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A Robust and Secure Method of Copyright Protection for Digital Videos using Split Watermark Embedding Algorithm : SWEA

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ABSTRACT

In the current scenario, Copyright Protection of the digital media is a serious issue and watermarking is an important method of protecting the intellectual property and copyright of the digital media. In this paper, we proposed a robust and secure algorithm SWEA (Split Watermark Embedding Algorithm) for digital videos. SWEA has three important parts, first one is splitting of original watermark into small pieces, second is embedding of the small pieces of watermark into the detail coefficients of identical frames (I Frames)of digital video and the third is extracted these small pieces and merge them in an efficient manner. Watermark data is inserted into the detail coefficients in an adaptive manner based on the energy of high frequency. The proposed algorithm has undergone various attacks, such as compression, uniform noise, Gaussian noise frame repetition and frame averaging attacks. The proposed algorithm, sustain all the above attacks and offers improved performance compared with the other methods from the literature.

Keywords : SWEA, DWT, I-Frame, Detail Coefficient, H.264, MPEG-4., SCD

I. INTRODUCTION

The future growth of the domestic digital copyright protection products basically depends on real network and Microsoft windows media. A huge amount of multimedia data has been exchanged with the internet but the security is provided to protect the data is not enough. There are various approaches for data security such as steganography [1], fingerprinting and copyright protection etc. In this paper we have introduced a new copyright protection technique i.e. SWEA. For this, a block of digital watermark or digital pattern (text, image, audio or video) is inserted inside Digital Video Frames. In this paper, digital video copyright protection using DWT [1]-[5] is proposed. Extraction of I-frame, watermark pre-processing, watermark embedding and extraction, piracy tracking are implemented. In the case of SWEA, it is very hard to detect the original pattern of inserted watermark. In this paper, the robustness and security of inserting a digital pattern or watermark and transparency of watermarked media is improved using SWEA.

In Figure 1 we are showing the block diagram of our algorithm. Here we have applied SWEA (Split watermark embedding algorithm) algorithm on original watermark and SCD (Scene changed detection) algorithm on original video. Now to extract the watermark, apply the de-watermarking algorithm on watermarked video.

The rest of the paper is organized as follows: In Section II, the Proposed Scheme is illustrated which explains the embedding and extraction of the watermark from video sequence. Section III shows some experimental results and evaluates the performance of the proposed technique. At the end, conclusions are drawn in Section IV and provide some future work directions.

