A Semi Blind DWT-SVD Video Watermarking Under Attacks

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***Abstract*—Digital watermarking was introduced due to rapid advancement of networked multimedia systems. It was developed to enforce copyright technologies for protection of copyright ownership. This technology is first used for still images but recently they have been developed for other multimedia objects such as audio, video etc. In this paper a new digital video watermarking scheme is proposed which combines Discrete wavelet transform (DWT) and Singular Value Decomposition (SVD) in which watermarking is done in the high frequency sub band and then various attacks have been applied. Tests have been undergone to check the proposed scheme for robustness and imperceptibility.**

Keywords: Video Watermarking, Discrete Wavelet Transform (DWT), Singular Value Decomposition (SVD)

I. INTRODUCTION

The widespread expansion of the internet has led to availability of digital data such as audio, images and videos to the public which leads to the issue of data protection. Many techniques has been used but digital watermarking is new technique to issue these problems [1]. The watermarking is a covert security feature used for copyright protection, authentication. Digital watermarking means embedding the secret information in the form of watermark into the digital multimedia such as image, audio and video. The embedded information is extracted out to reveal the real owner/identity of the digital media. After embedding the watermark the original data should not alter. These watermarks should be robust against any kind of intended or unintended attacks. There are three parameters in digital watermarking: data payload, fidelity and robustness. Digital watermarking has been extensively used for still images but now they are used for other multimedia objects such as audio and videos [2]. Digital video watermarking is the process of embedding and extracting watermark from the videos. There are many algorithms of video watermarking some of which consider videos as group of continous still images. Some algorithms consider the temporal dimension. Watermarking techniques can be applied in two domains: Spatial domain and transform domain. Spatial domain technology embeds watermark directly into the pixels which changes the intensity values [3]. Previously watermarking techniques were based on spatial domain example least significant bits (LSBs). This method is easy and simple but affected by the attacks. Transform domain technology embeds watermark in the transform of the signal. These transform are discrete fourier transform, discrete wavelet transform (Chan and Lyu [4], [5]), discrete cosine transform (Cox et al [6], Hsu and Wu [7]). Section II introduces the two main concepts of the paper i.e., SVD and DWT. Section III introduces the proposed method of video watermarking. Section IV represents experimental results and section V gives the concluding remarks.

II. PRELIMINARIES

A. *Singular Value Decomposition (SVD)*

The SVD is popular mathematical technique that provides tool for analysis of matrices. It is an elegant way for extracting algebraic features from an image [8]. It was first introduced by Beltrami and Jordan in 1870 for square matrices and then Eckart and Young in 1936 extended to rectangular matrices. SVD has provided its great application in image processing and watermarking. The SVD matrix of an image has good stability. When a small perturbation is added to an image, large variation of its SVs does not occur. Using this property of the SVD matrix of an image, the watermark can be embedded to this matrix without large variation in the obtained image. Let us consider an image A as matrix of size M*N. Using SVD matrix A can be decomposed as:

$$A = USV^T$$

$$U = [u_1, u_2, \ldots\ldots, u_n]$$

$$V = [v_1, v_2, \ldots\ldots\ldots, v_n]$$

$$S = \begin{bmatrix} s_1 & . & . \\ . & s_2 & . \\ . & . & s_n \end{bmatrix}$$

where U and V are orthogonal matrices of size M*N and S is a diagonal matrix. The columns of V called right singular vectors and the columns of U are left singular vectors of the image A. In SVD based watermarking, SVD of the original image is taken and then singular values of the matrix are modified by introducing the singular values of watermark. The properties of svd that made it popular are as follows:

1. SVD do not affect the image quality.
2. It preserves non symmetric properties.
3. They are robust to various attacks such as rotation, scaling, compression, noise addition and cropping.
4. It extract algebraic properties of digital image.

