A NOVEL DIGITAL VIDEO WATERMARKING TECHNIQUE BASED ON WAVELET, SVD AND CZ-TRANSFORM

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Abstract — Digital Watermarking technology embeds data into digital multimedia content to verify the credibility of the content or to recognize the identity of digital content owner. To identify the ownership of the digital content a new digital video watermarking algorithm is proposed. The proposed algorithm divides frames of a cover video into three colour bands of red, green and blue. Then the following three tasks are performed on every one of three colour bands independently. At first, each colour band is divided into blocks of small sizes and afterward the entropy of each block is computed. Based on the average entropy of all blocks, threshold value is calculated and the blocks with lower entropy than threshold, the subsequent operations are applied. Discrete wavelet transform is applied to get a wavelet representation of each block followed by singular value decomposition, orthogonal-triangular decomposition, and a chirp z-transform to embed watermark on the cover video. On watermarked video signal processing attacks are applied for robustness of the algorithm. The Proposed algorithm is compared with Least Significant Bit watermarking algorithm. Experimental results show that proposed algorithm outperforms the Least Significant Bit algorithm of watermarking quantitatively in term of PSNR.

Keywords — Digital Video Watermarking, Entropy, DWT, CZT, SVD, QR.

I. INTRODUCTION

We have a large volume of multimedia data available today, which can be perfectly copied and easily distributed at large scale. This raised the issue of security. It became a matter of some concern for the content owners when they realized that conventional protection mechanisms, such as encryption, were no longer sufficient. At some moment, digital data has got to be decrypted and presented to users. At the present time, the security offered by encryption, not anymore exists. That's why researchers started investigating digital watermarking as a complementary technology.

We have got two mechanisms; watermarking and steganography to transmit information by hiding it in any other digital media, which is generally known as cover media. Researches about steganography and watermark mostly focus on either field separately. However, their correlation is ignored while they apply highly similar techniques to hide information in images. After Image watermarking scientist invented video watermarking [1, 2].

Watermarking is a technique of embedding copyright information into the cover data to protect the intellectual right and the originality of data. Video watermarking technique is an extension of the watermarking concept [3, 4].

In data security field, video watermarking; which is just an expansion of image watermarking is regarded as one of the central features. It allows embedding of more data with the same and optimized length of the cover video; it maintains the quality of cover videos up to a considerable degree too and hence enhances the data limit for embedding data. The studies reported on watermarking techniques in the literatures at [6, 7, 8, 9, 10] have categorized them into three major categories, namely, blind, non-blind, and semi-blind. The underlying notion of the foregoing perception lies in the fact that in non-blind watermarking technique, both the cover image and the watermark are necessary for embedding and extraction process, whereas in semi-blind watermarking only the watermark image is needed, and in the blind variant, neither of them is necessary. Alternatively, watermarking algorithms can be classified based on the domain within which they operate, i.e. either the spatial domain or frequency domain, where the latter modifies the parameter values according to the frequency-domain representation of the cover image [11]. And, watermarking in the spatial domain changes the pixel values, and consequently, demands a comparatively lower computational complexity and cost, but suffers from the deficiency that relatively less amounts of information could be embedded into the cover image, which may result in a lack of robustness against attacks [12, 13, 14].

II. PROPOSED APPROACH

Embedding and extraction of a watermark is performed. Extraction is performed after applying different attacks on watermarked video. We consider some of the attacks like GPEG compression, rotation and scaling attacks and propose a different video watermarking scheme. Embedding, as well as extraction of an image i.e. watermark image, is performed by a mixture of properties of Discrete Wavelet Transform, QR decomposition, Singular Value Decomposition and Chirp Z-Transform. These steps are explained below.
A. Embedding of Watermark

Suppose, we consider one still image i.e. one frame of cover video. The first step is to extract the three color channels of Red (R), Green (G) and Blue (B) from the frame. Then from each channel of size of \( m \times n \), blocks of size of \( \alpha \times \beta \) are extracted, where \( \alpha \) and \( \beta \) divide \( m \) and \( n \) respectively \[15\]. We can consider \( N = n/\beta \) and \( M = m/\alpha \). Then each block can be described as in equation (1).

\[
B_{mn} = \{e_1, \ldots, e_N\}, me_\{1, \ldots, M\}
\]

(1)

An entropy value \( E \) is calculated for each block, and then a threshold value \( T \) is considered based on an average value of all \( E \) of all blocks. Where \( T \) is computed by the following equation \[15\]:

\[
T = \sum_{m=1}^{M} \sum_{n=1}^{N} \frac{E(B_{mn})}{m \times n}
\]

(2)

