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A Hybrid DWT-SVD Method for Digital Video Watermarking Using Random Frame Selection

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Abstract: *Digital watermarking refers to embedding watermarks in a multimedia documents and files in order to protect them from illegal copying and identifying manipulations. We proposed a technique is Hybrid DWT-SVD method for digital video watermarking. This paper presents a robust and secure watermarking algorithm for video sequence. Proposed scheme divide the video in to frames and then blue channel is used for watermarking insertion. Discrete wavelet transform is used for watermark embedding. Watermark is inserted in to mid frequency component for better resistance to video manipulation operation. PSNR and MSE are computed for testing the proposed method.*

I. Introduction

Watermarking is the imperceptible transmission of additional data along with some cover data (often multimedia data) by so-called watermarks [1]. Watermarking is a process in which a signal is hidden or embedded into another signal, usually a photograph, video or music. It offers means to “attach” data to audiovisual material in a way that the original media format is not altered by the embedding process. In this sense, watermarking is a method for establishing a hidden data channel within existing channels for audiovisual communication which does not require additional infrastructure. With the rapid growth of the Internet and multimedia systems in distributed environments, it is easier for digital data owners to transfer multimedia documents across the Internet. Therefore, there is an increase in concern over copyright protection of digital contents [2, 3, 4, 5]. Traditionally, encryption and control access techniques were employed to protect the ownership of media. These techniques, however, do not protect against unauthorized copying after the media have been successfully transmitted and decrypted. Recently, watermark techniques are utilized to maintain the copyright [4, 6, 7, 8].

In last decade or so lots of research work has been done in digital image watermarking but video watermarking witness a little work over its field. Since video is the sequence of correlated images therefore watermarking in video can be done either frame by frame (Frame wise) or block by block (Block-wise). This paper presents a frame by frame approach for video watermarking. For achieving higher robustness, watermark embedding process is done in the wavelet coefficients. Before presenting the proposed watermarking scheme, it is better to have a look at what type of algorithm have been presented in for video watermarking in the related work section.

Nowadays the digital media is easily to be reproduced due to the rapidly growth of internet and the multimedia technologies, this drives to urgent need to resolve the security and copyright protection issues. Therefore, the field of digital watermarking grows extremely fast in these few years [9]. The purpose of a digital watermark is to embed auxiliary information into a digital signal by making small changes that are not perceptible to its intended recipient. For instance, in the case of multimedia watermarking, the hidden signal should not result in any visible or audible distortions. Because the embedded signals enable invisible tags to be attached to digital documents, watermarks are powerful tools that will play a role in solving the growing digital property identification problem [10].

In the literature, large number of watermarking algorithm for text [11][, audio[12] and image [13] These algorithm modify the cover media to embed the watermark. Most of the video watermarking algorithm proposed so far can be grouped either in frequency domain or spatial domain [14-24].

II. Methodology

The basic block diagram of the proposed method is shown in the figure 1. There are two phase in this algorithm. The first and second phases are watermarking and embedding process and the watermark extraction phase respectively. Algorithm steps for proposed embedding process are as follows

Step 1: Input the video.
Step 2: Convert the video into frames.
Step 3: With the help of Key1, Select the random frames.

Step 4: Separate the R, G, and B channel of selected frames.
Step 5: Select the Blue channel of the selected frames.
Step 6: Decompose the blue channel in to different frequency band i.e. LL(Low Frequency band), LH(Mid frequency band), HL(Mid frequency band) and HH(High frequency Band) with the help of discrete wavelet transform.
Step 7: Extract the mid frequency band (LH and HL).
Step 8: With the help of Key2, generate a random pn sequence.
Step 9: Perform the watermark embedding on mid frequency band using following equation.

$$FW_{u,v} = \begin{cases} Fi + G^{*}pn & \text{if} \quad W = 0, u, v \in HL, LH \\ Fi & \quad u, v \in HL, LH \end{cases}$$

