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An Efficient Video Watermarking Using Color Histogram Analysis and Biplanes Image Arrays

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ABSTRACT
Video watermarking is a novel technology that has the ability to solve the problem of illegal digital video manipulation and distribution. In video watermarking, the copyright bits are embedded into video bit streams. This paper proposes an effective, robust and indiscernible video watermarking algorithm. A video can also undergo several intentional attacks like frame dropping, averaging, cropping and median filtering and unintentional attacks like addition of noise and compression which can compromise copyright information, thereby denying the authentication. In this paper, the design and implementation of SVD and multiple bit plane image based watermarking is proposed. The developed method embeds 8 bit-plane images, obtained from single gray scale watermark image, into different frames of a video sequence. In this algorithm, some of the luminous values in the video pictures are selected and divided into groups, and the watermark bits are embedded by adjusting the relative relationship of the member in each group. A sufficient number of watermark bits will be embedded into the video pictures without causing noticeable distortion. The watermark will be correctly retrieved at the extraction stage, even after various types of video manipulation and other signal processing attacks.
Keywords— video watermarking, SVD, bit-plane images

I. INTRODUCTION

Music, Images and Video are the digital data that can be easily reproducible over information networks and Vulnerable to various types of attacks. Hence, there is an urgent need of copyright protection for such forms of data. As a result of these consequences, creators of digital data are diffident to provide access to their own digital scholarly property. Digital watermarking has been propositioned as a means to identify the owner and dissemination path of digital data. Creating Digital watermarks for digital data address this issue by embedding owner credentials candidly into the digital data.

When there is a problem with ownership, the information can be extracted to entirely distinguish the owner or distributor of the data. The main aim of this paper is to hide the information in the video for the security purpose.

A. Video Watermarking

As digital video-based solicitation technologies grow, such as Internet video, wireless video, videophones, and video conferencing, the problem of illicit copying and circulation of digital video rises more and more, thus crafting copyright predicament for the multimedia industry in customary, and to the audio-video industry in specific. Many researches and technologies were propositioned to offer procedures to elucidate the problem of illegitimate copying and exploitations of digital video. An appealing method that has been suggested a decade ago to instigate copyright information in multimedia documents is digital watermarking.

Video watermarking methodologies can be categorized into two principal categories based on the technique of hiding watermark information bits in the host video. The two principal categories are spatial domain watermarking a transform-domain watermarking. In spatial-domain watermarking techniques, embedding and detection are executed on spatial pixels values (luminance, chrominance, and color space) or on the complete video frame. Spatial domain techniques are tranquil to implement, however they are not robust against customary digital signal processing operations such as video compression. Transform-domain techniques, on the contrary, modify spatial pixel values of the host video according to a pre-governed transform. Frequently used transforms are the Discrete Cosine Transform (DCT), the Fast Fourier Transform (FFT), the Discrete Wavelet Transform (DWT), and the Singular Value Decomposition (SVD). Transform-domain watermarking techniques substantiated to be more robust and imperceptible contrasted to spatial domain techniques since diffuse the watermark in the special domain of video frame, making it very arduous to remove the embedded watermark. The paper discusses two distinct blind, imperceptible and robust video watermarking algorithms centered on Singular Value Decomposition (SVD). Each algorithm embeds the watermark in the transform-domain

II. PROPOSED METHOD

In the method proposed, a gray-scale image is used as watermark signal. The gray-scale image is first converted into multiple bit-plane images. These multiple sets of bit-plane images are embedded in the original video pictures. Only one set of a single bit-plane image are used for embedding in all the video frames of a single scene. When the scene change occurs, another set of bit-plane image is used to embed. So all the frames in a scene contain the same watermark information and different scenes of a video embed information of different watermarks. The decomposition of gray scale image into 8 bit plane image is shown in figure 1.

The first proposed algorithm for video watermarking is based on transforming the host video using the SVD operator and then embedding the watermark information in the S, U, or V matrices in diagonal-wise manner. The proposed algorithm consists of two techniques, the former embeds the watermark into the original video clip, whereas the latter extracts it form the watermarked version of the digital video clip. Foreground pixels are only embedded into the watermark.

A. Watermark Embedding

The video watermarking algorithm proposed will embed the each bit plane image of gray scale watermark into the Y channel of each video picture of same scene. Different bit-plane image of watermark is embedded into different scene of the video.