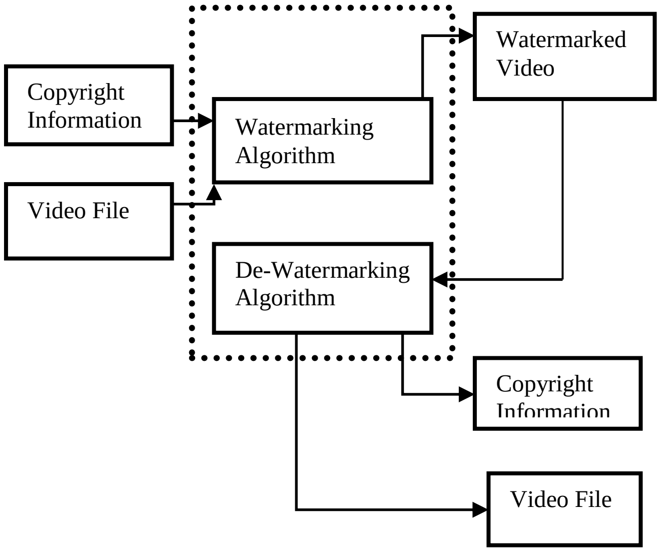


Figure 1. Block Diagram of Video Watermarking

II. PROPOSED WATERMARKING TECHNIQUE

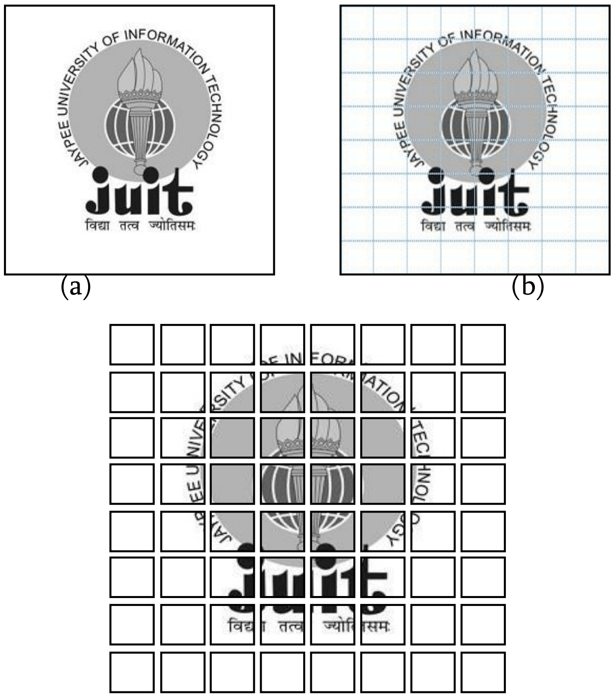
A gray level image (256 x 256) is used as a watermark signal. For embedding the watermark we have taken 'Foreman' video sequence. After applying scene changed algorithm [6] on these video sequences, 77 scenes changed frames are obtained. Before embedding the watermark inside the original video, preprocess the watermark and input video.

2.1. Watermark Pre-Process

For the process of watermark embedding, scale the watermark to a particular size with the help of equation 1. Fig. 1 shows an original watermark juit.jpg (256 x 256).

$$\left(4^n \le m;\ n > 0\right) \qquad (1)$$

Where m is the total no. of scene changed frames and 4^n is the total number of split watermark in which n is an integer. In this case, the watermark will be divided into 4^n smallimages using SWEA that are shown in Figure 1.



(a) (b)

(c)

Figuer 2. Watermark Pre-process
(a) Original Watermark. (b) Split watermark in 8x8 using proposed algorithm. (c) 64 small pieces of original watermark.

The MPEG-4 video coding standard has the sequence of GOPs (group of pictures) and each GOP has 12 frames of images which are managed as IBBPBBPBBPBB where I, P and B areidentical frame, predictive frame and Bidirectional frame respectively.

2.2. Video Pre-Process

In Figure 2, a scene changed detection algorithm is applied on input video sequence and get the non-overlapping GOP [7], [8]. Select the I-frame with the help of the identical frame selection scheme. After getting the I-frames, apply 2-level DWT and embed the watermark information.

2.3. Watermark Embedding Algorithm

1. Apply a scene changed detection algorithm [6] on the original video sequence (O_{video}) and then divide the each scene into non-overlapping

group of pictures. Each group of pictures has an Identical frame (I). Select all the I-frame from input video for embedding the watermark.

$$WmI_i = k \times (Lf_2) + q \times (Wm_2)$$

Where WmI_i is watermarked I frame, Lf_2 is low frequency approximation of original frame, Wm_2 is low frequency approximation of watermark image, k & q are scaling factors.

2. Let W = Digital Watermark Image (256 x 256). Generate small blocks of digital watermark using the proposed algorithm in which $4^n \le m$. Where 4^n is the total number of small blocks of the watermark (W1, W2…… W (4^n)). N is the number of rows or columns of split watermark images and m is the total number of scenes changed identical frames.

3. Size of watermark block (x,y) = $\left[\left(\sqrt{4^n}\right) * \left(\sqrt{4^n}\right)\right]$

4. while m ≥ 4^n, $I_i = W_{4^n} I_i$, I_i is Original identical frame (where small blocks of watermark has to be embedded), $W_{4^n} I_i$ = watermarked identical frame, i = 1,2,3……………m, 4^n = total number of watermark pieces and n > 0.

