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A Robust Video Watermarking Scheme In DWT domain Using Selective Row Extraction

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Abstract—

Watermarking in video is one of the most efficient method for video authentication. Apart from applied in image and audio, watermarking can be extended to the video sequence as well. In this paper, a very efficient and secure watermarking is proposed for protecting the video from unauthorized person. In proposed method three rows from each frames are selected randomly and form the new frame in which the watermark is embedded in the DWT domain. After embedding the watermark all the rows of the frames are placed in their position in the respective frames to get the watermarked video. Experimental results shows that that this method is able to achieve optimum performance

***Keywords*— DCT (Discrete Cosine Transform), DWT(Discrete wavelet Transform), SVD(Singular value Decomposition), contourlet Transform(CT).**

I. INTRODUCTION

Interchanging the information between different people in the world has now become common. The advancement in information technology has led us to share the information with one another.

Video sharing site like U-tube, social site like face-book and wat's up has enable the people to share their video with other in the whole world.

Earlier due to the low data rate technology deterred the people to share the video on the internet But with the emergence of high speed 3G and 4G network has increased the sharing of video in internet. One of the disadvantage of sharing the video or any other information in the internet is that any other unauthorized person can use these information without permission and even temper the video or republish this video for fulfilling its own interest. This poses biggest challenges to the user who want to share their information in the internet. The researcher were always in search of some kind of algorithm which can be used to add some security to video or other digital media[1]. Digital watermarking emerged as one of the possible solution to this problem. In digital watermarking, an ownership information is hidden inside the video in the form of digital watermark. A digital watermarking can be used in text audio image as well as in video also. All the digital image watermarking techniques can be applied to the digital video watermarking because of the fact that the video is basically composed of different images taken in different time slots which is called frames.

The video or audio or image in which the information is embedded is called cover media.

The volume of digital information which can be successfully embedded or hidden in the cover media

is known as the payload. Due to the large size of the video as compared to the image, video watermarking also suffer the problem of managing the large volume of video data. In any watermarking algorithm, watermark is embedded into the host media or cover media directly (like Least significant bit method) or in to the transformed edition of host or cover media.

The embedded watermark is basically used for authentication purpose. Only the owner knows the method to extract out the embedded watermark therefore no one can temper the watermark in digital media and hence it is protected by unauthorised person. One of the requirement of the watermarking algorithm is that it must be efficient enough to produce least distortion in the host file or host media [2]. In past most of the research has been carried out on image watermarking while watermarking in video has witnessed little research work. Since video is basically consists of number of frames therefore video watermarking techniques can be divided into two different approaches. First approach is known as frame by frames approach in which the watermark is embedded in to a different frames. While the other approach is block based approach in which block of frames are selected to embed the information. In this paper a frame by frame approach is proposed for watermark embedding in video sequence. Since transform domain approach is more robust and secure therefore transform domain approach is preferred in this proposed method. In the transformed domain based approach, the cover media is transformed in to different frequency component and then watermark information is inserted in to the frequency bands. After embedding the watermark information in to the frequency band, reverse transformation is applied to convert the host file in to original time domain.

Next section of this paper review some of the past noteworthy research work in video watermarking.

II. RELATED WORK

Review of the past literature in the field of watermarking reveals that previously a significant number of watermarking approach or methods have been proposed in text watermarking[3][4][5], watermarking in audio[6] and image watermarking[7][8][9][10].In these approaches, cover media is modified for embedding the wartermark.

Like image watermarking, video watermarking algorithm can also be divided in to two different approaches. The first one is the frequency domain approach and the second one is spatial domain approach. Bothe approaches has some advantages and some disadvantages. Next section present some of the noteworthy research work in video watermarking.

A video watermarking approach which is invariant to scaling rotation and translation is proposed by Xiamu[11] in 2002. In this scheme, he inserted a watermark in to the pixel which lies along the temporal axis.

In 2006, Noorkami[12] suggested a motion intensity based approach for video watermarking. In this approach, motion intensity is estimated in the video frames and then this information is used for embedding the watermark in the frames. He also proposed a motion encoder for computing the motion intensity in the video frames.

