

A Video Watermarking Scheme Based on 2d DWT and Pseudo 3D DCT

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Abstract. The copyright protection becomes more and more attentive and important for the cyber space. The digital watermarking is an efficient and promising means to protect copyrighted works. In this paper, we proposed an effective video watermarking method based on 2D discrete wavelet transform (DWT) and pseudo 3D discrete cosine transform (DCT) against several attacks. The experimental results indicate the method can survive noise attacks, frame exchange, frame drop and MP4 compression with transparency and robustness.

Keywords: Video watermarking, 2D DWT, Pseudo 3D DCT, Quantization

1. Introduction

With the rapid development of computer network, multimedia and information science, problems about copyright protection and integrity authentication of digital contents have become more and more serious. Digital watermarking is an effective way to solve this kind of problems. It is permanently embedded into the digital contents for copyright protection and may be used to check whether the contents have been illegally modified [1].

Watermarking techniques can be classified as the spatial domain or frequency domain. In this paper, we chose the frequency domain to embed watermark. In the frequency domain, a watermark is embedded into coefficients obtained by using an image transform process. There are several papers described as follows.

Hsu and Wu in [2] proposed a DCT-based embedded watermark scheme. A watermark processed using a pseudorandom permutation is embedded into the DCT coefficients of the middle frequency within each image block. Suhail and Obaidat in [3] proposed a watermarking system based on a DCT transform that uses a pseudorandom sequence of real numbers in the DCT coefficients for each segment of the host image to embed the watermark. Some watermarking studies based on the DCT domain and DWT domain have been reported [4-10].

Many watermarking schemes have been suggested for image, audio, and video. In this paper, the proposed algorithm improved the robustness by using 2D DWT and pseudo 3D DCT to achieve copyright protection against to the various attacks. This paper is organized as follows. Section 2 introduced the technique of 2D DWT and pseudo 3D DCT. Section 3 described the proposed method, including the embedding and extracting watermark. Section 4 showed the experimental results to indicate the effectiveness of the proposed method. And the summaries was made in the last section.

2. Proposed Method

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2.1 Technique of 2D DWT and pseudo 3D DCT

In this paper, we proposed a method based on 2D DWT and pseudo 3D DCT. For video data, we take several successive frames as a group. Every frame within a group make 2D DWT and then choose the coefficients of HL and LH which will be divided into a number of blocks and transformed into the DCT domain by the pseudo 3D DCT method. The pseudo 3D DCT are described in the following [8].

First, take several key frames as a group, and every frame within a group is divided into some blocks. Next, the DC value of each block located in the same position of successive frames for a group is transformed into the DCT domain again. After transforming the second DCT process, we will obtain a new DC value and several AC values. This procedure is called a pseudo 3D DCT.

The 2D DWT and pseudo 3D DCT diagram is shown in Fig. 1.

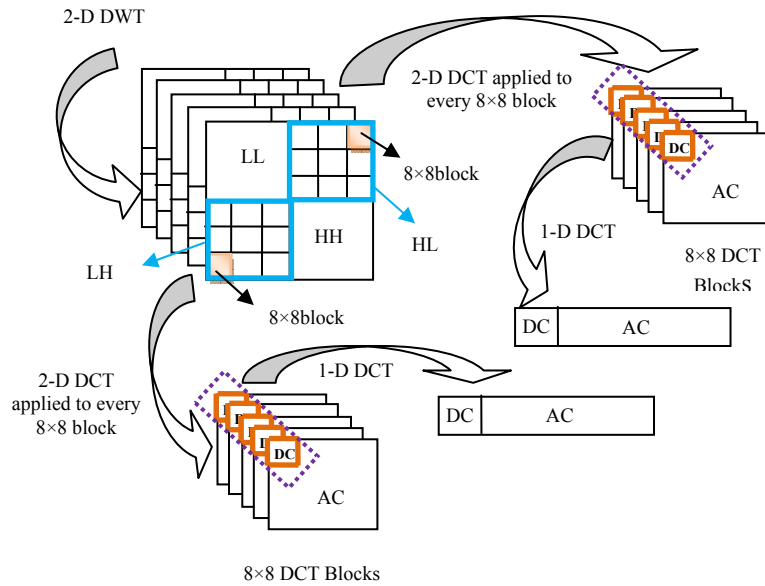


Fig. 1 Illustration of 2D DWT and pseudo 3D DCT

2.2 Proposed algorithm

According to the video sequence characteristics, the B-frame and P-frame are dependent on the I-frame. And the raw video data can also be considered as a sequence of several still images. The flowchart of the proposed method is shown in Fig. 2.

