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Design of Semi Blind Digital Video Watermarking Using Dwt and Svd

Patel Hiteshkumar Natvarlal*

EC Department, CHARUSAT Changa,Gujarat, India, email: hiteshpatel.ec@charusat.ac.in

ABSTRACT.

Recently, digital watermarking algorithms are widely applied to digital image, audio or video for ownership protection and tampering detection. Digital watermarking is the process of reversibly or irreversibly embedding information into a digital signal. Digital video theft is an escalating crime now days. Today, there are so many torrent sites that host copies of movies, sometimes months before their release. This is mostly seen before award seasons (such as Oscars, Golden Globes, etc.). The adjudicators are given free copies of the movies, and they often end up in torrent sites. Video watermarking is extremely useful tool for theft identification and copyright protection. Once a unique image or message is embedded within a video, (on a selected number of random frames), it becomes a unique copy. In this paper, Video watermarking algorithm based on discrete wavelet transform and singular value decomposition scheme is proposed. Since the embedding is carried out in SVD of some of the (lower) frequency wavelets, it is impossible for the viewer to see a significant difference anywhere in the video. Furthermore, without having access to the original video and the frame numbers where the embedding has taken place, it is nearly impossible to remove the watermark from the video as well. The DWT-SVD watermarking of a video is known to be highly robust against many known attacks, and therefore, there is a more chance that the copy can be identified even after distortion.

KEYWORDS: Video watermarking, Discrete wavelet transform(DWT), Singular Value Decomposition (SVD),robustness, perceptual quality.

***Corresponding author**

Prof. Hitesh N. Patel

Department of Elec. & Communication,

Charotar University of Science & Technology,Changa.

Anand-388421,Gujarat,India.

Email: hiteshpatel.ec@charusat.ac.in Mob No-7069398235

INTRODUCTIO

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. We have seen an explosion of data change in the Internet and the extensive use of digital media. Consequently, digital data owners can transfer multimedia documents across the Internet easily. Therefore, there is an increase in the concern over copyright protection of digital content [1,2,3]. In the early days, encryption and control access techniques were employed to protect the ownership of media. They do not, however, protect against unauthorized copying after the media have been successfully transmitted and decrypted. Recently, the watermark techniques are utilized to maintain the copyright [4,5].

Many techniques have been used but digital watermarking is new technique to issue these problems [6]. Digital watermarking means embedding the secret information in the form of watermark into the digital multimedia such as image, audio and video. The information that is embedded, is extracted out so as to reveal the real owner/identity of the digital media. After embedding the watermark the original data should not alter much. 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 [7].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 continuous 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 [8].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 [9,10], and discrete cosine transform [11,12].

PRE-PROCESSING PRELIMINARIES

Singular Value Decomposition (SVD)

The SVD is popular mathematical technique that provides tool for analysis of matrices. It is good way for extracting algebraic features from an image [13]. 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 changes is added to an image, SVs does not vary largely. 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:

$$A = USV^T \quad (1)$$

$$U = [u_1, u_2, u_3, u_4, \dots\dots\dots u_n] \quad (2)$$

$$V = [v_1, v_2, v_3, v_4, \dots\dots\dots v_n] \quad (3)$$

$$S = \begin{bmatrix} s_1 & 0 & 0 \\ 0 & s_2 & 0 \\ 0 & 0 & s_n \end{bmatrix} \quad (4)$$

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) small changes SVD does not affect the image quality..

2) They are robust to various attacks such as rotation, scaling, compression, and noise addition and cropping.

3) It extracts algebraic properties of digital image.

Discrete Wavelet Transform

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 [14]. DWT is multi resolution mathematical tool for decomposing an image. An image is considered as two dimensional signals 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 sub band (LH2), the vertical sub-band (HL2), and the diagonal sub-band (HH2). Again decomposition of image results intoLL3, 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 [15].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.