In 2006, Chung[13] suggested video watermarking method to minimize the degradation in the cover video. In his method he applied error correcting code for improving the video quality of the host video. In his approach BCH and turbo code is used for correcting the error produced during the transmission of the video.

Principal component analysis (PCA) is one of the method which is also used for image watermarking. In 2008, Hanane Mirza[14] suugested PCA based approach for video watermarking. In this method, color similarity is used for selecting the scene in which the watermark is to be embedded. Some of the frames of this selected video scene is used to embed the watermark. PCA is used for embedding the watermark.

Apart from DWT, PCA singular value decomposition(SVD) is also frequently used in image watermarking. Lama rajab Tahlani [15] introduced a SVD based approach for video watermarking . his scheme is just an extension of the SVD approach in image watermarking. In this method, first of all, SVD transformed video is obtained from the original video sequence and then watermark is embedded in the SVD transformed video.

In 2009 sakib ali[16] introduced a spread spectrum based video watermarking scheme. In this scheme, video is converted in to a DCT domain and then watermarking is applied in DCT domain.

In 2009, Lin in[17] suggested a new video watermarking scheme which was based on the wavelet decomposition. His watermarking scheme is blind watermarking scheme. In his scheme he first formed the block of wavelet coefficient having different size. The some of the block are chosen randomly for embedding the watermark. The results reveals its robustness and security.

In 2013, Masouumi Majid[18] suggested another scene detection based video watermarking algorithm. In this approach first of all, a scene is detected in the video and then this section of the video is transformed in to the wavelet domain in which the watermark in inserted.

In 2013, Yung-Lung Kuo[19], suggested different approach for inserting the watermark in the video sequence. He proposed, intensity, texture and motion property of the frame for watermark insertion. All the frames which full-fill the above mentioned properties are selected for watermark insertion. The experimental results shows its high robustness.

In 2012 wassermann[20] presented a double transform based video watermarking scheme. In his schema, he used both DWT and DCT transform for embedding the watermark in the video. In his approach first of all the frames are decomposed in to DWT coefficients and then low frequency coefficients are again DCT transformed. This DCT transformed version of the frames are used for embedding the watermark.

Different scene in the video can also be used for embedding the watermark information in video file. This fact is utilized by the singh in his paper [21]. In this scheme first of all different scenes and its frames are selected and then watermark is embedded in these frames.

Cedillo-Hernandez in his paper [22] suggested a video transcoding invariant video watermarking scheme. In this scheme they used QIM(quantization index modulation) in DCT domain for making video watermarking invariant to video transcoding.

III. METHODOLOGY

Since Video is basically a sequence of still images which are known as the frames. In our proposed method, we have introduced a digital watermarking algorithm for video sequence. In this method, first of all, a video is taken and converted in to frames. Then Number of frames in a video is stored in a variable. Blue channel of each frame is selected and 3 consecutive row from each frame is extracted and stored in a new frame which work as a host file. Once three rows from all the frames are extracted and stored in a new frame then we take the discrete wavelet transform of the new frame. Watermark is selected and embedded in a new frame as describe in a next section. Once watermark is embedded then we take the inverse discrete wavelet transform of the new frame to convert it into a time domain. This new frame is called watermarked frames. From the watermark frames, a group of three rows are extracted consecutively and stored in the blue channel of their respective frames. These frames are combined to get the video. This video is a watermarked video i.e. watermark is embedded in this video. In the whole algorithm number of rows which is to be extracted from the each frames are flexible. If we take more number of rows from each frame then the size of host file is large. Watermark embedding and extraction is robust but it requires more processing time.

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 watermark embedding process are as follows

Step 1: Input the video.

Step 2: Convert the video into frames.