The details of the watermark embedding processes are the follows:

- Use the frame change detection algorithm and find the different frames in a video.
- Get the luminous channel of the video picture and divide it into non-overlapping 8×8 blocks.

In this, 7 triple groups of luminous values are selected, and are used to embed the watermark. These groups are presented in TABLE 1 and they are marked from A to G in alphabetical order, and each group contains 3 luminous values and the number next to the letter represents the order in its group. Get 7 bits watermark from the binary watermark image, if there are no 7 bits, and then get the rest. For each 8×8 blocks, embeds 1 bit watermark frame to each selected luminous value in the order group A to group G.

Suppose that group A is the current group, and m is the current watermark bit, m can be 0 or 1. When m=0, then A2 should be the absolute maximum of group A, if A2 is not maximum, exchange the value of A2 with the maximum of group A. When m=1, then A2 should be the absolute minimum of group A, if A2 is not minimum, exchange the value of A2 with the minimum of group A.

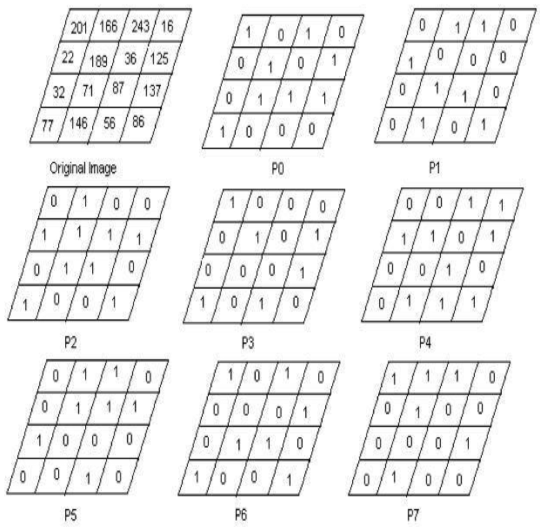

Figure 1: Bit decomposition of 8-bit watermarking image signal [P0 is the least-significant bit (LSB) and P7 is the most-significant bit (MSB)].

TABLE 1: GROUP OF 8×8 LUMINOUS VALUES

						G1	G2
					F1	F2	G3
				E1	E2	F2	
			D1	D2	E3		
		C1	C2	D3			
	B1	B2	C3				
A1	A2	B3					
	A3						

After the 8×8 blocks has been embedded watermark bits rebuilt the video picture, and reconstruct the entire video using each embedded video pictures.

A. Frame Change Detection

The color histogram of an image can be computed by dividing a color space, e.g., RGB, into discrete image colors called bins and counting the number of pixels falling into each bin. The difference between two images I_i and I_j based on their color histograms H_i and H_j can be formulated as

$$d(Ii,Ij) = \sum_{k=1}^{n} \text{abs}(\text{Hik} - \text{Hjk})$$

The above relation denotes the difference in the number of pixels of two image that fall into same

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bin. In the RGB color space, the formula (1) can be written as

$$d_{RGB}\,(Ii,Ij) = \sum_{k}^{n} \mathrm{abs}(\mathrm{Hik} - \mathrm{Hjk}) + \big(\mathrm{abs}(\mathrm{Hik} - \mathrm{Hjk})\big) + (\mathrm{abs}(\mathrm{Hik} - \mathrm{Hjk})))$$

Color histogram is used for detecting the changes in the successive video frames. Each video picture frame is converted into RGB image. For each RGB image $d_{RGB}(I_i, I_j)$ is calculated using equation (2). The average of $d_{RGB}(I_i, I_j)$ is compared with a predefined threshold value. A value of $d_{RGB}(I_i, I_j)$ greater than threshold is selected. If average of $d_{RGB}(I_i, I_j)$ is greater than threshold, it means that a new scene has appeared by replacing the previous scene [8]. When a new scene is detected, a new watermark image is selected from the list of bit-plane images for embedding in all the host image frames. In this process, an identical watermark is used for each frame within a motionless scene. In order to make the watermarking process more robust, the selection of the bit-plane image is controlled in a specific order. So only a predetermined detector can recover the original watermarks and its sequences [2].

C. Watermark Extracting

Proposed system is a blind video watermarking. At the extraction process original video is not required only watermarked video is used. The extracting process is as follows:

- Calculate the luminous value of each video frames.
- For each 8×8 blocks, extracting the watermark bit from the luminous group in the alphabetical order as TABLE I presents. The extracting algorithm is as follows. Suppose current group is A. If the coefficient of A2 is maximum than other two coefficients A1 and A3, then 0 has to be extracted.