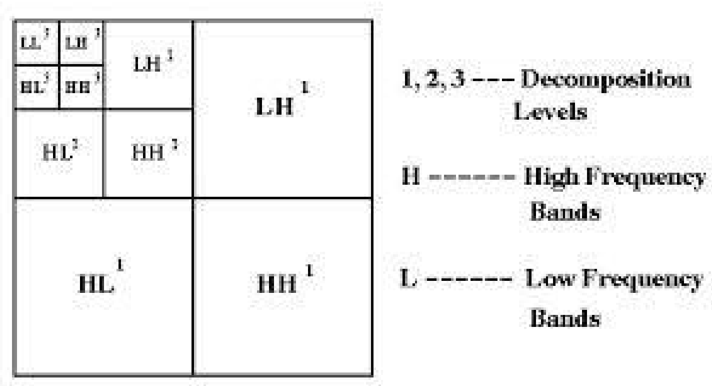

Figure 1. 3-Level DWT

PROPOSED VIDEO WATERMARKING TECHNIQUE

Video watermark embedding process

Proposed video watermarking block diagram is shown in figure 2.

1) Uncompressed video is taken as input which is group of continuous frames. An input video is converted into frames.

2) Frames are converted in to images and random images from videos are selected for watermark embedding process, Which are known to transmitter and receiver side.

3) All selected images are converted in YCbCr format from RGB format and only Y component is selected for watermark embedding process

4) 4-Level Haar based Discrete wavelet transform (DWT) is applied to Y components of selected images and is decomposed into four sub-bands LL_a ,LH_a , HL_a , HH_a , where a Represents the decomposition level.

5) Apply SVD to 4th level mid frequency sub-bands (LH_4 and HL_4) of the Y component.

$$LH_4 = U_{LH} * S_{LH} * \text{Transpose}(V_{LH}) \quad (5)$$

$$HL_4 = U_{HL} * S_{HL} * \text{Transpose}(V_{HL}) \quad (6)$$

6) Select Gray scale image as a watermark for embedding process, number of pixels in watermark image should be equal to nonzero elements in S_{HL} and nonzero elements in S_{LH}.

7) Modify the singular value of S_{HL} and S_{LH} and obtain modified singular value of watermarked image. Where S_{HL} is Singular matrix , S^*_{HL} is modified Singular matrix , k is embedding factor and $W(i,j)$ is watermark image pixel.

$$S^*_{HL} = S_{HL} + k * W(i,j) \quad (7)$$

$$S^*_{LH} = S_{LH} + k * W(i,j) \quad (8)$$

8) Generate mid frequency sub-bands using modified Singular matrix.

$$LH^*_4 = U_{LH} * S^*_{HL} * \text{Transpose}(V_{LH}) \quad (9)$$

$$HL^*_4 = U_{HL} * S^*_{LH} * \text{Transpose}(V_{HL}) \quad (10)$$

9) Generate modified Y component (Y*) using inverse DWT of modified sub-bands.

10) generate watermarked RGB image using Y*CbCr .

11) Compute similarity measurement component $PSNR$ between original video images and watermarked video images.