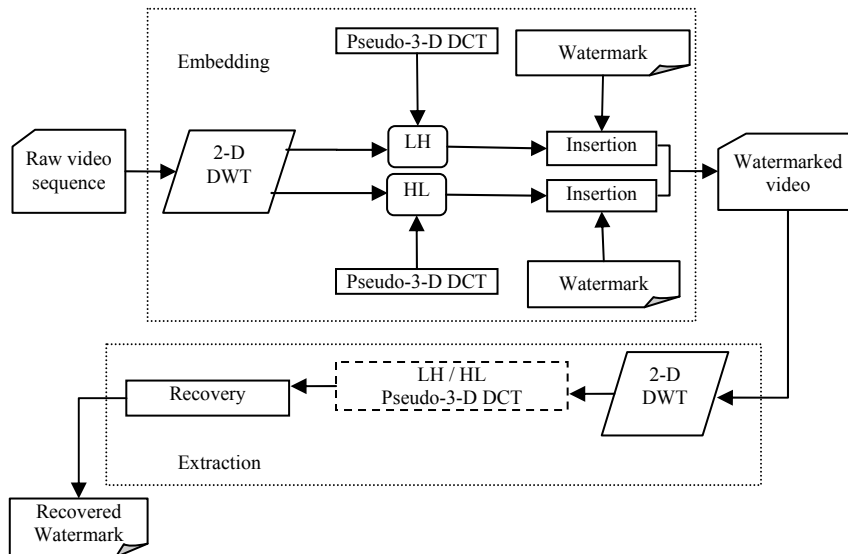


Fig. 2 Flowchart of the proposed method

The embedding process is as follows:

Choose the I frames of raw video sequence and separate them into GOPs, and each group consists of N frames.

- Step 1) Take 2D DWT for every frame of every GOP.
- Step 2) The LH and HL coefficients of every frame of every GOP are divided into blocks, and the size of each block is $n \times n$.
- Step 3) Take pseudo 3D DCT for every block and obtain the corresponding 3D DC coefficients.
- Step 4) According to the quantization modify every 3D DC coefficient to embed the watermark.
- Step 5) Reconstruct the video.

The extracting process is just the oppsite of embedding process.

3. Experimental Results and Analysis

In order to evaluate the performance of the proposed method, we have done various experiments, including rotation, noise attacks, frame exchange, frame drop and MP4 compression.

3.1 Experimental environment and Performance measure

In the experiments, we used the video with size 320×240 and it consists of 100 frames. We took five I-frames as a group and the LH and HL coefficients of 2-D DWT of every frame within one group are divided into numbers of 8×8 blocks. The watermark is denoted by a binary image size of 20×15 and shown in Fig. 3. In our scheme, the watermark is mainly embedded into the luminance component of each I-frame in the uncompressed domain.



Fig. 3 Watermark binary image



Fig. 4 Extracted watermark

The transparency and the robustness are very important factors for watermarking. Therefore, to evaluate the transparency, we used the peak signal-to-noise ratio (PSNR) as a criterion to estimate the invisibility. And to evaluate the robustness, we used the normalized correlation (NC).

3.2 Experimental Results

The average PSNR of all the watermarked frames is 43.87dB.

Without any attack we can extract the watermark exactly with $NC=1$ shown in Fig. 4. Then, we did the Noise attacks including Gaussian noise and Salt & Pepper noise (shown in Tab. 1), the MP4 compression attack (shown in Tab. 2) and frame attacks including frame exchange and frame drop (shown in Tab. 3).



Tab. 1 Noise Attacks

| | | Variance | 0.0005 | 0.002 | 0.005 |
|---------------|---------------------|---------------|--------|-------|-------|
| Gaussian | Attacked Frame | | | | |
| | Extracted Watermark | | | | |
| | NC | | 1 | 0.99 | 0.94 |
| | | Noise Density | 0.002 | 0.005 | 0.05 |
| Salt & Pepper | Attacked Frame | | | | |
| | Extracted Watermark | | | | |
| | NC | | 1 | 0.99 | 0.81 |
| | | | | | |

All the experiments we have tested just for the key frames. Especially, in the frame exchange of frame

attacks shown in the Tab. 3, we chose the two frames, 1st and 9th, from the same group and also chose two frames, 5th and 21st, from the different groups in order to verify the robustness.

Tab. 2 MP4 Compression Attacks

| Compression | MP4 | |
|---------------------|---|---|
| Bit Rate | 500Kbps | 1000Kbps |
| Extracted Watermark |  |  |
| NC | 0.71 | 0.92 |

Tab. 3 Frame Attacks

| Exchange | Exchanged Frames | 1 st ↔9 th | 5 th ↔21 st |
|----------|------------------|----------------------------------|-----------------------------------|
| | NC | | 1 |
| Drop | Dropped Frame | 9 th | 21 st |
| | NC | 1 | 1 |

4. Summaries

In this paper, we have proposed an effective video watermarking based on 2-D DWT and pseudo-3-D DCT. This scheme is proved that it can survive for many attacks such as noise attacks, frame exchange, frame drop and MP4 compression attacks and has good transparency and robustness. However, the capacity of watermark need to be improved and the method is not robust against H.264 compression. Therefore, further improving the capacity and resisting the H.264 compression will be the next work in the future.

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