5. Take 2 level 2 dimensional DWT of I_i
   for i = 1 : m
   [Ca_i, Ch_i, Cv_i, Cd_i] = DWT2(I_i, "haar")
   j=i+1
   [Ca_j, Ch_j, Cv_j, Cd_j] = DWT2(Ca_i, "haar")

6. Insert first block of watermark into detail coefficients of step 5 which are Ch_i, Cv_i, Ch_j, Cv_j. Now , mod Ch_i, mod Cv_i, mod Ch_j, mod Cv_j are the modified coefficients of watermark inserted identical frame.

Take IDWT of watermark inserted identical frames. Finally, get the watermark inserted frame. Let Watermark inserted frames = W_f, where f=1,2,3……………………2^n.

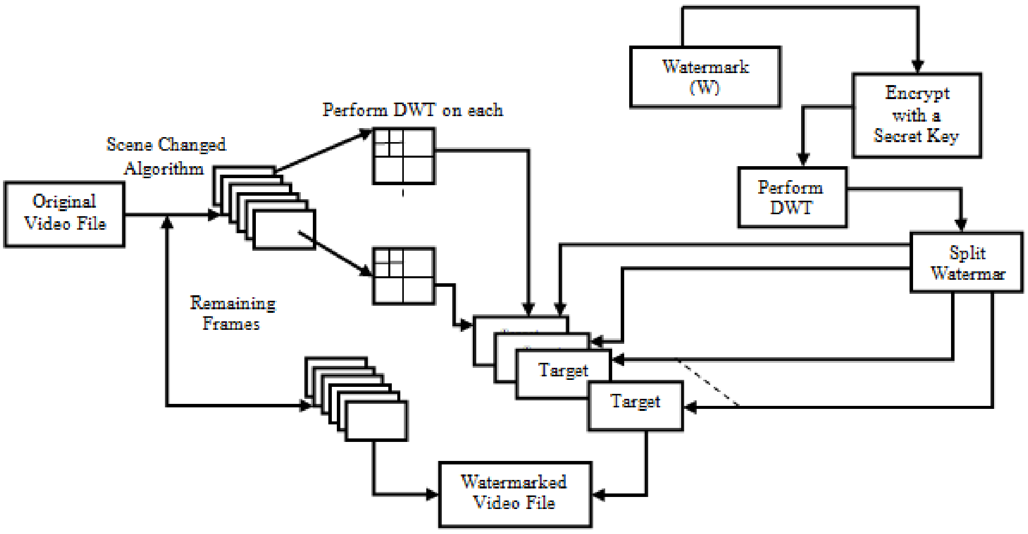


Figure 3. Video Pre-process

2.4. Watermark Detection Algorithm

1. Apply a scene changed detection algorithm [6] on the watermarked video sequence (Wvideo) and then divide the each scene into non-overlapping GOPs. Select all I frames from input watermarked video. Take the watermarked frame (Wf) (I-frame) and original identical frames (Ii). Apply DWT on both watermarked image and identical frames.

2. Subtract first level detail coefficients of the watermarked frame from the first level detail coefficients of original I frame which are mod Chi, mod Cvi, Chi and Cvi respectively.

Now, NewChi = mod Chi - Chi

NewCvi = mod Cvi – Cvi

3. Calculate cross correlation between the new values of detail coefficients (NewChi and NewCvi) and the detail coefficients of original watermark.
4. If correlation = high

Then, Stop the execution. Detected watermark is similar to original watermark.

else

Take both detail coefficients together and repeat from step 3.

else if

Take 2-level detail coefficients and repeat from step 3 until the detected watermark will get similarity with original watermark.

else

Watermark not found.

2.5. Merging small pieces of watermark images

Propose watermark split and detection algorithm on the watermarked I-frames, collect all the small pieces of watermark picture and embed one after another. Vertical and horizontal axes of final matrix picture have the same rule. Now Scan xy where x = number of rows and y = number of columns. These pictures are stored in the program folder with the same name. With the help of 'for' loop all grayscale images are used. Total no of scene changed frames are 77 for foreman video.

