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Performance Analysis of Digital Watermarking Of Video in the Spatial Domain

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Abstract: **In this paper, we have suggested the spatial domain method for the digital video watermarking for both visible and invisible watermarks. The methods are used for the copyright protection as well as proof of ownership. In this paper we first extracted the frames from the video and then used spatial domain characteristics of the frames where we directly worked on the pixel value of the frame according to the watermark and calculated different parameters.**

Keyword: **Digital video watermarking, copyright protection, spatial domain watermarking, Least Significant bit substitution**

I. Introduction

Digital watermarking includes a number of techniques that are used to imperceptibly convey information by embedding it into the cover data. Here the cover data taken is a video sequence and the watermarking is thus called the Video Watermarking. Video watermarking is a field that is rapidly evolving in the area of multimedia and interest of the people in this field is increasing day by day because of the major factors as stated below.

- Privacy of the digital data is required and because the copying of a video is comparatively very easy.
- Fighting against the "Intellectual property rights breach"
- Tempering of the digital video must be conceled.
- Copyright protection must not be eroded.

The figure 1 shows the idea of the video watermarking at the sending end where first of all frames is extracted from the video sequence. The next step is to divide frame into its Red, Green and Blue part. Each part is then individually given to the embedding algorithm block where the other input is a watermark that is to be embedded. After each part is watermarked the next frame is taken and the procedure is repeated untill the last frame. After the watermark is embedded in every frame, all frames are mixed to make the watermarked video which is then transmitted in the channel. The figure 2 shows the idea of the video watermarking at the receiver end the watermarked video is divided into the frames which are divided into Red, Green and Blue part from where the watermark is extracted. This Procedure is repeated for all frames so as to recover the watermark.

II. Visual Quality Matrices

We have mainly used the following visual quality metrics for the sake of comparison of degradation after the watermark is added to video.

$$MSE = \frac{1}{M \times N} \sum_{x=1}^{M} \sum_{y=1}^{N} \{(f(x,y) - f'(x,y))\text{^}2\} \qquad (1)$$

$$PSNR = 10 \times \log \frac{255^2}{MSE} \qquad (2)$$

Here MSE – Mean Square Error

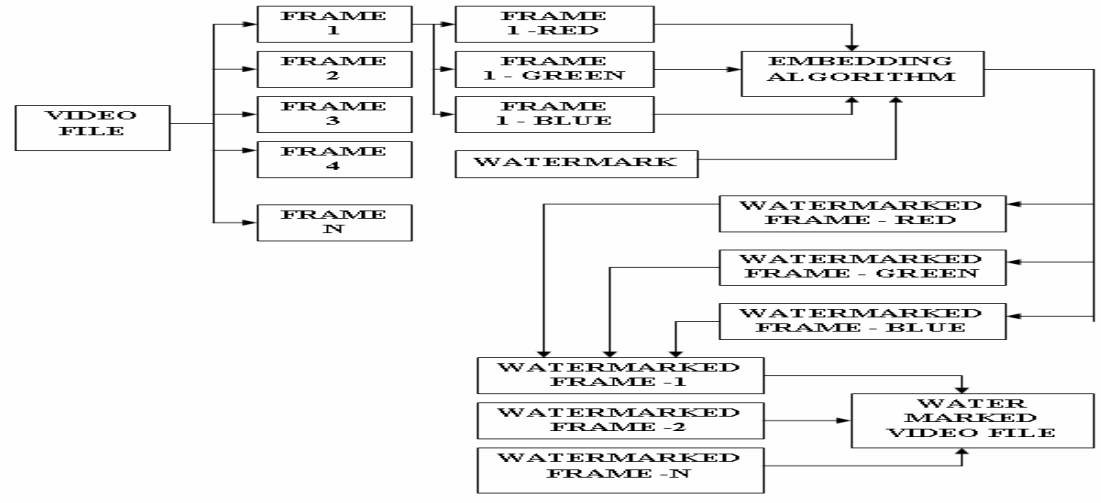
PSNR – Peak Signal Signlal to noise Ratio