B. Discrete Wavelet Transform (DWT)

Wavelet transform is time domain localized analysis method and it differentiates time in high frequency part of DWT transformed signals and frequency differentiated in low frequency parts of signals [9]. DWT is multiresolution mathematical tool for decomposing an image. An image is considered as two dimensional signal which when passed through high and low pass filters decompose into several sub bands having different resolutions. DWT decomposes an image into four components namely LL,HL,LH,HH where first letter corresponds frequency operation and second letter is the filter applied. LL represents approximate features of an image and it is half of the original image. LH (Vertical high frequency), HL (Horizontal high frequency) and HH (High frequency) represents detail of an image. It can further decompose by applying 2-level DWT on the sub-image. After applying a 2-level DWT, sub-image get decomposes into the approximation sub-band (LL2), the horizontal subband (LH2), the vertical sub-band (HL2), and the diagonal sub-band (HH2). Again decomposition of image results into LL3, LH3, HL3 and HH3 sub-band respectively. Several algorithms has been proposed on using dwt-svd, one such algorithm is proposed by Osama S. Faragallah [10]. It is an efficient and robust video watermarking technique based on SVD and DWT. In this technique, middle and high frequency bands are SVD transformed and watermark is hidden in that.

III. PROPOSED VIDEO WATERMARKING TECHNIQUE

A. Video Watermark Embedding Process

Figure 1 shows the algorithm of the watermark embedding process.

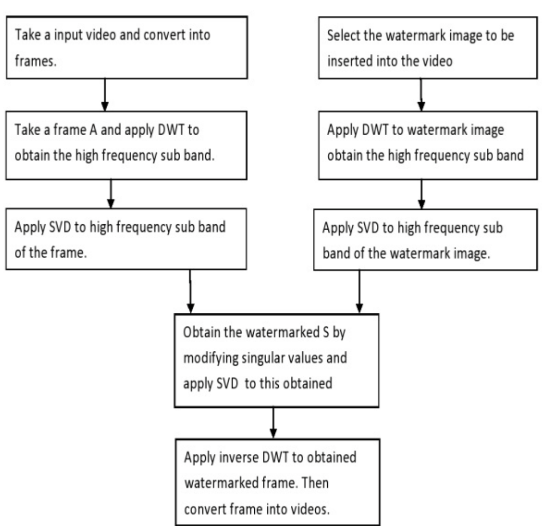


Fig. 1 Video Watermarking Embedding Process

B. Video watermark Extraction Process

Figure 2 shows the algorithm of the watermark extraction process.

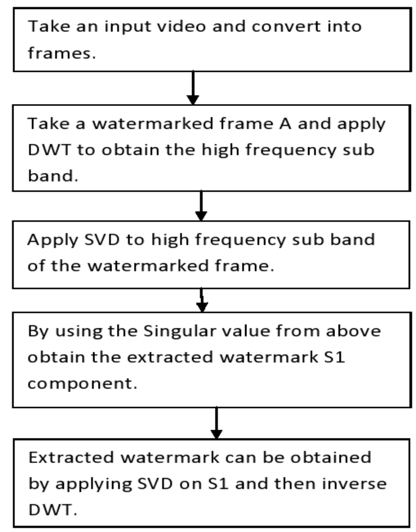


Fig. 2 Video Watermarking Extraction Process

IV. SIMULATION RESULTS

The experimental simulation is carried out using MATLAB R2010b. In this paper we have taken a standard video ‘Rhinos’ as a host video and the watermark is any image. We have taken α as a scaling factor and its value is 0.2. The proposed scheme can perform test on many other videos. The properties that are evaluated for the proposed scheme are imperceptibility and robustness. Imperceptibility means that after the watermark is added the quality of the video should not be affected. It is measured by using PSNR (peak signal to noise ratio). It is measured “Before attack, after embedding”. Robustness of watermark means that the after intentional or unintentional attacks the watermark is not destroyed and it can be still used to provide certification and it is measured using correlation coefficient. It is measured “after attack”. For the robust capability, mean absolute error (MSE) measures the mean of the square of the original watermark and the extracted watermark from the attacked image. The lower the value of the MSE lower will be the error. It is represented as:

$$\mathrm{MSE} = \frac{1}{\mathrm{XY}\left[\sum_{\mathrm{i}=1}^{\mathrm{X}} \sum_{\mathrm{j}=1}^{\mathrm{Y}} (\mathrm{c}(\mathrm{i},\mathrm{j}) - \mathrm{e}(\mathrm{i},\mathrm{j}))\right]}$$

X and Y are height and width respectively of the image. The c (i, j) is the pixel value of the cover image and e (i, j) is the pixel value of the embed image.

