International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

AN EFFICIENT VIDEO WATERMARKING USING COLOR HISTOGRAM ANALYSIS AND BITPLANE IMAGE ARRAYS

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Abstract - *The paper presents video watermarking technology based on color histogram analysis and luminance value adjustment in according to watermark bitplane image arrays. The main objective of this approach is to minimize the error at high data hiding capacity in order to preserve the quality of video. By considering this, the watermarking process will be handled in luminance plane and frame selection is based on changes of RGB histogram bins. This technology is used to hide copyright information to protect original contents from video tampering, broadcasting and for other authentication. Implementation of this method involves watermark bitplane image conversion, color histogram based changes detection in video scenes and luminance value adjustment. Before the watermark embedding, the original watermark pixels intensities will be converted into bitplanes. Then by using RGB space histogram variation between the successive two frames, the relevant frame will be selected. After selecting the frame, each bit of bitplane image will be embedded into luminance plane of corresponding frame. The desired pixels will be selected from the 8x8 non overlapping blocks of luminance plane. At each block, seven bits of bitplane image are hidden under the luminance values chosen by data hider. This process is continued for all remaining watermark bits. At watermark recovery, continue same process handled in embedding stage. The simulated results shows that watermarking using color histogram and luminance adjustment provides better performance interms of preserving original video quality and accuracy in recovered watermark during extraction. The performance measures such as smean square error and peak signal to noise ratio are evaluated to evaluate the system performance.*

Key Words: *video watermarking, bit-plane images*

1. INTRODUCTION

The multimedia data which is available in the internet is all in the form of digital. If the data is in analog form then we cannot produce as it is. But the data which is in the form of digital can be reproduce as it is without any error. Due to the advancements in digital technology. So, the owners of content are suffering with illegal copying of their data. The traditional copyright protection methods like encryption etc. are not sufficient. Because, the content can be protected only while during transmission. After receiving the data, if once the decrypted then the data cannot be protected. To overcome this problem watermarking technology is developed.

Robustness, fidelity and data payload are the three parameters of watermarking. There exists a complex trade off between these parameters. Robustness of watermark refers to the ability to withstand non-malicious distortions. Fidelity is the visual similarity between the stego image and its cover image. Data payload is the encoded message size of a watermark in an image. The simplest form of watermark has no payload. These three parameters are conflicting and tradeoff has to be found which is often tied to the targeted application.

Digital watermarking is an effective method to protect the authenticity by hiding the copyright information in the original content. Applications of digital watermarking include Digital rights management, copyright protection, authentication, tamper detection and localization, Broadcast monitoring, device control,, communication enhancement. Video contains large amount of redundant data.

Based on the embedding watermark, video watermarking can be classified into 3 types as follows.

1. Watermark embedding in compressed bit stream.
2. Watermark embedding in the quantization coefficients during encoding the video.
3. Watermark embedding into original video.

The first method does not require encoding and decoding of video. And also not affect the video quality. But, the algorithm is not easy to design. In the second method, the algorithm is easy to design and bit rate of video will not increased. But, the video quality will decrease.

In this paper we propose a new blind video watermarking algorithm. The grey scale image is used as watermark image. The grey scale image decomposed into 8-bitplane images and each bit plane is embedded into different scenes of video sequence. The bit planes of watermark image are embedded only in the Y-channel. Some of luminance values from video frames are selected and divided into groups. By adjusting the relative relationship of the member in each group, watermark is embedded. Only a sufficient number of bits has to be embedded in the video without causing any noticeable distortion. The watermark can be retrieved at the extraction stage even after various types of video manipulation and other signal processing attacks.

This paper is organized into four sections as follows. Section 2 describes the proposed video watermarking scheme in detail. Section 3 presents experimental results and examines the performance of the algorithm. The conclusion is provided in Section 4.

2. PROPOSED METHOD

In this proposed method grey scale image is used as watermark image. The grey scale image is converted into multiple bit plane images. (Here grey scale image converted into 8-bit plane images). The bit plane images are embedded in the frames of original video. All the frames which corresponds to the same scene consist of same bit plane image. The bit plane is changed if the scene changes. That means different video scene consist of different watermarks. The decomposition of watermark into bit plane images is as shown in figure1.

2.1 Watermark Embedding

The proposed algorithm will embed the watermark into Y-channel of each video picture of same scene. Different bit planes are embedded into different video scenes. The watermark embedding is as follows.

- By using scene change detection algorithm we find different scenes in the video.
- Separate the y-channel from the video pictures and divide it into non overlapping 8x8 blocks.

Select the 7 triple groups of luminous values to embed the watermark. Mark the groups from A to G as shown in the TABLE-I. Each group consist of 3 luminous values. The order in its group represented by the number next to the letter.