f(x,y) – Original Frame of the video

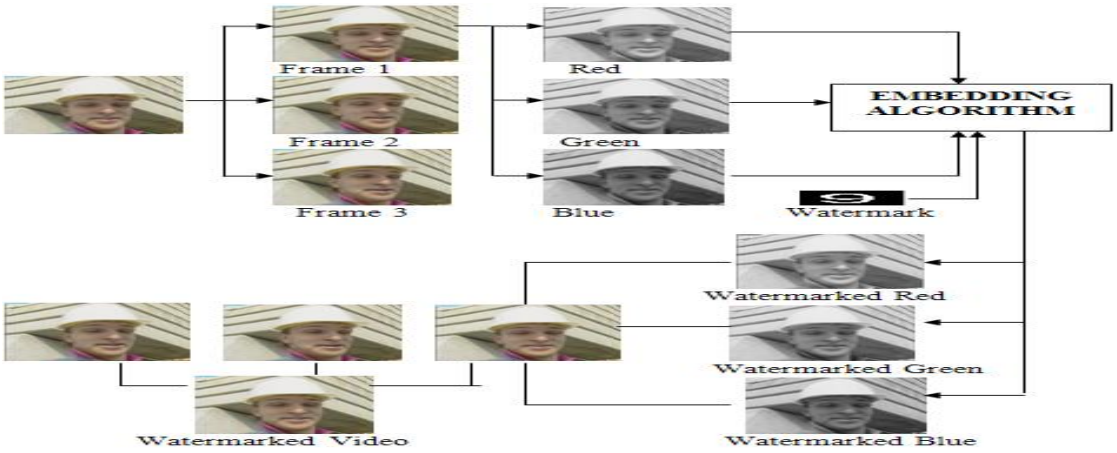
f'(x,y) – Watermarked Frame of the Video.

The phrase peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale. A higher PSNR would normally indicate that the reconstruction is of higher quality at the receiver end.

PSNR is most easily defined via the Mean Square Error(MSE) which for two m×n Frame f and f' where one of the Frames is considered a noisy approximation of the other.

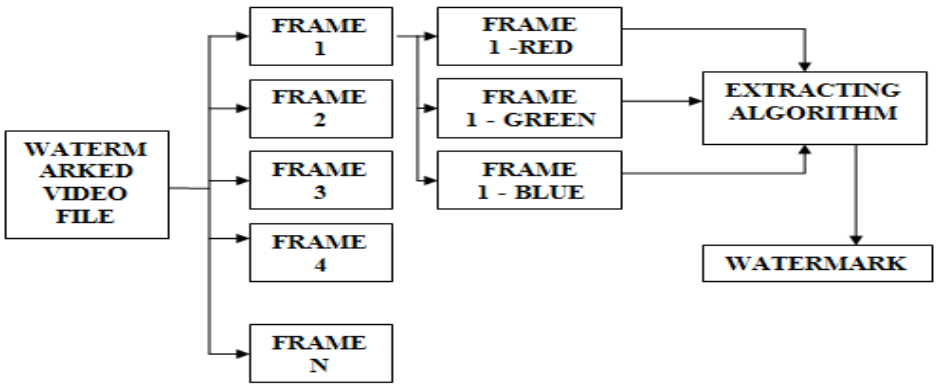


(a)

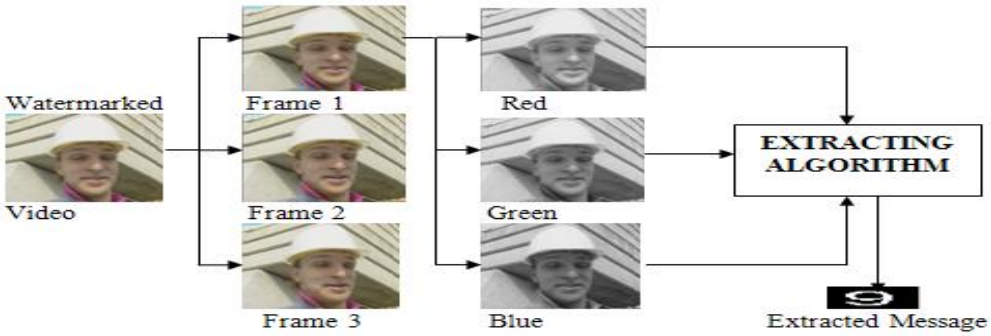


(b)

Fig. 1 Idea of Video watermarking - Embedding a watermark



(a)



(b)

Fig. 2 Idea of Video watermarking - Extracting a watermark

III. Visible watermarking

Visible watermarking schemes are used to protect digital images that have to be released for some purposes, such as the contents used in learning websites or digital libraries, while illegal copying or reproduction is prohibited. A visible watermark is a secondary translucent overlay on the primary video and appears visible to a viewer on careful inspection.