PSNR represents the degradation of the image or reconstruction of an image. It is expressed as a decibel scale. Higher the value of PSNR higher the quality of image. PSNR is represented as:

$$\text{PSNR} = 10\log 10\left(\frac{L * L}{\text{MSE}}\right)$$

Correlation coefficient (CC) measures the robustness of the watermark. It correlates the extracted watermark with the original watermark. More the value of CC, more robust is the scheme.

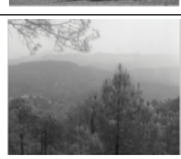
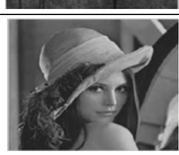
BER is the ratio that describes how many bits received in error over the number of the total bits received.

$$\text{BER} = \frac{P}{(H * W)}$$

Fig. 3 a) Original First Video Frame b) Watermark c) Watermarked First frame

Table 1 shows the values of MSE, PSNR and BER of the watermarked frames. These values shows the imperceptible property of the scheme as the values of PSNR are high which means that after embedding the watermark there is very less quality distortion. After embedding, we apply different attacks on the watermarked video and check the robustness of the scheme by calculating CC, more the CC is close to one more is the robustness.

TABLE 1 VALUES OF MSE, PSNR AND BER OF DIFFERENT WATEMARKS EMBEDDED IN THE ORIGINAL VIDEO

Different Watermarks	MSE	PSNR (db)	BER
	0.0016647	75.9303	0.01317
	0.027612	63.7208	0.015694
	0.0093057	68.4458	0.01461
	0.012425	67.1897	0.014883
	0.01165	67.4696	0.014822
	0.0064714	70.0234	0.014281

The attacks applied on the original video are Gaussian noise, poisson noise, salt and pepper noise, blur, frame averaging and rotation. These attacks are applied on each frame of the original video and then extraction is done from each frame. The watermark obtained after that is compared with the original watermark and CC is determined. Tables 2, 3, 4, 5 show the various attacks, its PSNR and CC.

TABLE 2 PSNR AND CC VALUES UNDER GAUSSIAN NOISE ATTACK

Extracted Watermarks	Variance	PSNR(dB)	CC
	0.05	33.4891	0.9748
	0.1	33.7385	0.9754
	0.5	34.7857	0.9855
	1	36.8331	0.9933

TABLE 3 PSNR AND CC VALUES UNDER POISSON NOISE ATTACK

Extracted Watermarks	Variance	PSNR(dB)	CC
	0.01	35.0208	0.9877
	0.1	31.2171	0.9428
	0.5	29.3861	0.8588
	1	28.9467	0.8097

TABLE 4 PSNR AND CC VALUES UNDER BLUR ATTACK

Extracted Watermarks	Variance	PSNR(dB)	CC
	10	36.7267	0.9935
	50	36.6353	0.9932
	100	36.6311	0.9932
	200	36.6333	0.9932

TABLE 5 PSNR AND CC VALUES UNDER ROTATION NOISE ATTACK

Extracted Watermarks	Degree	PSNR(dB)	CC
	30	36.8967	0.9937
	60	36.8343	0.9935
	90	37.2511	0.9953
	180	38.5889	0.9956

V. Conclusion

In this paper a new semi blind scheme has been proposed for video watermarking that is more robust towards these attacks. The watermark object has been embedded in each frame of the original video. Since the watermark is embedded in each frame it provide robustness against attacks such as frame dropping, frame averaging and lossy compression. If in any case some frames are dropped then also we can authenticate as watermark is embedded in every frame. The algorithm has been tested by taking many videos as input and also for different attacks for imperceptible and robustness. From overall observation it has been established that the proposed scheme yields better imperceptibility and robustness against various attacks which makes the proposed scheme suitable for some application.

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