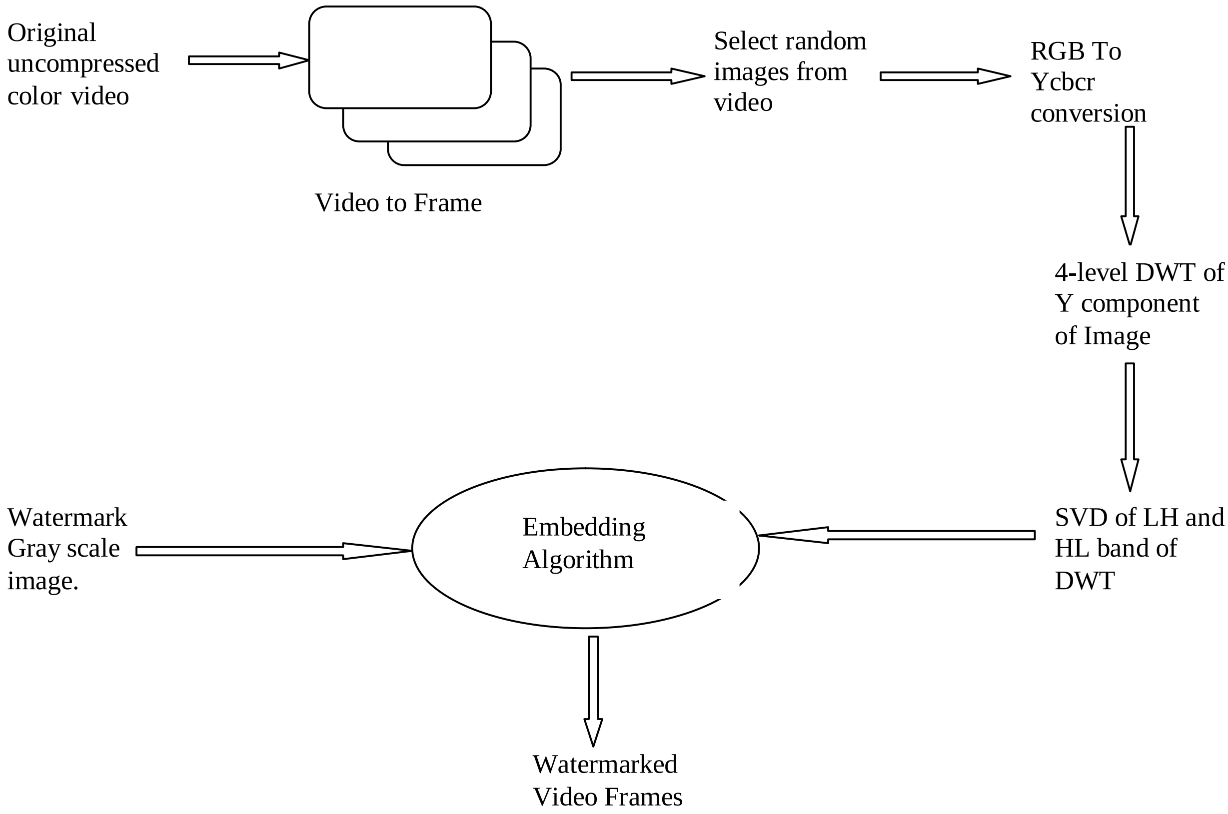

Figure 2. Proposed Video Watermarking Block Diagram

Video Watermark Extraction Process

1) watermarked video is taken as input which is group of continuous frames. An input video is converted into frames.

2) Frames are converted in to images and random images from videos are selected for watermark extraction process.

3) All selected images are converted in Y*CbCr format from RGB format and only Y* component is selected for watermark extraction process

4) 4-Level Haar based Discrete wavelet transform (DWT) is applied to Y* components of selected images and is decomposed into four sub-bands LL_a ,LH_a^* , HL_a^* , HH_a , where a Represents the decomposition level.

5) Apply SVD to 4th level mid frequency sub-bands ($LH_4^*$and HL_4^*) of the Y* component.

$$LH_4^* = U_{LH} * S_{HL}^* * \text{Transpose}\,(V_{LH}) \qquad (11)$$

$$HL_4^* = U_{HL} * S_{LH}^* * \text{Transpose}\,(V_{HL}) \qquad (12)$$

6) Evaluate recovered watermark image using following equation. Where k is the embedding factor used in embedding procedure.

$$W(i,j) = \frac{S_{HL}^* - S_{HL}}{k} \qquad (13)$$

(7) Compute MSE between watermark image and recovered watermark image.