Visibly watermarked videos often contain recognizable but unremarkable copyright patterns indicating the identity of intellectual property rights (IPR) owners. The main advantage of using visible watermarks is that it conveys an immediate claim of ownership. It also prevents or at least discourages unauthorized use of copyrighted high quality images. A functional visible watermarking scheme should meet the following requirements:

1. Perceptibility of host video details: all the details in the original host videos should remain perceptible after watermark embedding.
2. Visibility of watermark patterns: the embedded watermark should be easily recognized from the watermarked video by the naked eye.
3. Adaptive spreading over host video: the visible watermark should be adaptively spread over a large or important area of host video to prevent its deletion by clipping.
4. Robustness: embedded watermarks should be difficult or impossible to remove unless exhaustive and costly human interventions are involved.
5. Efficiency: the watermark patterns should be applied automatically with little human labor.

A. Embedding Algorithm

In the actual embedding algorithm we have gone through the following steps.

1. The Video is converted into the number of frames.
2. When there is a black pixel (00000000) i.e non transperent part of the message, the corresponding pixel of the frame is replaced with the black pixel so as to have a visual perception.
3. When there is a white pixel (11111111) i.e transperent part of the message, the corresponding pixel of the frame is kept as it is.
4. Next frame is taken and step 2 and 3 is repeated untill the last frame comes.
5. All watermarked frames are combined so as to have the watermarked video.

Fig. 3 Video with visible Watermark

IV. Invisible watermarking

The most straight-forward method of watermark embedding would be to embed the watermark into the least-significant-bits of each frame in the video.

Consider one of the MxN frames of the video where M shows number of rows and N shows number of columns. In this frame each pixel value is represented by a decimal number in the range determined by the number of bits used. In a gray-scale frame, with 8 bit precision per pixel, each pixel assumes a value between [0, 255] and each positive number β10 can be represented by:

$\beta 10 = b0 + b1*G1 + b2*G2 + \ldots\ldots$ where $G = 2$ (3)

This property allows the decomposition of an image into a collection of binary images by separating the bi into n bit planes. Figure 4 shows LSB decomposition of one Pixel.

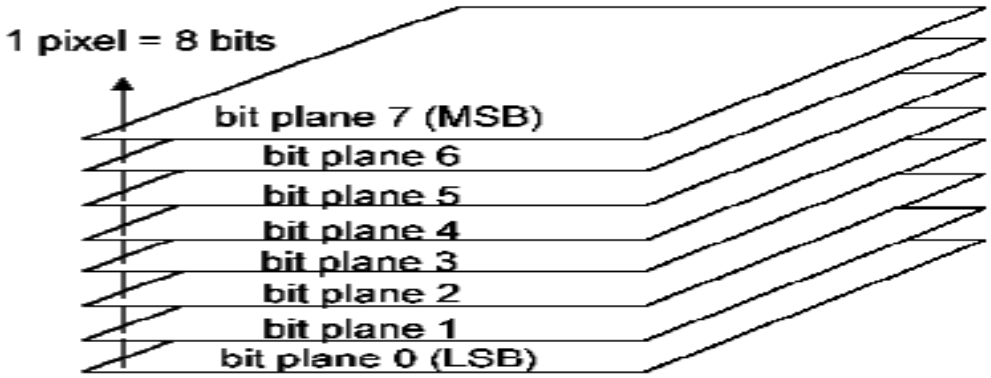


Fig. 4 LSB decomposition of one pixel

Here we have first divided the video into frames and then each frame is divided into red, green and blue parts. Each of the part is considered to be a greyscale frame and the above said method can be applicable to each frame.

