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A SEMI BLIND DWT-SVD VIDEO WATERMARKING

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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; DWT; SVD;

INTRODUCTION

The digital revolution has changed the model of multimedia distribution. High quality copies of digital data are produced and distributed through the internet by exploiting recent network and software technologies. A broad range of application achieved for video such as video broad casting, videoconferencing, DVD, video on-demand and high definition TV which has made a security issues, videos can be tampered, forged or altered easily. Illegal acts such as tampering, forging and altering violate the copyright and the security in respect with cases of authentication. Security techniques that are based on cryptography only provide assurances for data confidentiality, authenticity, and integrity during data transmission through a public channel such as transmission through an open network. However, such security techniques do not provide protection against unauthorized copying or transmitting of illegal materials. This leads to the need for digital watermarking technologies. Video Watermarking is a young and rapidly evolving field in the area of multimedia. Following factors have contributed towards the rising of interest in this field.

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a) The society is contaminated by the tremendous privacy of digital data makes copying of digital media very easy.
b) This is an era where need has to fight against the"Intellectual property right violations".
c) Copyright protections have to be protected from malicious attacks.
d) Tampering of the digital data needs to be kept secret at some point.

The requirement of secure communication and digital data transfer has potentially increased with the development of multimedia systems. Data integrity is not secure in image and video transfers. The main technique used for protection of an Intellectual Property rights and copyright protection is digital water marking. The copyright data may be in the form of text, image, audio, and video. Watermarking may be visible or invisible. It provides methods to solve the problem of illegal copying and manipulations in thedigital data.

Digital watermarking refers to embedding watermarks in a multimedia documents and files in order to protect them from illegal copying and identifying manipulations. This promising technology received a considerable attention for embedding copyright information in a wide range of multimedia applications. In particular, video proposed watermarking techniques embed small copyright information called a watermark in the digital video such that the watermark is imperceptible and robust against attempts to degrade it or remove it from the digital object. Thus avoidingthe copying of the digital data.

WATERMARKING TECHNIQUES

Discrete Wavelet Transform (DWT):

An image is decomposed into four subbands denoted by LL, LH, HL and HH at level 1 in the DWT domain, where LH, HL, and HH represents the finest scale wavelet coefficients and LL stands for the coarse-level coefficients .The lowest resolution level LL consists of the approximation part of the original image .The remaining three resolution levels consist of the detail parts and the LL subband can further be decomposed to obtain another level of decomposition. The decomposition process continues on the LL subband until the desired number of levels determined by the application is reached .LH, HL and HH are the finest scale wavelet coefficients. Since human eyes(HVS) are much more sensitive to the low-frequency part (the LL subband), the watermark can be embedded in the other three subbands to maintain better image quality. In the proposed algorithm, watermark is embedded into the host image by modifying the coefficients of high-frequency bands i.e.HHsubband.

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Singular Value Decomposition (SVD):

Singular value decomposition is a mathematical tool used to decompose a matrix into two orthogonal matrices and one diagonal matrix consisting of the singular values of the matrix. From the point of image processing an image can be considered as a 2D matrix. Therefore, consider an image A to be an m × m matrix; the SVD of A can be given by A = USV, where U and V are orthogonal matrices, and S = diag (λ), is a diagonal matrix of singular values λi = 1, 2 . . . m arranged in decreasing order. The columns of V are the right singular vectors, whereas the columns of U are left singular vectors of the image A. In case of SVD based watermarking, SVD of the cover image is taken and then singular values of the matrix are modified by introducing the watermark. SVD approach has found use in watermarking field because of the fact that singular values obtained after decomposition of the image matrix are very stable and do not change on introduction of small perturbations. Moreover, singular values represent intrinsic algebraic image.

In linear algebra, the singular value decomposition (SVD) is an important factorization of a rectangular real or complex matrix, with several applications in signal processing and statistics. The spectral theorem says that normal matrices can be unitarily diagonalzed using a basis of Eigen vectors. The SVD can be seen as a generalization of the spectral theorem to arbitrary, not necessarily square, matrices.

Suppose M is an mxnmatrix. Then there exists a factorization for M =U$\sum V\ T$of the form where, U is an mxmunitary matrix, the matrix Σ is mxnwith nonnegative numbers on the diagonal and zeros on the off diagonal, and V T denotes the conjugate transpose of V, an nxn unitary matrix. Such a factorization is called a singular value decomposition of M.

1. The matrix V thus contains a set of orthonormal „input" vector directions for the matrix M.
2. The matrix U contains a set of orthonormal „output" basis vector directions for the matrix M
3. The matrix Σ contains the singular values, which can be thought of as scalar „gain controls" by which each corresponding input is multiplied to give a corresponding output.