After finding the threshold, a two-level discrete wavelet transform (DWT) is applied on blocks with a value of entropy less than \( T \), in order to decompose them into four sub bands of one Low frequency (LL) and three high frequency in vertical (LH), horizontal (HL) and diagonal direction as given in equation (3)[15].

\[
\text{LL}_{mn} \text{LH}_{mn} \text{HL}_{mn} \text{HH}_{mn} = \text{DWT}(B_{mn}), \forall B_{mn} \in \{B_{mn}\} < T
\]

(3)

Then, a CZT of LL\(_{mn}\) is calculated for all decomposed blocks given in equation (4)[15].

\[
C_{mn} = \text{CZT}(\text{LL}_{mn})
\]

(4)

Then, A QR decomposition algorithm is applied in this step to matrix \( C_{mn} \) from equation (4) to calculate diagonal matrix in the following equation[15].

\[
[Q_{mn}R_{mn}] = \text{QR}(C_{mn})
D_{1m} = \text{diag}(R_{mn})
D_{mn} = \text{zeros}(R_{mn})
D_{mn} = D_{1m}
\]

(5)

An SVD algorithm is applied to diagonal matrix \( D_{mn} \) so as to further decompose it as shown below in equation (6)[15].

\[
[U_{mn}S_{mn}V_{mn}] = \text{SVD}(D_{mn})
\]

(6)

On the other hand, the SVD algorithm is applied to a watermark image \( W \) in order to decompose it to three matrices of \( U_1, S_1 \) and \( V_1 \). Modified upper-triangular matrix \( R_{mn} \) and Unitary matrix \( Q_{mn} \) are combined as shown in following equation[15].

\[
C_{2mn} = Q_{mn} \times R_{mn}
\]

(7)

An inverse CZT of \( C_{2mn} \) is used to get watermarked LL sub band as shown in equation (8)[15].

\[
\text{LL}_{2mn} = \text{ICZT}(C_{2mn})
\]

(8)

Then an inverse DWT is used to get watermarked image block. Instead of using \( \text{LL}_{mn} \), a modified \( \text{LL}_{2mn} \) is used as shown in equation (9).

\[
I_{mn} = \text{IDWT}(\text{LL}_{2mn} \text{LH}_{mn} \text{HL}_{mn} \text{HH}_{mn})
\]

(9)

In the last step, modified version of blocks with low entropy, high entropy patches and all three color channels are combined in order to obtain watermarked image.

B. Extraction of Watermark:

Extraction of watermark is the same as the watermark embedding section till equation (6); the steps right from equation 1 to equation 6 are exactly same. These same steps are also applied for the extraction of watermark process. Singular values of cover frame blocks and the singular values of watermarked frame blocks are subtracted from each other, and then the singular values of the extracted watermark image is found by a divination of the subtraction result and scaling factor \( \gamma \) [15], as given below in following equation (10).

\[
S_{t'_{mn}} = (s_{mn}' - S_{mn})/\gamma
\]

(10)

\( U_1 \) and \( V_1 \) are combined to extract the watermark for each block from watermark image with the singular values found in above equation is given below in the following equation (11)[15].

\[
W'_{1_{mn}} = U_1 \times s_{mn}' \times V_1^T
\]

(11)

III. EXPERIMENTAL RESULTS

The implementation was carried out using MATLAB R2016a on a test video and a watermark image from ImageProcessingPlace.com. Transparency has been considered as the reference to measure the quality of proposed scheme. In general, an image with PSNR value equal or greater than 35 dB is considered to have got high quality. Table 1. Shows PSNR values of LSB algorithm and the PSNR values of proposed scheme.
Fig 1. Suzie.avi as cover video

Fig 2. Watermark image

Fig 3. Watermarked Suzie.avi video

Fig 4. Extracted Watermarked

Table 1. PSNR COMPARISON OF PROPOSED ALGORITHM WITH LSB ALGORITHM OF VIDEO WATERMARKING FOR THE FIRST 20 WATERMARKED FRAMES OF SUZIE.AVI VIDEO

<table>
<thead>
<tr>
<th>Range of Frame Numbers</th>
<th>PSNR(dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Using LSB Algorithm</td>
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In this paper we proposed a novel video watermark algorithm that incorporate watermark in all frames of a cover video. Firstly, cover video frames are divided into three color channels of Red, Green, and Blue and then each channel is divided into separate block. Secondly a watermark is embedded into a block with low entropy and by DWT and CZT techniques the different blocks are decomposed into frequency channels. Finally to incorporate watermark into cover video frames the orthogonal-triangular decomposition and singular value decomposition are used. From the experimental results the proposed algorithm outperforms LSB technique of video watermarking. In our future work, we will improve the algorithm to gain better performance compare to existing algorithms against different attacks.

REFERENCES:


Communications and Image Processing, pp. 1–6, Nov. 2013.