Else if the coefficient of A2 is minimum than other two coefficients A1 and A3, then 1 has to be extracted. Extracting process is continued until the entire watermark bits have been extracted.

General overview of the watermarking method is shown in figure 2.

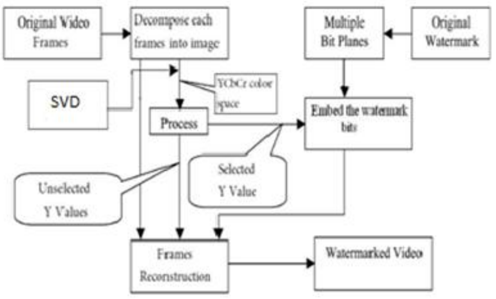


Figure 2: General overview of the watermarking method

III. SECOND PROPOSED SVD-BASED VIDEO WATERMARKING ALGORITHM

The second video watermarking algorithm is centered on transforming the host video by means of the SVD operator and then embedding the watermark information in the U, or V matrices in a block-wise manner. Foreground pixels are only embedded into the watermark.

A. Watermark Embedding Procedure:

The embedding procedure of the second proposed algorithm, with its three possible disparities, is described in detail through the following steps:

Step 1: Split the video clip into video scenes Vsi.

Step 2: Sort out the frames of each video scene utilizing SVD described in steps 3 ~ 8 below.

Step 3: Translate every video frame F from RGB to YCbCr color matrix structure.

Step 4: Calculate the SVD for the Y matrix in each frame F. This operation generates 3 matrices (U, S, and V).

Step 5: Rescale the watermark image so that the size of the watermark will counterpart the size of the matrix which will be utilized for embedding U or V.

Embedding procedure in Matrix U Block-wise:

$\mathbf{Y'= U_{Y'}S_Y V_Y{}^T}$

Embedding procedure in Matrix V Block-wise:

$\mathbf{Y'= U_{Y'}\,S_Y\,V_Y{}^T}$

Where **Y'** is the updated luminance in the YCBCR color representation.

Step 6: Translate the video frames F' from YCBCR to RGB color matrix.

Step 7: Reconstruct frames into the conclusive watermarked Video scene **Vsi**.

Step 8: Reconstruct watermarked scenes to get the conclusive watermarked Video.

B. Watermark Extraction Procedure:

The algorithm is a blind watermarking algorithm, and there by it does not require the original video clip during extraction procedure. Hence watermark image can be extracted from watermarked video by employing the following steps:

Step 1: Split the watermarked Video clip V' into watermarked scenes Vsi'.

Step 2: Route the watermarked frames of every single watermarked video scene using SVD as described in steps 3 ~ 8.

Step 3: Translate the video frame F' from RGB color matrix to YCBCR.

Step 4: Calculate the SVD for the Y matrix in frame F'. , this process generates 3 matrices (U, S, and V).

Step 5: Inverse the pixel value for 5 pixels in each odd block used in the embedding process in the U matrix if it is used in the embedding, or in the V matrix, similar to x= (1/pixel value).

Step 6: Extract the embedded watermark from the integer part of x.

Step 7: Build the image watermark WVsi by gushing all watermark bits extracted from all frames.

Step 8: Reiterate the equivalent procedure for all video scenes.

IV. EXPERIMENTAL RESULTS

In this experiment, we implemented the proposed video watermarking algorithm under MATLAB 7.7 environment. The size of the uncompressed AVI video used is 144x176 and 7 watermark bits can be embedded into each 8×8 block, so the maximum capacity of each video frame in the proposed watermarking algorithm is 2772 watermark bits at most. Therefore, gray scale image of size 49×56 is chosen, and the watermark is shown in Figure 3. The quality of the watermarked video is compared with the quality of the original video by calculating the PSNR value of the same video picture [3]. The calculated PSNR of different videos are presented in TABLE II. Images *I* and *K* where one of the images is considered a noisy approximation of the other is defined.

Figure 3: Original gray scale watermark image

$$MSE = \frac{1}{MN}\sum_{i=0}^{m-1}\sum_{f=0}^{n-1}[I(t,f) - K(t,f)]^2$$

The PSNR is defined as:

$$PSNR = 10\log_{10}\left(\frac{MAX^2}{MSE}\right)$$

$$= 20\log_{10}\left(\frac{MAX}{\sqrt{MSE}}\right)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per three RGB values per pixel, the definition of PSNR is the same except the MSE is the sum over all squared value differences divided by image size and by three different color space.

