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Watermarking using DWT and PCA

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Abstract: This work presents a novel technique for embedding a binary logo watermark into video frames. The proposed scheme is an imperceptible and a robust hybrid video watermarking scheme.pca is applied to each block of the two bands (LL– HH) which result from discrete wavelet transform of every video frame. The watermark is embedded into the principal components of the LL blocks and HH blocks in different ways. Combining the two transforms improved the performance of the watermark algorithm. The scheme is tested by applying various attacks. Experimental results show no visible difference between the watermarked frames and the original frames and show the robustness against a wide range of attacks such as mpeg coding, jpeg coding, Gaussian noise addition ,histogram equalization, gamma correction, contrast adjustment , cropping.

Keywords: DWT, DWPT, NC, PCA, PSNR, RGB.

I. INTRODUCTION

Watermarking is a technique for securing various copyright data such as text, image, audio and video. Copyright protection is the major part of the watermarking. Since 13th century, Digital Watermarking came into existence[1].

Digital Watermarking is basically a phenomenon by which we can easily encrypt and decrypt a data in digital format so that it can be used by authorized users and unauthorized users will not be able to decrypt the data. There are various applications Digital Watermarking such as

1. Broadcast Monitoring.
2. Owner Identification & Copyright Infringement- we can easily identify the owner.
3. Online and Offline money transaction.
4. Copy Control- to prevent illegal copying of videos, data etc [2].

Video watermarking refers to embedding of a watermark data in a video sequence to defend from illegal copying or sharing and also protection of identity of authorized consumer or creator of the work. Scan pattern and watermarking in DWT domain to get dual protection of video content that makes the technique more secure[3].

Watermark embedding in a video can be of two types frame based or stream based including AVI, MPEG-2 and MPEG-4 video frames/streams. In frame based embedding the watermark bits are embedded in the video by means of complete frame or tiles of the frame. In stream based watermark embedding technique, only the lines of the video frame are embedded[4].

Video watermarking approaches can be classified into two main categories based on the method of hiding watermark bits in the host video. The two categories are:

Spatial domain watermarking where embedding and detection of watermark are performed by directly manipulating the pixel intensity values of the video frame. Transform domain techniques, on the other hand, alter spatial pixel values of the host video according to a pre-determined transform[5].

Embedding a hidden stream of bits in a file is called Digital Watermarking[6].

The digital watermarking process embeds a signal into the media without significantly degrading its visual quality. Digital watermarking is a process to embed some information called watermark into different kinds of media called Cover Work[7] .

A. *Techniques of Watermarking*

For implementation of robust video watermarking scheme following transforms are used. Discrete Wavelet Transform (DWT) and Principle Component Analysis (PCA).

1) *Discrete Wavelet Transform:* DWT is used to implement a simple watermarking scheme. The 2-D discrete wavelet transforms (DWT) decomposes the image into sub-images. The 2-D DWT is an application of the 1-D DWT in both the horizontal and also the vertical directions. The DWT decompose an image into a lower resolution approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components.

Embedding the watermark in low frequencies obtained by wavelet decomposition increases the robustness with respect to attacks that have low pass characteristics like lossy compression, filtering, and geometric distortions.

LL_1	HL_1
LH_1	HH_1

Fig 1.Standard DWT decomposition

2) Principal Component Analysis: PCA is a method of identifying patterns in data, and expressing the data in such a way so as to highlight their similarities and differences. PCA produces linear combinations of the original variables to generate the axes, also known as principal components, or PCs. PCA transform is used to embed the watermark in each colour channel of each frame of video. The main advantage of this approach is that the same or multi-watermark can be embedded into the three colour channels of the image in order to increase the robustness of the watermark[8].

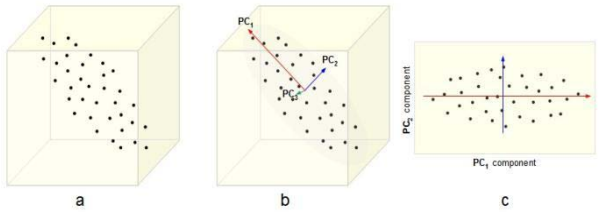

Figure 2. Principal components

DWT is more computationally efficient than other transform methods because of its excellent localization properties which provide the compatibility with the Human Visual System (HVS)[9].

