A Novel Algorithm of Video Watermarking in DWT Domain

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Abstract- 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.

Index Terms- DWT (Discrete Wavelet transform), DCT (Discrete Cosine transform), SVD (Singular Value Decomposition), watermark

1. INTRODUCTION

Unprecedented development in the technology of computer and network, it has become easier to reproduce and redistribute the digital media. It is therefore necessary to protect the digital media from unauthorized reproduction and redistribution [1]. With the introduction of digital signal processing and digital image processing, digital watermarking has emerged as one of the possible solution to this problem. The concept of watermarking in digital image is extended to audio and video file also. In watermarking, aw watermark is inserted into a digital media which can be extracted or detected for authentication and detection purpose. The embedding process must be carried out in such a way that it cannot create any appreciable distortion in the host digital media[2]. 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.

2. RELATED WORK

In the literature, large number of watermarking algorithm for text [3][4][5], audio[6] and image [7]-[10] 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. Some of the noteworthy contribution in this field is presented in this section.
In 2002 Xiamu[11] proposed the rotation ,scaling and translation invariants watermarking scheme for video. In this approach, watermark information is inserted in the pixel along the temporal axis.
In 2006, Noorkami[12] presented a watermarking scheme by computing the motion intensity in video frames and utilizing motion intensity for inserting the watermark. Motion encoder is used for computing the motion intensity.
In 2006, Chung[13] applied error correcting code in video watermarking for keeping the degradation in host video minimum BCH and Turbo code is used in this scheme for error correction.
In 2008, Hanane Mirza[14] applied principal component analysis(PCA) for watermarking insertion in video sequence. In this approach, first of all some video scene are selected based on the colo similarity and then some of the key frames from thes video scene are extracted for watermarking insertion.
Lama rajab Tahlani[15] suggested a video watermarking algorithm which was based on the singular value decomposition(SVD). In this method first of all video is transformed into a SVD video and then watermark insertion process is applied.
Spread spectrum based video watermarking scheme is developed in 2009 by the sakib ali[16]. This scheme work in DCT domain.
Wavelet based blind watermarking scheme for video sequence is proposed by Lin in 2009[17]. In this method, a different size block of wavelet coefficients are formed and then watermark is inserted in randomly chosen such block.
In 2013, Masouumi Majid[18] presented a scheme of video watermarking which was based on the scene detection in the video. Awavelet transform is used for watermark insertion operation.
In 2013, Yung-Lung Kuo[19], presented a novel watermarking scheme in which the watermark is inserted in in the frame which has high intensity, texture and motion. This scheme help to improve the robustness of the video watermarking.
A DCT and DWT based approach for watermarking is proposed in 2012 by Wassermann[20]. In this scheme video frames are decomposed by wavelet transform and then the approximate coefficients are transformed by DCT before watermark insertion.
A video watermarking scheme for embedding the different part of the watermark in different scene of the video is presented by the Singh [21].
A video watermarking scheme which is robust against the video transcoding is presented by the Cedillo-Hernandez in his paper [22]. This watermarking scheme employed quantization index modulation in 20d DCt domain for achieving this goal.
ELM (Extreme learning machine) based video watermarking[23] and scene based watermarking scheme[24] for video watermarking are some other noteworthy contribution in this field.

3. METHODOLOGY

Basic building block of the proposed method is shown in the figure 1. There are two phase in this algorithm. First phase is watermarking embedding process and the second phase is the watermark extraction phase.
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.