DWT-SVD BASED WATERMARKING

Robustness, capacity and imperceptibility are the three important requisites of an efficient watermarking scheme. Ordinary SVD based watermarking scheme has high imperceptibility. Although the SVD based scheme withstands certain attacks, it is not resistant to attacks like

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rotation, sharpening etc. Also SVD based technique has only limited capacity. These limitations have led to the development of a new scheme that clubs the properties of DWT and SVD.DWT based technique is one of the most popular transform domain techniques.

This particular algorithm proves to be better than ordinary DWT based watermarking and ordinary SVD based watermarking scheme. The above mentioned SVD-DCT scheme has enormous capacity because data embedding is possible in all the sub-bands. Watermark was found to be resistant to all sorts of attacks except rotation and achieved good imperceptibility. The disadvantage is that the embedding and the recovery are time consuming process because the zigzag scanning to map the coefficients into four quadrants based on the frequency, is a time consuming process. Alternatively if we apply DWT we get the four frequency sub-bands directly namely; approximation, horizontal, vertical and diagonal bands. So the time consumption will be greatly reduced.

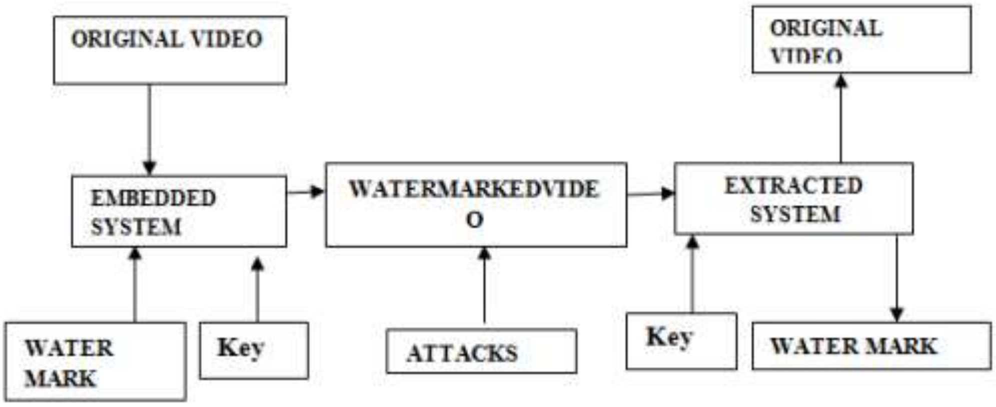

Fig 1: Block diagram of Video Watermarking

ASPECTS OF VIDEO WATERMARKING:

A. **Fidelity:** An effective watermarking system should meet a high level fidelity as one the main requirements of watermarking. The distortion made through the watermark should be less.
B. **Robustness:** Robustness refers to that watermark should not be destroyed if someone performs the common manipulations and any malicious attacks.
C. **Use of the key:** The improvement of security by using a secret key is involved with cryptography techniques which enhance the robustness of the watermarking algorithm
D. **Speed:** With development of high speed hardware‟s and computing technologies, speed became as a least requirement is a watermarking system.

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E. **Capacity:** Capacity refers to a maximum number of bits are allowed to embed in a cover media. The size of the watermark depends on application which determines the type of watermark data and embedding policy.
F. **Statistical imperceptibility:** The watermark should be statistically imperceptible. It means a statistical analysis should not be able to reveal the watermark.

TERMINOLOGIES OF VIDEO WATERMARKING

Video watermarking embeds data in the video for the purpose of identification, annotation and copyright. A number of video watermarking techniques have been proposed. These techniques exploit different ways in order to embed a robust watermark and to maintain original video fidelity. Conventional encryption algorithms permit only authorized users to access encrypted digital data. Once such data are decrypted, however, there is no way in prohibiting its illegal copying and distribution. The important terminologies pertaining to digital video watermarking are:

Digital Video

Video sequence is a accumulation of sequential and equally time spaced still images.

Payload

It is the amount of data that can be stored in a watermark. A vital idea in regards to the video watermarking payload is watermark granularity. Watermark granularity can be characterized as the amount of information is needed for embedding one unit of watermark data.

Perceptibility

Video watermarking procedure is called imperceptible if humans cannot recognize the original video from the video with embedded watermark.

Robustness

A fragile watermark should not be robust against intentional modification techniques, as failure to detect the watermark signifies that the received data is no longer authentic. In case of application such as copyright protection, it is desirable that watermark always remains in the video data, even if the video data is subjected to intentional and unintentional signal processing attacks. Hence, depending on the requirements of the application the watermark is embedded in a robust, semi-fragile or fragile manner.