Get 7 bits watermark from binary watermark image. In each 8x8 non overlapping block, embed 1 bit watermark frame to each selected luminous value in the order group A to group G. If m is the watermark bit and 'A' is the current group, then A2 should be absolute maximum of group A when m=0. If A2 is not maximum, then exchange the value of A2 with the maximum of group A. Similarly if the current watermark bit m=1, then A2 should be absolute minimum of group A. Otherwise exchange the value of A2 with the minimum of group A.

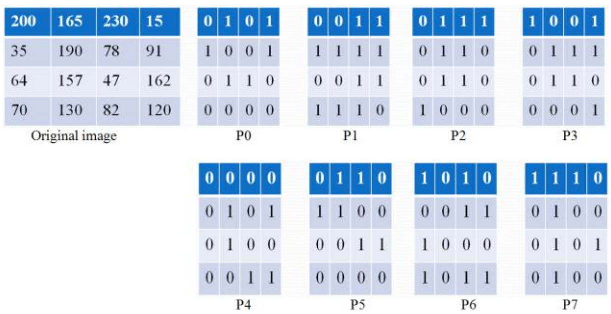


Figure 1: Bit decomposition of 8-bit watermarking image signal [P0 is the least-significant bit (LSB) and P7 is the most-significant bit (MSB)].

Table 1: group of 8×8 luminous values

						G1	G2
					F1	F2	G3
				E1	E2	F3	
			D1	D2	E3		
		C1	C2	D3			
	B1	B2	C3				
A1	A2	B3					
	A3						

After embedding the 8x8 blocks with watermark bits, rebuilt the video by using watermarked video pictures.

2.2 Color histogram analysis

To detect the changes in successive video frames, color histogram is used. All frames are converted into RGB images. The color histogram can be computed by dividing color space into discrete image colors called bins and counting the number of pixels falling into each bin. By using color histograms H_i and H_j , the difference between two images I_i and I_j is calculated as follows.

$$d(I_i, I_j) = \sum_{k=1}^{n} abs(H_{ik} - H_{jk}) \quad (1)$$

It denotes the difference in the number of pixels of two images that fall into same bin. The above farmula can be written as

$$d_{RGB}(I_i, I_j) = \sum_{k}^{n} (abs(H_i^r(k) - H_j^r(k)) + (abs(H_i^g(k) - H_j^g(k)) + (abs(H_i^b(k) - H_j^b(k))) \quad (2)$$

For each image of video calculate the $d_{RGB}(I_i, I_j)$ using equation (2). Compare the average of $d_{RGB}(I_i, I_j)$ with the predefined threshold value. If $d_{RGB}(I_i, I_j)$is greater than the threshold value, it means new scene is detected. When the new scene is detected, a new watermark image is selected from the list of bit plane images. Same watermark is used in each frame with in motionless scene.

2.3 Watermark extracting

The proposed method is blind video watermarking. The original video is not required at the extraction process. Only the watermarked video is enough to retrieve the watermark. The extraction process is as follows.

- For each video frame calculate the luminous value.

- The algorithm for extracting watermark is as follows

Suppose current group is A. '0' will be extracted when A2 is maximum than other two coefficients. While '1' will be extracted when A2 is minimum than other two coefficients A1 and A3. The entire watermark bits have been extracted.

General overview of the water marking method is shown in figure (2).

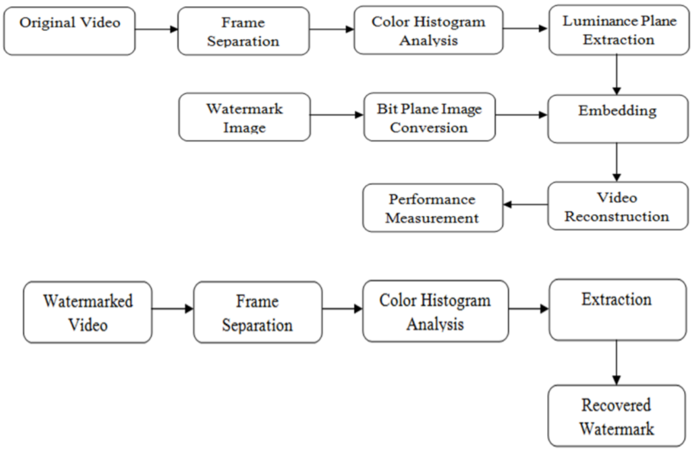


Figure 2: General overview of the watermarking method

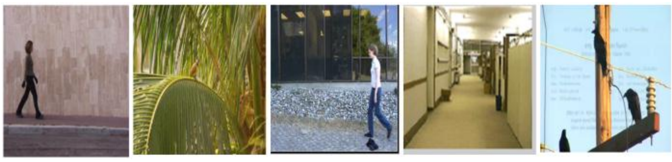
3. Experimental results

In this experiment, the proposed algorithm is implemented under MATLAB-7.5 and above versions. The size of the uncompressed AVI video used is 256x256 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 7168 watermark bits at most. Therefore, gray scale image of size 49×56 is chosen, and the watermark is shown in Figure 3.