$FW_{u,v}$ = Watermarked frame

Fi = Original frame

G = Gain factor

pn = pseudo random number

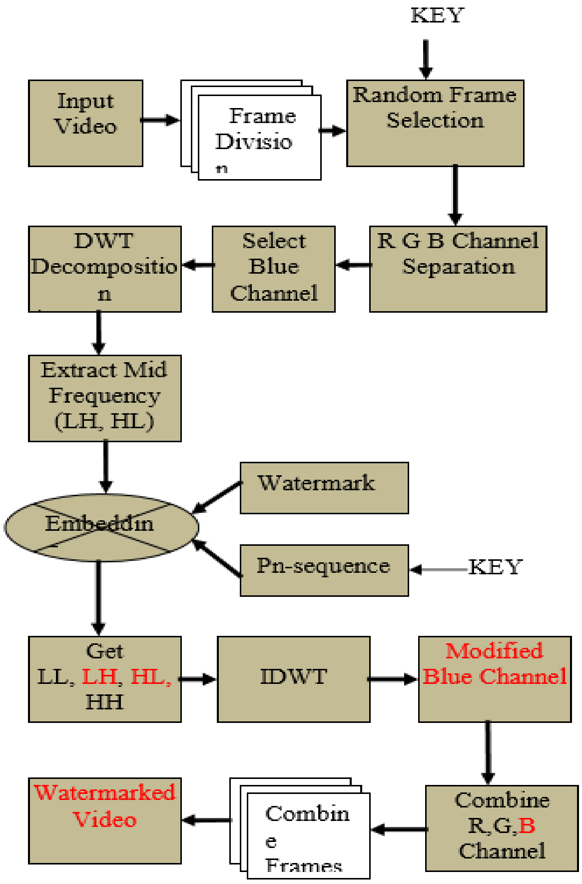


Fig.1 Block Diagram of Proposed watermarking algorithm

Step 10: Combine the HH, LL and watermark embedded mid frequency band LH and HL.
Step 11: perform the IDWT (Inverse discrete wavelet transform) to get the watermarked blue channel.
Step 12: Combine the Red, green and watermarked Blue channel to get back the frame.
Step 13: Combine all the video frames and convert in to a video. This is a watermarked video.

Similarly the algorithm steps for watermark extraction are as follows and the block diagram Fig. 2 shows watermark Extraction process

Step 1: Input the watermarked video.
Step 2: convert the video in to a frames.
Step 3: With the help of key 1, select the frames of the video.

Step 4: Separate the Red, Green and Blue channel of the selected frames.
Step 5: Select the Blue channel.
Step 6: Decompose the blue channel in ti different frequency band with the help of discrete wavelet transform (i.e. Low frequency (LL), mid frequency (LH, HL) and high frequency HH).
Step 7: Extract the mid frequency band.
Step 8: With the help of Key 2, generate the random pn-sequence.
Step 9: Compute the correlation between mid frequency component HL, LH and pn-sequence with the help of following formula.
Step 10: watermark extraction is complete.

It is important to note that in the following method instead of single randomly selected frame, we are using multiple selected frames and one particular row of all the frames are collected and form a 256 ×256 dimension image which work as a host frame for the watermark embedding process. Once the watermark is embedded in this frame then after performing IDWT, we place back the rows of all the selected blue frames to their respective locations. Here we can use another key for selecting one particular row or column from the randomly selected frames. This can increase the security of the watermarking method even stronger.

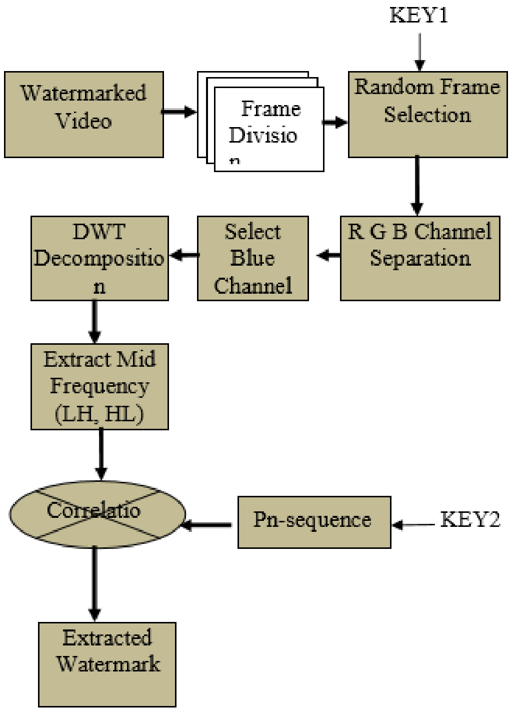


Fig. 2 watermark Extraction process

III. Experimental Results

In this section, the robustness of the DWT-SVD based hybrid watermarking scheme is tested. To implement the proposed watermarking scheme, the MATLAB Version 7.8.0.347 (R2009a) software is employed. The performance of the new video watermarking scheme is evaluated through different attack. Four video clips with 210 frames of size 176×144 are used in our experiments. The experiments are done on laptop with Intel(R) Core(TM) i5 CPU 2.40GHz and 4GB RAM.