SIMULATION RESULTS

The experimental simulation is carried out using matlabR2016b. In this paper we have taken a standard video ‘Rhinos’ as a host video and the watermark is any image. We have taken k as a scaling factor and its value is 0.1. 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 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:

$$MSE = \frac{\sum_{mn}[i1(i,j) - i2(i,j)]^2}{m*n} \qquad (14)$$

m and n are height and width respectively of the image. The i1 (i, j) is the pixel value of the cover or watermark image and i2 (i, j) is the pixel value of the watermarked image or recovered watermark image. PSNR represents the degradation of the image. It is expressed as a decibel scale. Higher the value of PSNR higher the quality of image. PSNR is represented as:

$$PSNR = 10log_{10}\left(\frac{R^2}{MSE}\right) \qquad (15)$$

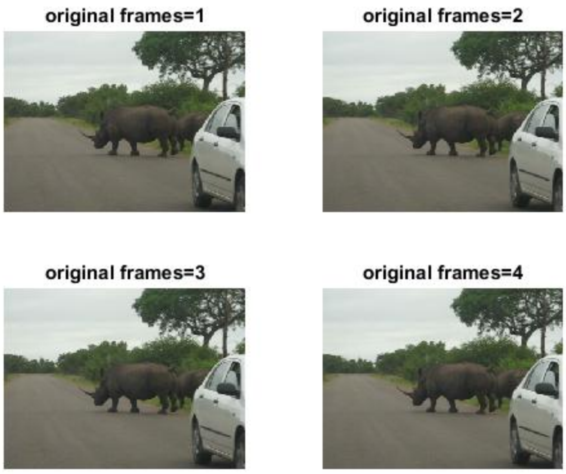

Figure 3. Original Video frames

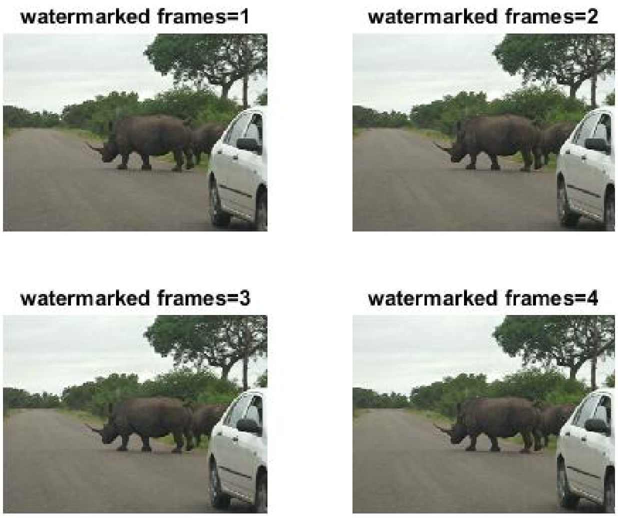

Figure 4. Watermarked Video Frames (PSNR 43.27)