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Security

The security of the watermarking algorithm is ensured in the same way as in encryption methodology. According to the Kerckhoff's assumption, the algorithm for watermark embedding can be considered to be public, where as the security depend solely on the choice of a key from a large key space.

Video watermarking is not a standalone technology. It can be associated with different approaches to achieve a sophisticated system. This research can be continuous by applying this new proposed scheme to specific environment or application and examine its usefulness.

PROPOSED VIDEO WATERMARKING TECHNIQUE

Video Watermark Embedding Process

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

2) Discrete wavelet transform (DWT) is applied to frame A and is decomposed into four sub-bands LL_a,LH_a,HL_a and HH_a

3) Apply SVD to high frequency sub-band of the original frame.

$$HH_a = U_a^h S_a^h V_a^h$$

4) Discrete wavelet transform is applied to the watermark image W and decomposed into four sub-bands:

LL_w, LH_w, LH_w and HH_w

5) Apply SVD to high frequency sub-band of the watermark

$$HH_w = U_w^h S_w^h V_w^h$$

6) Modify the singular value and obtain singular value of watermarked image.

$$S_w^{*h} = S_a^h + k * S_w^h$$

Where k is a scaling factor.

7) Apply SVD on obtained singular value:

$$S_w^{*h} = U_a^{hh} S_a^{hh} V_a^{hh}$$

8) Using DWT to S_a^{hh} obtain HH_a^*

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$$HH_a^* = DWT(S_a^{hh})$$

9) Apply IDWT to obtain watermarked cover image A* using LL_a,LH_a,$HL_a$and HH_a^*

Video watermarking Extraction Process

1) Decompose the watermarked image A* into four sub bands using DWT:LL_a,LH_a, $HL_a$and HH_a^*

2) Apply SVD to high frequency sub-band HH*a

$$HH_a^* = U_{wa}^h S_{wa}^h V_{wa}^h$$

3) Decompose the original image A into four sub-bands.

4) Apply SVD on high frequency sub-band of original image, as in embedding process.

$$HH_a = U_a^h S_a^h V_a^h$$

5) Using DWT decompose watermark image W, into four sub-bands and apply SVD to high frequency sub-band as in embedding process:

$$HH_w = U_w^h S_w^h V_w^h$$

6) Extract the singular value of high frequency sub-band watermark image:

$$S = (S_w^h - S_a^h)/k$$

7) Using above S recover the high frequency sub-band of watermark image:

$$HH_w = U_w^h S_w^h V_w^h$$

8) Using LL_w, LH_w, LH_w and HH_w apply IDWT to recover the watermark image W .

SIMULATION RESULTS

The experimental simulation is carried out using matlabR2010b. 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 0.2. 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

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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:

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

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:

$$\mathrm{PSNR} = 10\log10\left(\frac{L*L}{\mathrm{MSE}}\right)$$

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.

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

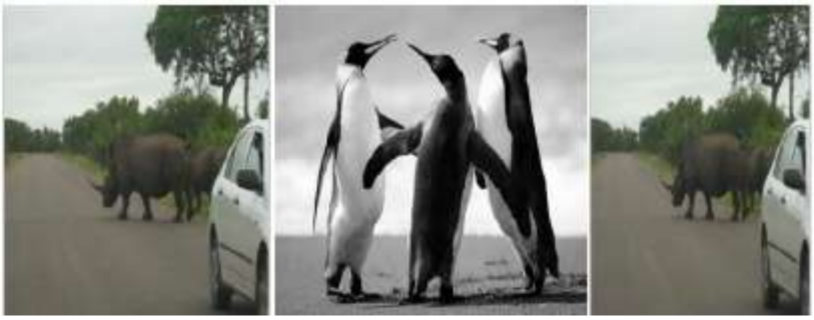

Fig. 2. a) Original First Video Frame b) Watermark c) Watermarked Fisrt frame

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

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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 I. 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, poisons noise, salt and pepper noise, blur, frame averaging and rotation. These attacks are applied on each frame of the

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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. Table 2 shows the various attacks, its PSNR and CC.

TABLE II. VALUES OF PSNR AND CC OF EXTRACTED WATEMARK AFTER APPLYING VARIOUS ATTACKS ON THE ORIGINAL VIDEO

Extracted Watermarks	**Different Attacks**	**PSNR(dB)**	**CC**
	Gaussian noise	33.2908	0.9956
	Poisson Noise	35.6241	0.9742
	Salt and pepper Noise	32.3132	0.9904
	Blur	36.8717	0.9940
	Frame averaging	38.5889	0.9946
	Rotation	38.2881	0.9955

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CONCLUSIONS

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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