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

Where
$FW_{u,v}$ = Watermarked Frame
Fi = Original frame
G = Gain factor

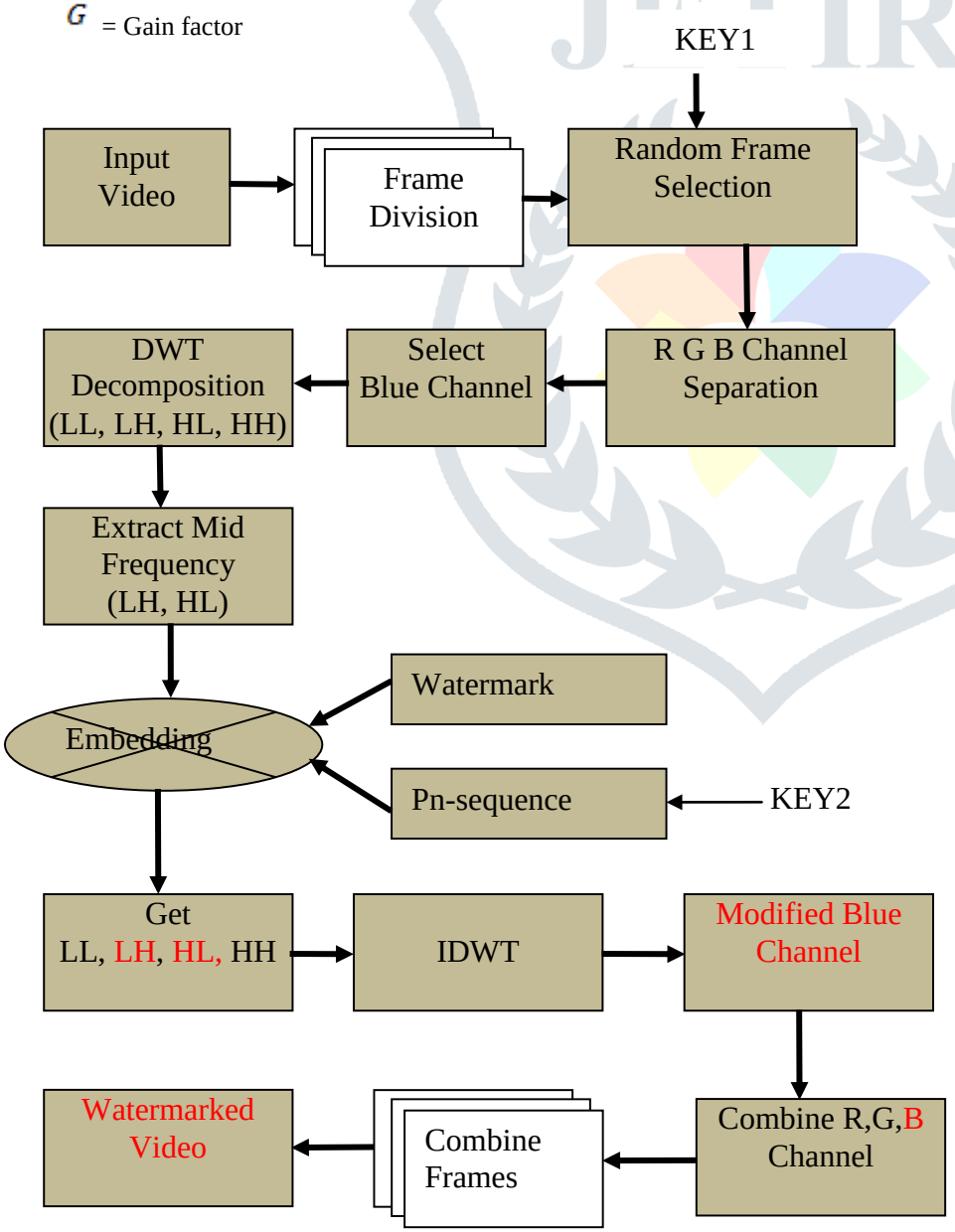

Fig.1 Block Diagram of Proposed Watermarking algorithm

pn = pseudo random number
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-
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.

