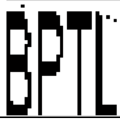
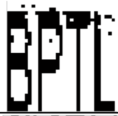
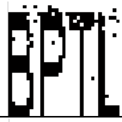
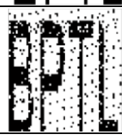
S.No	Type of Attack	NCC	Extracted Logos
1.	Salt & Pepper Noise (Density=0.001)	0.97	
2.	Gaussian Noise (mean=0,variance=0.001)	0.972	
3.	Frame Removal	0.97	
4.	Frame Averaging	0.97	
5.	MPEG-4	0.81	
6.	Compressed JPEG AVI	0.9	
7.	Motional JPEG 2000	0.96	
8.	Gaussian filter	0.98	
9.	Frame resizing (60%)	0.927	

Table 2 Comparison of Performance

Parameter	Lu Jianfeng et al method [2]	Proposed method
Average PSNR(db)	36.29	43.05
No.of attacks Applied	4	9

V. CONCLUSION

The proposed method gives good results for noise attacks and filtering attacks. For compression attacks, the extracted logo is slightly disturbed, but it is easy to recognize. This scheme is not robust against geometrical attacks like frame rotation. In future, the algorithm can be improved to resist these attacks.

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Author’s Profile

D.Niranjan babu is a research scholar in Acharya Nagarjuna University, Guntur. He completed M.Tech in Sri Venkateswara University, Tirupathi. B.Tech in JNTU Anantapur. He has 19 years of experience in teaching undergraduate students and postgraduate students. He has ISTE membership. He has two international journals to his credit.

D.Jagsdeesh currently working as a Assistant professor in Vignan’s Nirula institute of Technology and science for women, Palakaluru, Guntur. He completed M.Tech in Bapatla engineering college, Bapatla. He completed B.Tech in Vignan’s Engineering College, vadlamudi. He has two years of teaching experience.