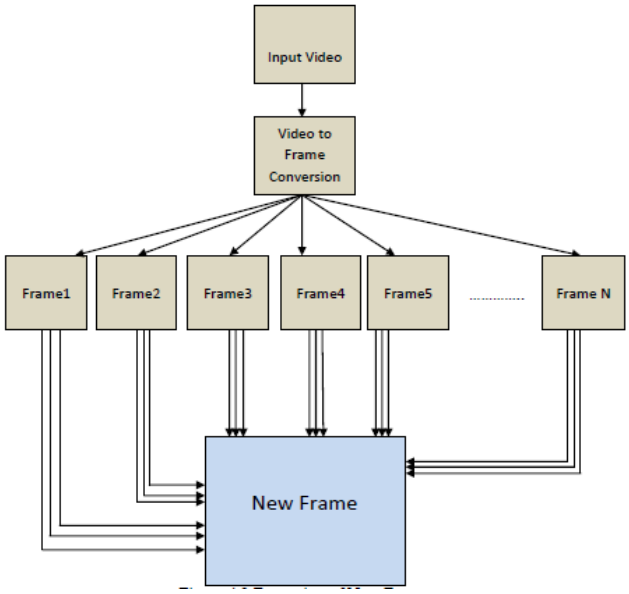

Figure 1 Video to Frame conversion process

Step 3:Select the frames one by one.

Step 4: Extract first three rows of all the three channel (Red, Green and blue) from each frames.

Step 5: Repeat step 4 for all the frames and form the new frame.

Step 6: Select the Blue channel of this new frame.

Step 7: Decompose the blue channel of New frames 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 8: Extract the mid frequency band(LH and HL).

Step 9: With the help of Key1, generate a random pn-sequence.

Step 10: 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

pn = pseudo random number

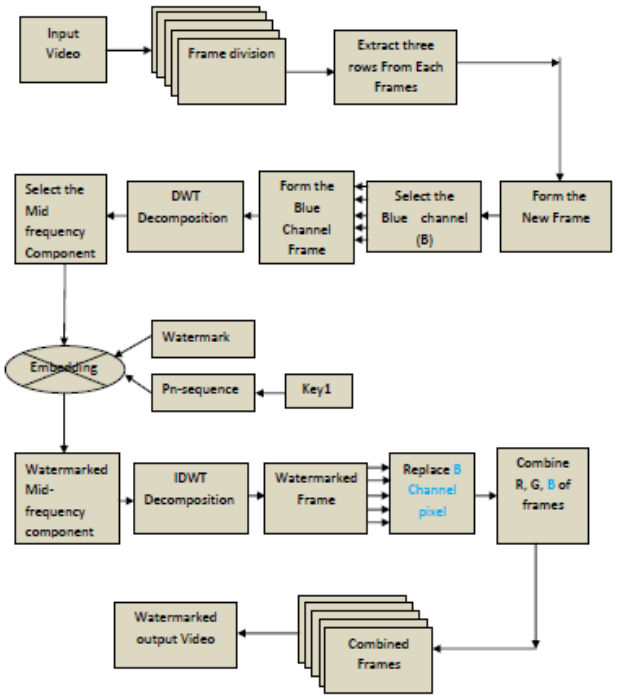

Figure 2 Block Diagram of Watermark Embedding Process

Step 11: Combine the HH, LL and watermark embedded mid frequency band LH and HL.

Step 12: Perform the IDWT (Inverse discrete wavelet transform) to get the watermarked New frame.

Step 13: Replace group of three rows to blue channel of their respective frames.

Similarly the algorithm steps for watermark extraction are as follows-

Step 1: Input the watermarked video.

Step 2: Convert the video into frames.

Step 3:Select the frames one by one.

Step 4: Extract first three rows of all the three channel (Red, Green and blue) from each frames.

Step 5: Repeat step 4 for all the frames and form the new frame.

Step 6: Select the Blue channel of this new frame.

Step 7: Decompose the blue channel of New frames 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 8: Extract the mid frequency band(LH and HL).

Step 9: With the help of Key 1, generate the random pn-sequence.

Step 10: Compute the correlation between mid frequency component HL,LH and pn-sequence with the help of following formula.

$$Msg = \begin{cases} 0 & if\ CM > Threshold \\ 1 & else \end{cases}$$

Here,

CM= Correlation Matrix between HL,LH and Psudo-random Number

Threshold= A fixed value (Generally taken as mean of correlation Matrix)

Step 11: 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 three particular rows of all the frames are collected and form 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 more.