The screen shots of original video frames for five different videos and corresponding video frame after embedding watermark are presented in figure (4) and figure (5). The extracted watermark is shown in figure (6).

Figure 3: Original gray scale watermark image

The quality of watermarked video is compared with the quality of original video by calculating MSE and PSNR of the same video picture. The MSE, PSNR of different videos are presented in TABLE- II. PSNR is commonly defined via the mean squared error (MSE), which for two m×n monochrome images I and K where one of the images is considered a noisy approximation of the other is equation (3)



(a) (b) (c) (d) (e)
Figure 4: Original video frames of four different videos
(a) (b) (c) (d) (e)

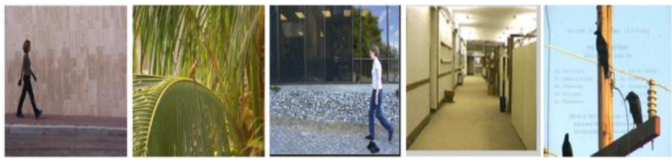


Figure 5: Watermarked video frames

Figure 6: Extracted watermarks

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (3)$$

The PSNR is defined as

$$PSNR = 10\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad (4)$$

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

Here MAX_I represents maximum possible pixel value of the image. MAX_I is 255 when the pixels are represented using 8 bits per sample. The MAX_I is 2^B-1 when samples are represented using linear PCM with B bits per sample. For color images with 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. Alternatively for color images the image is converted to a different color space and PSNR is reported against each channel of that color space. Ex: YCbCr or HSL.

Table 2 : Average PSNR value of watermarked video

Video	Average PSNR
V1	39.3214
V2	39.4850
V3	39.9502
V4	3707119
V5	38.5441

Generally PSNR is used to calculate the quality of still images. But, for measuring the quality of video it is not sufficient. VQM is used to measure the video quality. It can be calculated from the PSNR as follows

$$VQM = \frac{1}{1+e^{0.1701*(PSNR-25.6675)}}, 10 \leq PSNR \leq 55 \qquad (5)$$

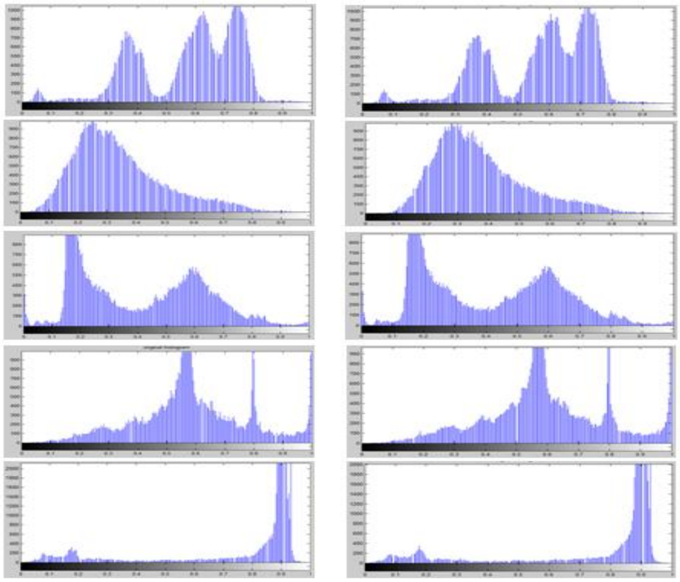
A video sequence of 200 frames is used to test under noise addition. The table below represents the quality of five different videos after noise attack.

Table 3: Quality of four different videos after noise attack

Video	MSE	PSNR	VQM
V1	7.6050	39.3214	0.9984
V2	7.3210	39.4850	0.9996
V3	6.5774	39.9502	0.9998
V4	11.012	37.7119	0.9989
V5	9.0920	38.5441	0.9978

The proposed method uses a series of watermark signals. Each frame of a particular scene consist of same watermark. So, if any frame is dropped, the remaining frames of that particular scene can have the same watermark. The watermark will be present in the video even when one frame of particular scene is present. If all the frames are dropped, then the video quality will decrease. So, the proposed method is robust against frame dropping and noise attacks.

The histograms of original and watermarked frames are as shown in figure below



(a) (b)

Figure 7: (a)original frames (b) watermarked frames

4. CONCLUSION

The method implementation involves watermark bit plane image conversion, colour histogram based changes detection in video scenes and luminance value adjustment. Before the watermark embedding, the original watermark pixels intensities will be converted into 8-bit bit plane image. Then the relevant frame will be selected using RGB space histogram variation between the successive two frames. After the frame selection, an each bit of bit plane image will be embedded into luminance plane of corresponding frame. The desired pixels will be selected from the 8x8 non overlapping blocks of luminance plane. At each block, eight bits of bit plane image are hidden under the luminance values chosen by data hider. This process is continued for all remaining watermark bits. At watermark recovery, continue same process handled in embedding stage. The simulated results shows that watermarking using color histogram and luminance adjustment provides better performance in-terms of preserving original video quality and accuracy in recovered watermark during extraction

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