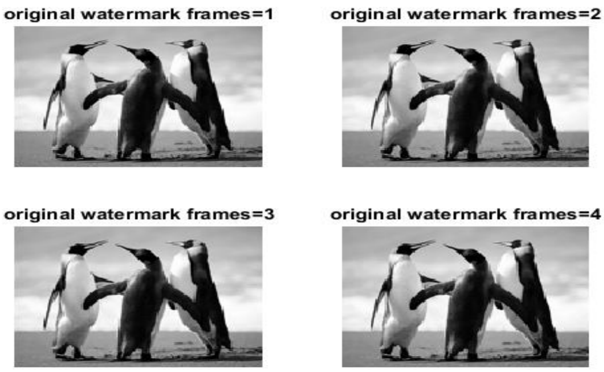

Figure 5.Original Watermark Frames

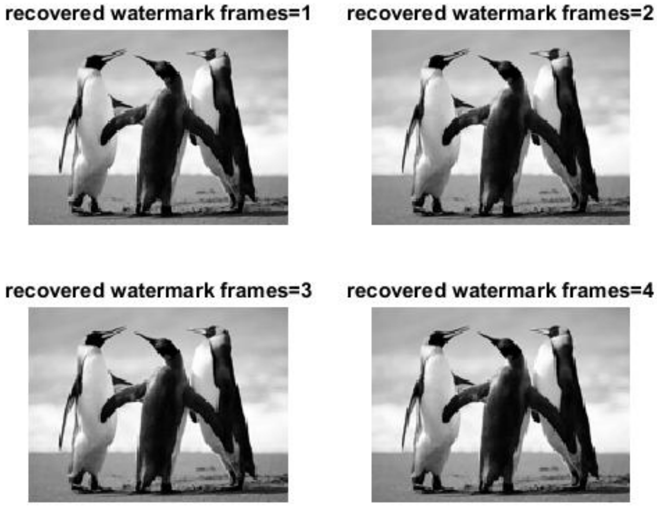

Figure 6.Recovered Watermark Frames Without Noise (PSNR 62 & MSE 0.001959)

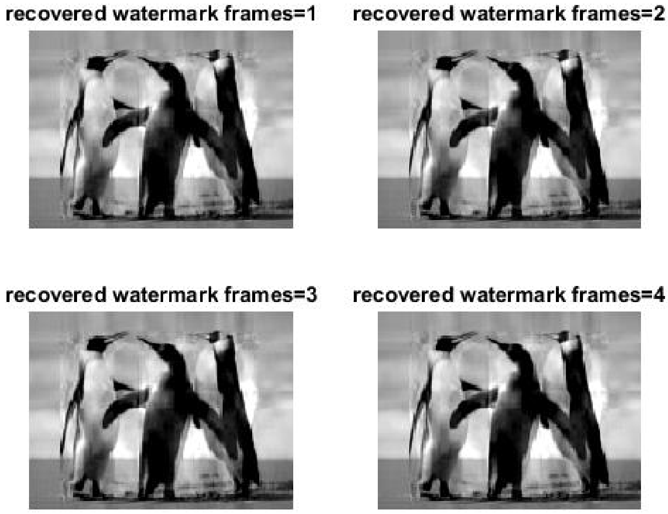

Figure 7. Recovered Watermark Frames With Rotate Operation By 2 Degree (PSNR 21 And MSE 0.9547)

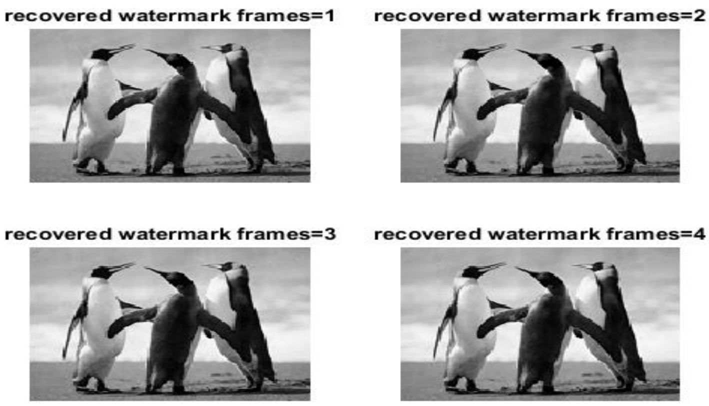

Figure 8.Recovered Watermark Frames With Salt & Pepper Noise (PSNR 32 And MSE 0.08234)

CONCLUSIONS AND FUTURE SCOPE

In this paper a new semi blind scheme has been proposed for video watermarking that is more robust towards attacks represented in simulation. The watermark image has been embedded in random frames of the original video. Since the watermark is embedded in random frames it provide robustness against attacks such as frame dropping, frame averaging and lossy compression. The algorithm has been tested by on many videos 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 film industry application.

The proposed algorithm can be improved by taking variable scaling factor and by embedding bit of watermark image pixels in SVD values of original frames. Also improvement can be done by selecting only some area of original frame without affecting whole frame area.

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