Now with the SWEA- : 43 ≤ 77 for n =3. Then, the watermark is divided into 4n smallblocks are 64.
Now, size of watermark block for foreman video = 8 x 8.

Now applied watermark detection algorithm on the watermarked I frames and collect all the small pieces of watermark picture. When one picture stops, a new picture always starts. It means that these pictures are not having over-end points. Vertical and horizontal axes of final matrix picture have the same rule.

Now Scan xy

Where x = number of rows

y = number of columns

We have the pictures of an object with the help of a proposed watermark split algorithm. These pictures are stored in the program folder with the same name given by the proposed watermark split algorithm.

This algorithm creates a new empty image frame. With the help of 'for' loop all grayscale images are used. In Matlab, 'imread' function is used to read images.

These empty image frames are composed from the read images & finally, the output image is created.

In Figure 5 we have smaller pieces of split watermark and in Figure 6 we have shown the process of merging the small pieces of split watermark. In the next part it has been shown in the form of a matrix.

$$\begin{pmatrix} \text{img}[1] & \cdots & \text{img}[n] \\ \vdots & \ddots & \vdots \\ \text{img}[n] & \cdots & \text{img}[n] \end{pmatrix} = \begin{pmatrix} [n[k]\,m[l]] & \cdots & n[k]m[l] \\ \vdots & \ddots & \vdots \\ n[k]m[l] & \cdots & n[k]m[l] \end{pmatrix} = \left[\sum_{i=1}^{n} n_i[k] \sum_{i=1}^{n} m_i[k] \right]$$

In our example we have taken a watermark image that has the dimension of 256 x 256 and we obtain total no of scene changed frames 77 and 97 for Foreman video and Car race video respectively. Now with the help of the proposed watermark split algorithm generate small blocks of digital watermark as follows for Foreman video.

III. EXPERIMENTAL RESULTS

To implement SWEA, original video 'Foreman' at the dimension of 352 x 288 and the size of the original watermark image is 256 x 256 are used. Fig. 3(a) shows original video frames and 3(b) watermarked frames using SWEA, 3(c) extracted watermark pieces and 3(d) extracted watermark. TABLE I shows the results, when the size of inserting a watermark is small, the PSNR of watermarked frame will reach too high.

(a)

(b)

(c)

Figure 4. SWEA algorithm on Foreman Video. (a) Original Frames of Foreman video. (b) Watermarked frames of Foreman video. (c) Extracted watermark.

	Gamma correction 0.5	Gamma correction 2	Gamma correction 4
Attacked frame	 PSNR=25.34 dB	 PSNR = 19.80 dB	 PSNR = 13.54 dB
Extracted watermark			

Figure 5. Block Diagram of Video Watermarking

Table 1. Experimental results for car race video.

Size of inserted watermark	PSNR (dB)	MSE
8 x 8	40.1001	6.3544
16 x 16	39.6682	7.0188
32 x 32	39.4523	7.3765
64 x 64	39.4006	7.4648
128 x 128	39.3987	7.4893
256 x 256	39.3812	7.4982

TABLE **2.** EXPERIMENTAL RESULTS FOR WAKNA ROAD VIDEO.

Size of inserted watermark	PSNR	MSE
8 x 8	42.3011	5.9673
16 x 16	41.8764	6.2643
32 x 32	41.1354	6.9065
64 x 64	39.8731	7.3108
128 x 128	39.4521	7.6874
256 x 256	39.0142	7.8432

IV. CONCLUSION

The proposed approach is more efficient because the watermark has been divided into small pieces and every piece of watermark has a very low space. So it increases the imperceptibility of watermarked frame just because of its small size. The proposed approach also increases privacy and security of the original watermark because it is very hard to detect the pattern of inserted watermark by using splittance technique.

Video watermarking is an essential need of copyright protection and a lot of research is still going on to find out the new methods for security and privacy of the multimedia contents. Current methods for video watermarking are extended form of image watermarking and there is a great scope of innovation. Research can be carried out to establish new strategies for digital video copyright protection which makes the system more robust and efficient.

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