We present our experimental results on the DWT-SVD based hybrid watermarking scheme. The experiments are basically test on robustness. In the following sections, we present the implementation details of the proposed scheme and the experimental results. Here we used four video clips. Each video clip has 210 frames and each frame having a size of 964 × 884 pixels. For the watermark, we used a grayscale image having size of 70 × 75 pixels. Both the video clips and the watermark were processed as described in details in the previous section. In order to test the proposed method, five different videos have been taken.

3.1 PSNR and MSE testing

For performance testing PSNR, MSE and Normalization coefficients are computed. PSNR and MSE between original video and the watermarked video is computed as per the following formula

$$PSNR = 10\log_{10}\frac{P\times P}{MSE}$$

P = is the row or column dimension of Host frame

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

I = Original host Frame

$I^{'}$ = watermarked Frame

M= Number of rows in original frames

N= Number of Column in Original frame

Table: 3. PSNR and MSE Comparison

Video	PSNR between Original and watermarked Video	MSE between Original and watermarked Video
Cute twins	13.5561	1.0096
Volcano	13.5187	1.0040
Hotel	13.5302	0.9976
Water fall	13.4026	1.0246
Shark	13.5336	1.0076

Normalization coefficient between original and extracted watermark is computed using the following formula

$$NC = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[W(i,j) - W^{'}(i,j)\right]}{\sqrt{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[W(i,j)\right]^2 \sum_{i=1}^{M}\sum_{j=1}^{N}\left[W^{'}(i,j)\right]^2}}$$

W = Original Watermark

$W^{'}$ = Extracted Watermark

Table: 4. Normalization Coefficient Comparisons

Video	Normalization Coefficient between Original and Extracted Watermark
Cute twins	0.8318
Volcano	1.6134
Hotel	0.5406
Water fall	0.4074
Shark	1.2280

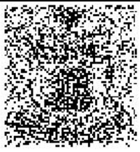
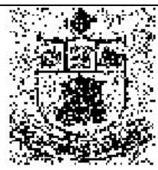
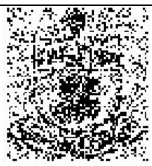
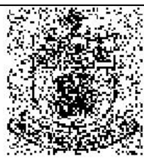
3.2 Tests on Robustness

Distinguishable attacks, Lossy compression, crop, noise, contrast and tamper are carried out to the watermarked video to test the robustness of our scheme. The NC values are retrieved when the watermarked video is facing different attacks. The high correlation value clearly indicates robustness of the algorithm against major attacks. The experimental results are described in details in the following sections.

3.2.1 Test of Robustness for other Attacks

There are other attacks like compression, crop, noise, contrast and tamper etc. In table below we show the robustness results obtained for the above mentioned attacks. Shown in the table. 5 are the extracted watermarks from the respective video clips.

Table: 5. The robustness results obtained for the different attacks

Video Clip Name	Cute twins	Volcano	Hotel	Water fall	Shark
Compression					
crop					
noise					
contrast					
tamper					

3.3 Overall Comparison

From the above results, the effectiveness of the DWT-SVD based hybrid scheme is demonstrated. The DWT-SVD based watermarking scheme achieves higher NC values when attacks based on video properties are launched. This indicates that the water marking scheme work well by applying DWT and SVD both in video clips. The overall performance, however, still shows improvement. The robustness of the scheme is also raised by engaging scene change detection approaches.

IV. Conclusion

This thesis investigates the knowledge of DWT-SVD Based Hybrid Digital Video Watermarking. After noticing the importance of the multimedia security and video watermarking in nowadays Internet world and reviewing the state-of the-arts technologies of the audio are watermarking, image watermarking and video watermarking, a hybrid digital video watermarking scheme is proposed. The process of this comprehensive video watermarking scheme, including watermark pre-processing, video pre-processing, watermark embedding, and watermark detection, is described in detail. Experiments are conducted to demonstrate that our scheme is robust against attacks by compression, crop, noise, contrast and tamper.

To conclude our work, we contribute on the followings:

1) We have performed a survey on the current watermarking technologies.
2) We propose a DWT-SDV based watermarking scheme. The scheme is robust against compression, crop, noise, contrast and tamper attacks.
3) We propose a hybrid approach with different watermarking schemes. We employ the hybrid scheme to embed different parts of a watermark into each frame of the video.
4) Experiment has been done on these video watermarking schemes to test and show its performance.

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