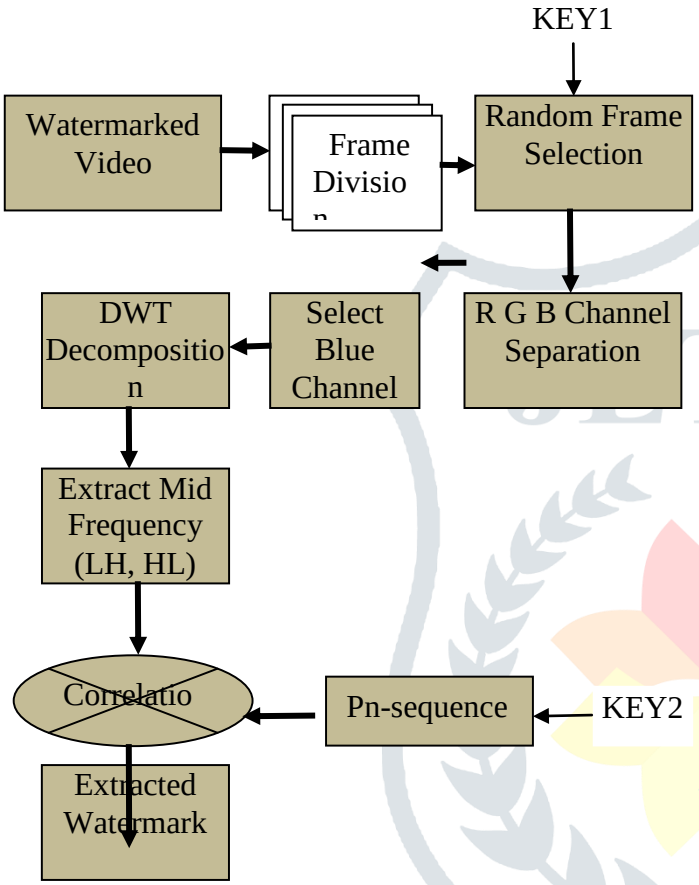

Fig. 2 watermark Extraction process

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.

4. EXPERIMENTAL RESULTS

In order to test the proposed method, three different video has been taken. Two of them are standard video and one is taken from the MATLAB directory .

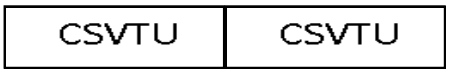

Fig. 3 Original (Left) and Extracted Watermark (right)

Fig. 4 Three different video for watermarking algorithm Rhino.avi (upper), coastguard.avi (middle) and akiyo.avi (lower)

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

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

Here

P = is the row or column dimension of Host frame

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

I = Original host Frame

$I^{'}$ = watermarked Frame

M= Number of rows in original frames

N= Number of Column in Original frame

Table 1 PSNR and MSE Comparison

Video	**PSNR between Original and watermarked Video**	**MSE between Original and watermarked Video**
01.avi	49.5159	0.4217
02.avi	51.7603	0.4498
03.avi	56.3135	0.5628
04.avi	55.4555	0.5733

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

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

W = Original Watermark

$W^{'}$ = Extracted Watermark

Table 2 Normalization Coefficient Comparison

Video	**Normalization Coefficient between Original and Extracted Watermark**
01.avi	0.9939
02.avi	0.9983
03.avi	0.9961
04.avi	0.9999

Table 3 NC for different Gain value

Video	**Value of gain Coefficient(G)**	**Normalization Coefficient between Original and Extracted Watermark**
01.avi	0.25	0.9999
	0.35	0.9999
	0.45	0.9998
	0.55	0.9998

Table 4 PSNR and MSE Comparison for different Gain Value (G)

Video	Gain (G)	PSNR between Original and watermarked Video	MSE between Original and watermarked Video
01.avi	0.25	49.5159	0.4217
	0.35	47.3660	0.6439
	0.45	47.3428	0.5914
	0.55	47.1041	0.5826

5. CONCLUSION

In this paper, a video watermarking scheme based on wavelet decomposition has been presented. Watermark is embedded in the randomly selected frames. Blue channel of the frames has been chosen for embedding. Watermark is embedded in mid frequency component to make it robust against the low frequency attack. PSNR , MSE and Normalization coefficients are computed for the validity of the proposed method. From the computed value it is evident that this scheme is able to embed the watermark without any appreciable degrading in the video. The quality of the extracted watermark is also same as that of the original one. Apart from this, because of using two key, the security of the scheme is also doubled.

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