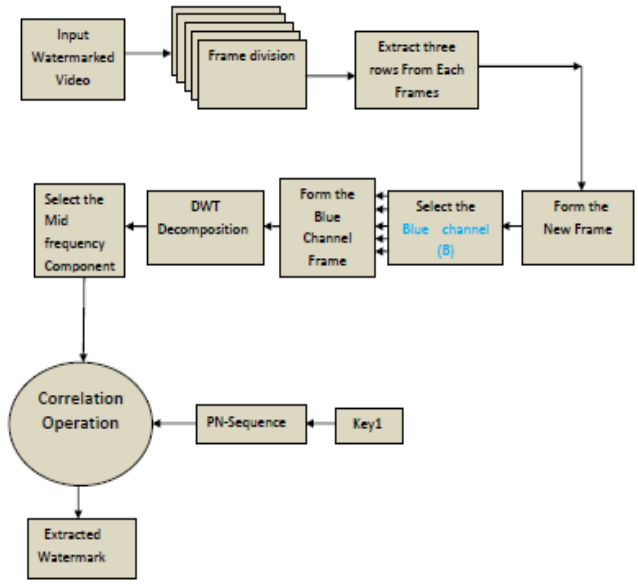

Figure 3 Block Diagram of Watermark Extraction Process

IV. EXPERIMENTAL RESULTS

In order to test the proposed method, three different video has been taken. Two of them are standard video i.e. “costguard.avi”, “akiyo.avi” and one is taken from the MATLAB directory i.e. Rhino.avi. Watermark image is also taken for embedding purpose. Each of above mentioned video is taken one by one and given as input to the simulation program designed for the proposed algorithm.

Figure 4 Rhino.avi Video

Figure 5 Costguard.avi Video

Figure 6 Akiyo.avi video

The three different video which are taken for testing purpose is shown in the figure given below

New frame obtained by taking "rhino.avi" as the input video for the simulation program is shown in the figure 7.

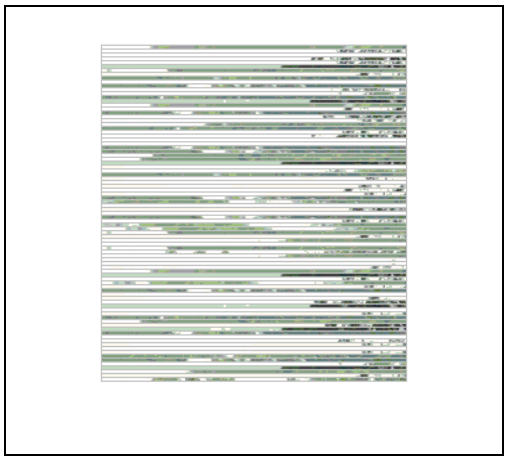

Figure 7 Frame obtained after extraction of rows from the selected frames of video "rhino.avi"

Once the embedding process and inverse discrete wavelet trnsfoem is applied, the watermarked frame is obtained which is shown in the figure 8

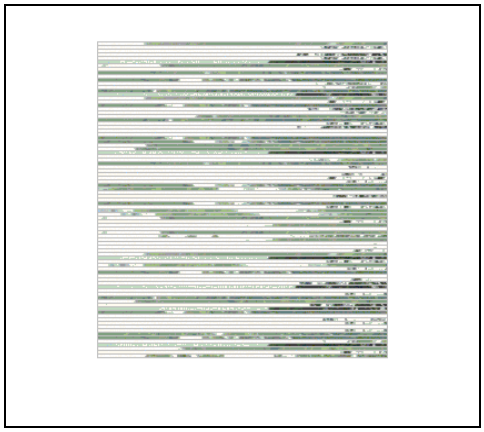

Figure 8 Frame after Watermark Embedding

Original watermark which is embedded in the input video is shown in the figure 9 while the extracted watermark is shown in the figure 10

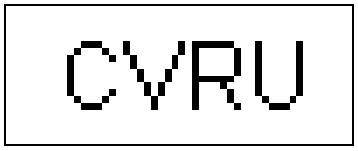

Figure 9 Original Watermark

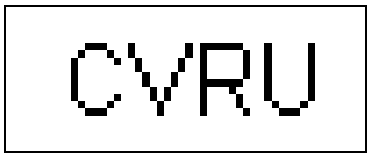

Figure 10 Extracted Watermark

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**
Rhino.avi	66.2903	0.5220
Akiyo.avi	39.9675	1.2051
Coastguard.avi	39.5734	1.2171