II. PROPOSED ALGORITHM

A. *Algorithm*

1. read the video
2. disintegrate into frames
3. perform DWT on each RGB frame of a video frame to get:
    a. red LH
    b. green LH
    c. blue LH
    d. red HL
    e. green HL
    f. blue HL
    g. red HH
    h. green HH
    i. blue HH
4. perform thresh holding operation on each sub band to get edge image
5. get the location of edges
6. read the watermark image
7. perform PCA on watermark image
8. convert PCA components into binary
9. insert these binary values into edge locations from step 5 (12 operations)
10. .reconstruct the frame
11. .reconstruct the video
12. .read the new video
13. disintegrate into frames
14. perform DWPT on each RGB frame of a video frame
    j. red LH
    k. green LH
    l. blue LH
    m. red HL
    n. green HL
    o. blue HL
    p. red HH
    q. green HH
    r. blue HH
    s. sqrt(red LH + red HL + red HH)
    t. sqrt(green LH + green HL + green HH)
    u. sqrt(blue LH + blue HL + blue HH)
15. get the edge locations from 5
16. extract the PCA components in binary form
17. .reconstruct the PCA components
18. Inverse PCA
19. get the watermark image

III. RESULTS

The research work has been implemented with along with multiple attacks on which its accuracy and efficiency can be judged. Following are the list of attacks that are applied on the watermarked video. Every time, after an attack, the watermark is extracted from the video.

1. Speckle noise
2. Gaussian noise
3. Histogram equalization
4. Contrast adjustment
5. Cropping

Following are the features that are calculated for determining the accuracy and efficiency of the algorithm

1. PSNR(peak signal to noise ratio) of original video VS reconstructed video
2. NC(normal correlation) of original video VS reconstructed watermark after attack
3. NC(normal correlation) of original watermark VS reconstructed watermark

A. *Different Attacks*

1) Speckle Noise

Figure3 GUI (Speckle Noise)

2) Gaussian Noise Attack

Figure 4 GUI (Gaussian Noise)

3) Histogram equalization attack

Figure 5 GUI (Histogram Equalization)

4) Contrast adjustment attack

Figure 6 GUI (Contrast Adjustment)

5) Cropping attack

Figure 7 GUI (Cropping)

B. Camparison of Result

Compare the numerical value of our result with the base paper shows below in the table

1) DWT

Table 5.1 Attacks in DWT mode

ATTACK	**PSNR**	**NC(with attack)**	**NC**
Speckle Noise	45.3535	0.40829	0.57454
Gaussian Noise	47.9684	0.34915	0.40651
Histogram Equalization	48.8177	0.70205	0.3301
Contrast Adjustment	50.0598	0.64513	0.5237
Cropping	43.1825	0.3087	0.60199

2) DWPT

Table 5.2 Attacks in DWPT mode

ATTACK	**PSNR**	**NC(with attack)**	**NC**
Speckle Noise	42.3023	0.70388	0.75767
Gaussian Noise	49.2057	0.76006	0.72103
Histogram Equalization	46.719	0.70284	0.76174
Contrast Adjustment	50.0245	0.79011	0.75001
Cropping	43.3626	0.70716	0.72352

IV. CONCLUSION

All the values are available on the GUI itself where we can compare the results very easily. We can successfully conclude 2 things here:

1. Watermark embedding was successful. Reconstructed video show no sign of embedding with naked eyes
2. Even after applying multiple attacks, we are able to extract the watermark from attacked video.

V. FUTURE SCOPE

The algorithm implemented using DWT-PCA is robust and imperceptible in nature and embedding the binary watermark in the low LL sub band helps in increasing the robustness of the embedding procedure without much degradation in the video quality. As a future work the video frames can be subject to scene change analysis to embed an independent watermark in the sequence of frames forming a scene, and repeating this procedure for all the scenes within a video.

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