VIDEO	AVERAGE PSNR
A	38.96db
B	42.47db
C	38.29db

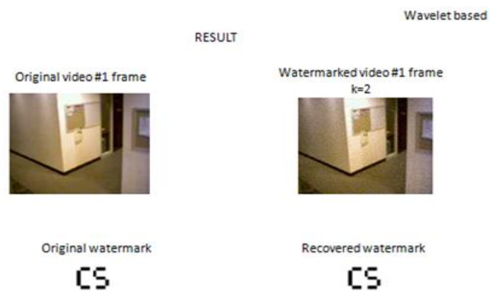
Table II : Average PSNR Value Of Watermarked Videos

To verify the similarity between the watermark W, and the extracted watermark W' after addition of noise is calculated using normalized correlation coefficient [4].

NC = $$\frac{\sum_i\sum_j (W_{ij} x W'_{ij})}{\sum_i\sum_j W_{ij}^2}$$

A video sequence of 400 frames with 8 scenes is used to test under frame dropping, noise addition and temporal shift attack.To investigate the robustness of the embedded watermark, different percentages of frames are dropped from the video and PSNR value is calculated for each extracted watermark.

DCT Based



Since the proposed method uses a series of watermark signals, one for each successive individual scene, with the repetition in a time-varying different scene, this makes it more robust against attack by frame dropping. In this case, all the frames in a scene are watermarked using an identical signal. So the watermark remains active in the rest of the frames even after deleting all frames in a scene, leaving only one frame. In order to remove a watermark signal, an attacker must need to remove the whole frames in a scene, that is, the complete scene, which would degrade the video sequences significantly. The watermark signals remain in all other scenes even after completely removing a specific scene, which only destroys a single watermark in a series.

In temporal shift attack, frames of a scene are removed from a video clip or inserted into a sequence so that the original scenes are shifted temporally. The proposed scheme shows robustness against this type of attack, since, here, a series of independent watermark signals are used, one for each scene, being repeated in a predetermined order. Keeping the original watermark signal indices and comparing them with the detected watermark signal indices, it can be readily detected where the two scenes would be lined up.

Noise Density	PSNR	MSE	NCC	AD
0	**4.8137**	**2.1464e +004**	**1.6616**	**-112.3201**
0.1	**8.0692**	**1.0029e +004**	**1.0389**	**-52.8224**
0.2	**8.0830**	**1.0143e +004**	**1.0391**	**-53.1698**
0.5	**8.1000**	**1.0071e +004**	**1.0402**	**-53.1576**
1.0	**8.1182**	**1.0111e +004**	**1.0397**	**-53.2310**

TABLE: PERFORMANCE COMPARISON TABLE

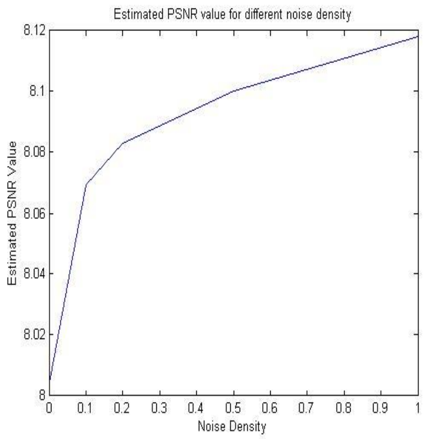


Fig: Estimated PSNRValue For Different Noise Density

V. CONCLUSION

With Multimedia becoming more and more popular and readily accessible, the copyright and ownership issues also assume significant importance. The design and implementation of blind watermarking algorithm for uncompressed video is proposed. The algorithm successfully embeds bit plane watermark bits into the luminous pixel value for each video frames. Scene change detection algorithm is used for detecting scenes in the video. In each scene same bit plane image is embedded and different scene contains different bit plane image. The extraction process is blind and the watermark can be extracted without any distortion from the watermarked frame. Experimental results demonstrate that the proposed technique is robust against attacks such as frame dropping, temporal shifts and addition of noise. Robustness of the scheme can be further improved by combining video with audio watermarks. This can considerably increase the robustness of the watermark since most of the specified attacks are on the video channel.

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