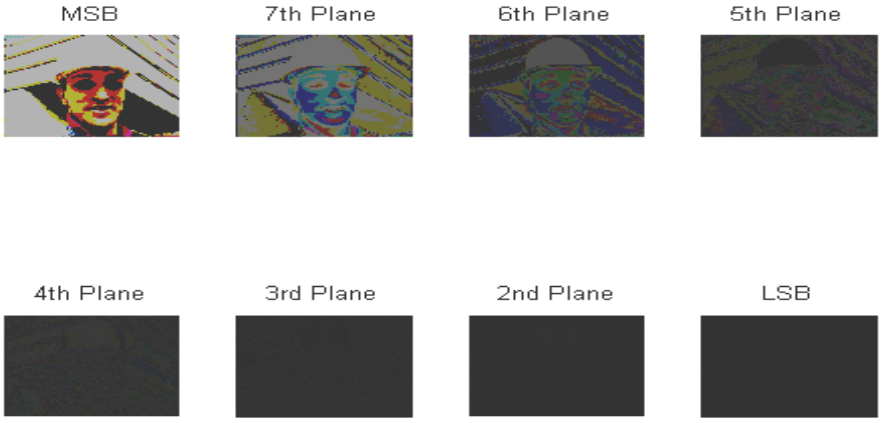


Fig. 5 Bit Plane Representation of the first frame of the video

A. Embedding Algorithm

From the fundamentals we can say that the LSB part of the image is least important compare to the MSB and here in the invisible watermarking using least significant bit we have make use of this fundamental. We replace the LSB of each pixel of every frame with the MSB of the watermark so that the most important information of the watermark is embedded into the least important information of the frame and hence the video.

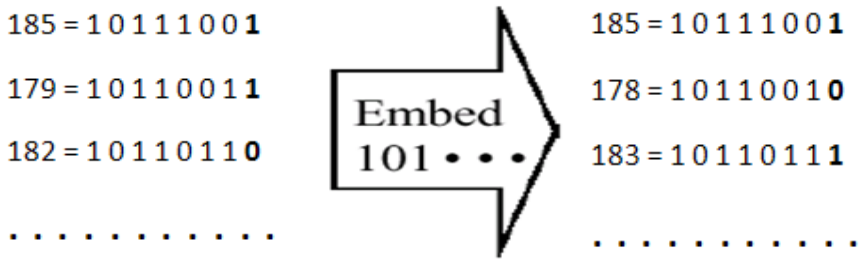
Following are the stepwise representation of what we have done to achieve the invisible watermarking of video.

1. The Video is converted into the number of frames.
2. Since the watermark image has only two values [0 and 255] and its binary representations are 00000000 and 11111111 respectively. So here we can replace the MSB of the message image with the LSB of the frame so that there is almost no visual degradation observed in the frame.
3. Next frame is taken and step 2 is repeated untill the last frame comes.

Figure 6 shows the graphical representation of the method.

(a) Binary Watermark to be embedded

(b) First frame is divided into R,G, and B frames



(c) LSB of the frames are replaced with MSB of the watermark

(d) Resultant Frames

(e) Watermarked Frame 1 of the video

Fig. 6 Graphical Representation of the LSB method of invisible video watermarking

Following table shows the visual quality metrices for the first six frames.

Table I
Visual Quality Matrices Value

Frame No.	MSE	PSNR (dB)
1	0.50059	51.136
2	0.49598	51.1762
3	0.50201	51.1237
4	0.49937	51.1466
5	0.49882	51.1514
6	0.49913	51.1486

Here we can also embed different message in the different frames so as to have a complete sentence of the message.

B. Extraction Algorithm

We have used the following steps to extract the watermark from the video.

1. The Video is converted into the number of frames.
2. Extract the last bit and apply the following condition.
3. If the extracted bit is 1, we would place a gray level of 255(White) in the respective place.
4. If the extracted bit is 0, we would place a gray level of 0(Black) in the respective place.
5. Next frame is taken and step 2 is repeated until the last frame comes.

Figure shows the extracted message.

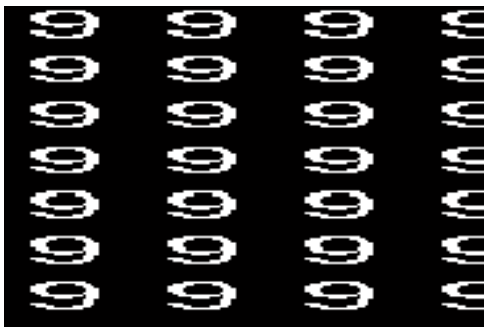


Fig. 7 Extracted Messages

V. Conclusion

The main advantage of such a technique is that the modification of the LSB plane does not affect the human perception of the overall video quality. Also the LSB method of invisible watermarking is robust against cropping attack.

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