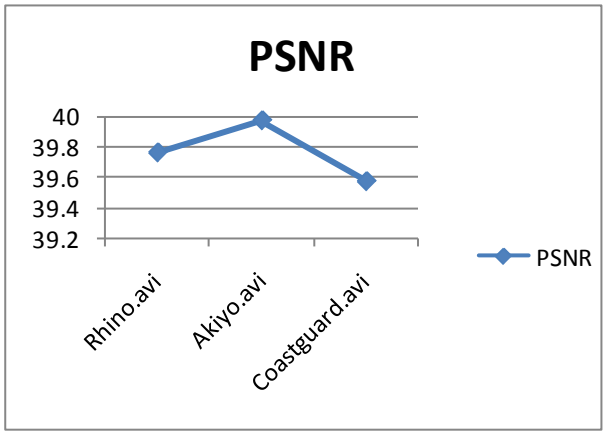

Figure 11 Graph of PSNR obtained for different Video

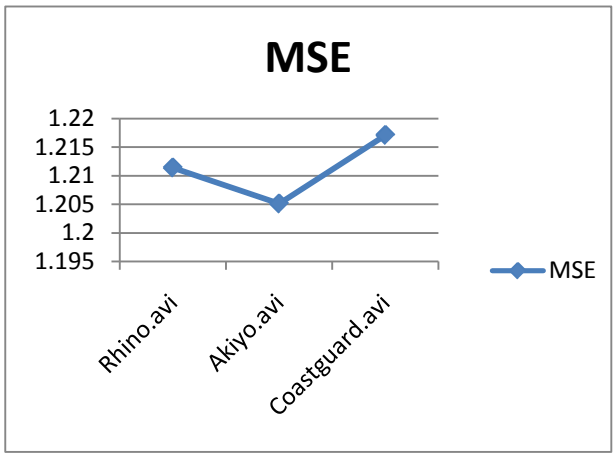

Figure 12 Graph of MSE for different Video

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**
Rhino.avi	0.9994
Akiyo.avi	0.9999
Coastguard.avi	0.9999

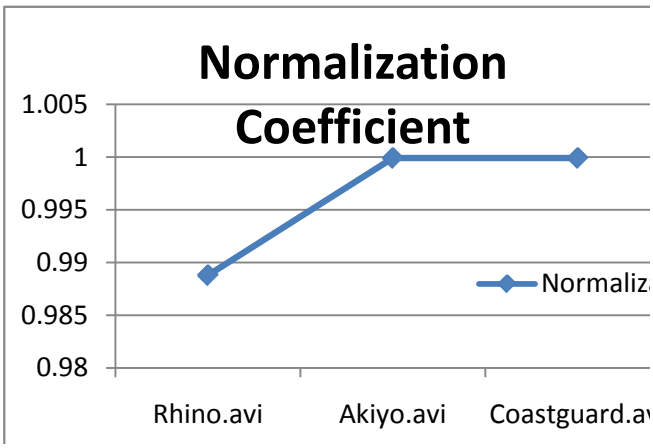

Figure 13 Graph of normalization coefficient for different videos

Table 3 NC for different Gain value

Video	**Value of gain Coefficient(G)**	**Normalization Coefficient between Original and Extracted Watermark**
Rhino.avi	0.25	0.9888
	0.35	0.9999
	0.45	1.0
	0.55	1.0

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**
Rhino.avi	0.25	39.7596	1.2114
	0.35	37.3660	1.2890
	0.45	37.3428	1.2898
	0.55	37.1041	1.2981

V. CONCLUSION

This thesis presents a DWT based video watermarking algorithm that embed the watermark in all the frames. A randomly generated psudo random number is used for embedding the watermark in randomly selected frames which enhance the security of the watermark while keeping the quality of cover frame almost intact.

Proposed watermarking technique has following advantages:

- Since we are using mid frequency component for watermark embedding therefore this method is able to extract watermark under high frequency and low frequency attack.
- In this project since we are using key for PN sequence, therefore this method shows better security.
- This method do not produce any appreciable distortion in cover image and hence keep the quality of video intact.

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