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ADAPTIVE VIDEO WATERMARKING WITH ROBUST PCA-BASED DECODING

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ABSTRACT

Data embedding and recovery in video watermarking, without loss of quality is a challenging one. A new method for video watermarking is presented in this paper. In the proposed method, we use undecimated wavelet transform. The location for data embedding in the LL subband of wavelet coefficients are selected adaptively based on the energy of high frequency subbands. The decoding is performed based on the comparison among the elements of the first principal component resulting from empirical principal component analysis (PCA). Testing and analysis were done by subjecting the watermarked video to various attacks like cropping, filtering and rotation. The results show that the proposed method offers improved performance compared with several conventional methods. Thus this adaptive stationary based data insertion is much suitable for various security multimedia based applications.

Keywords: video watermarking, principal component analysis, undecimated wavelet transform, decoding.

1. INTRODUCTION

Video Watermarking is an evolving field in the area of multimedia major issues include (1) Lack of privacy of digital data, when copying digital media. (2) Need for Intellectual property rights. (3) Copyright protection. (4) The copyright data may be in the form of text, image, audio, and video [7, 8, 9] interference of the digital data. Data integrity is not secure in video transfers. The technique used for the Intellectual Property rights and copyright protection is digital water marking. The text, image, audio, and video [1, 2, 3] are in the form of copyright data. Invisible watermarking is taken into account in this work. The Discrete Wavelet Transform (DWT) [6] is taken into account which transforms different domain techniques, but complementary, levels of robustness against the same attack.

One of the major obstacles in the computer network is the lack of effective intellectual property and protection of digital media which results in discourage of unauthorized copying and distribution. Hand-written signatures, seals or watermarks have been used from ancient times as away to identify the source, creator of a document or a picture. Ease of replication, ease of transmission and plasticity of digital media include in copyright issues. In face of the challenges derived from the characteristics of digital media and internet revolution, digital watermarking has been proposed. The proposed model perceptual model shows high fidelity and very effective. Through the computer simulations, it will be shown that the proposed watermarking algorithm [1] with the perceptual model. There are two kinds of watermark like embedding a watermark in compressed domain, embedding a watermark in uncompressed domain. There are 2D and 3D watermarking in uncompressed domain. The method has the disadvantage that is to need the original video stream and videos with high motions are relatively weak. Thus the proposed method embeds watermarks at the mid-range coefficients. Insertion and extraction streams are proposed. Detecting watermarks in received signals done by identification of watermarking patterns. The original signals are often highly non-Gaussian. Detection of multiplicative watermarks can be applied to copyright notification by robust optimum. Robust optimum watermarking detection has been applied to video watermarking.

Novel optimum detectors for multiplicative Watermarks [3] are derived using locally optimum detection for the generalized Gaussian distributions. Crucial requirements for valid invisible watermark detection are taken into consideration. Original image not be directly involved in the watermark detection process. Thus Digital media have made media security a very important issue. Digital watermarks have been proposed for intellectual property right protection of multimedia data. Digital watermarks can be used to identify the rightful owner, with the signature from the watermarked data. A statistical technique for detecting the invisible watermarks is then proposed [4] which will quantify the confidence of the detection probability and the optimal detection strategy is also analyzed. Thus in this paper we propose some video model based watermark encoding schemes, which is robust for resolving the dispute of rightful ownership. The rest of the paper is organized as follows: Section 2 summarizes the related work section 3 describes the system discusses the detailed design of the system model. Section 4 describes the issues of the proposed model. Section 5 concludes the paper.

2. RELATED WORKS

The related work discusses about the previous work carried out in the area of image processing and we have also discussed about how to add image in video using video processing.

a) Ownership verification of digital images using wavelet-based watermarking algorithm

Due to multiple networks, Digital Water Marking came into existence which leads to unauthorized copying and distribution of multimedia where Private control of the watermark is taken into consideration. Watermark is made

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invisible due to different frequencies. The algorithm inserts watermark into the middle frequency range to achieve invisibility and robustness. Randomly generated ortho normal filter banks is used as private key. A watermarking algorithm for ownership verification should avoid performing such subtraction in the detection process. The proposed algorithm achieves invisibility, robustness, resilience to counterfeit attacks, and provides private control of the watermark. The detection process does not subtract the original image, hence avoiding ambiguity. The storage requirement for the watermark and the size of overhead storage for the private keys are reasonable as well.

b) Image-adaptive data hiding and error correction

The hidden data can be recovered reliably under attacks by compression and limited amounts of image tampering and image resizing. The three main findings are as follows.1) In order to limit perceivable distortion while hiding large amounts of data, hiding schemes must use image-adaptive criteria in addition to statistical criteria based on information theory. 2) Potentially cause desynchronization of the encoder and decoder, while choosing local criteria to hide data. 3) For simplicity, scalar quantization-based hiding is employed, even though information-theoretic guidelines prescribe vector quantization-based methods. The hider is allowed to induce a mean squared error, while an attacker operating on the host with the hidden data is allowed to induce a mean squared error.

c) Video watermarking based on discrete wavelet transform domain

The video frames are transformed with the DWT using two resolution levels, in the proposed DWT-based SVD video watermarking method which is characterized by two improvements. Two powerful mathematical transforms; (1) The Discrete Wavelet Transform (DWT)-based SVD using additive method, and (2) an error correction code is applied. The high frequency band HH and the middle frequency bands LH and HL are SVD transformed and the watermark is hidden in them. The high and middle frequency bands HH, LH and HL are SVD transformed and a watermark is embedded in the diagonal matrix of each band. The robustness against attacks based on video characteristics and the robustness against image processing attacks is increased which realize high security level, protect the watermark against bit errors and obtain good perceptual quality.

3. SYSYTEM MODEL

a) Watermark embedding process

The architecture diagram of the proposed system is as shown in Figure-1 and 2. The input video is taken as input which is divided into sequence using scene Detection Algorithm. The Generated Video Sequence is divided into Frames. The frames are divided into non overlapping blocks. Cubes are generated from each of the divided blocks. PCA is applied for Selected Cubes. Apply SWT to each Block. Strength factor is calculated for Embedding strength. Then Watermarking Embedding calculation is done. Inverse SWT is applied. Finally by reconstructing the watermarked frame watermarked video is obtained.

b) Watermark extraction process

Video Sequences are divided into scenes using Scene Change Detection Algorithm. During Cube Selection process, the cube is selected as well as process video scenes and Side information is added. Then the cubes are applied to SWT.$\check{X}^{W}$(Element of the first row in the matrix) is applied to First Principal Component. AUX bit is calculated using $\check{Y}^{W}$(Element of first column in the matrix). Then Secret Key is added to the video. Finally Watermark bits are obtained.

c) Undecimated algorithm

To overcome the lack of translation-invariance of the discrete wavelet transform (DWT) the stationary wavelet transform (SWT) algorithm is designed. Translation-invariance is achieved by removing the down samplers and up samplers in the DWT. The output of SWT contains the same number of samples as the input – so there is a redundancy. This algorithm is known as "algorithme à trous" which was introduced by Holschneider *et al.*

This algorithm is based on no decimation. It both down sampling in the forward and up sampling in the inverse transform is omitted. It applies the transform at each point of the image. From level to level there is very small step in the scaling filter - instead of 8 pixels at the third level of DWT, here its width is 5 pixels where the information is more precise. Removal of the noise only at the places that it really exists, without affecting the neighboring pixels.

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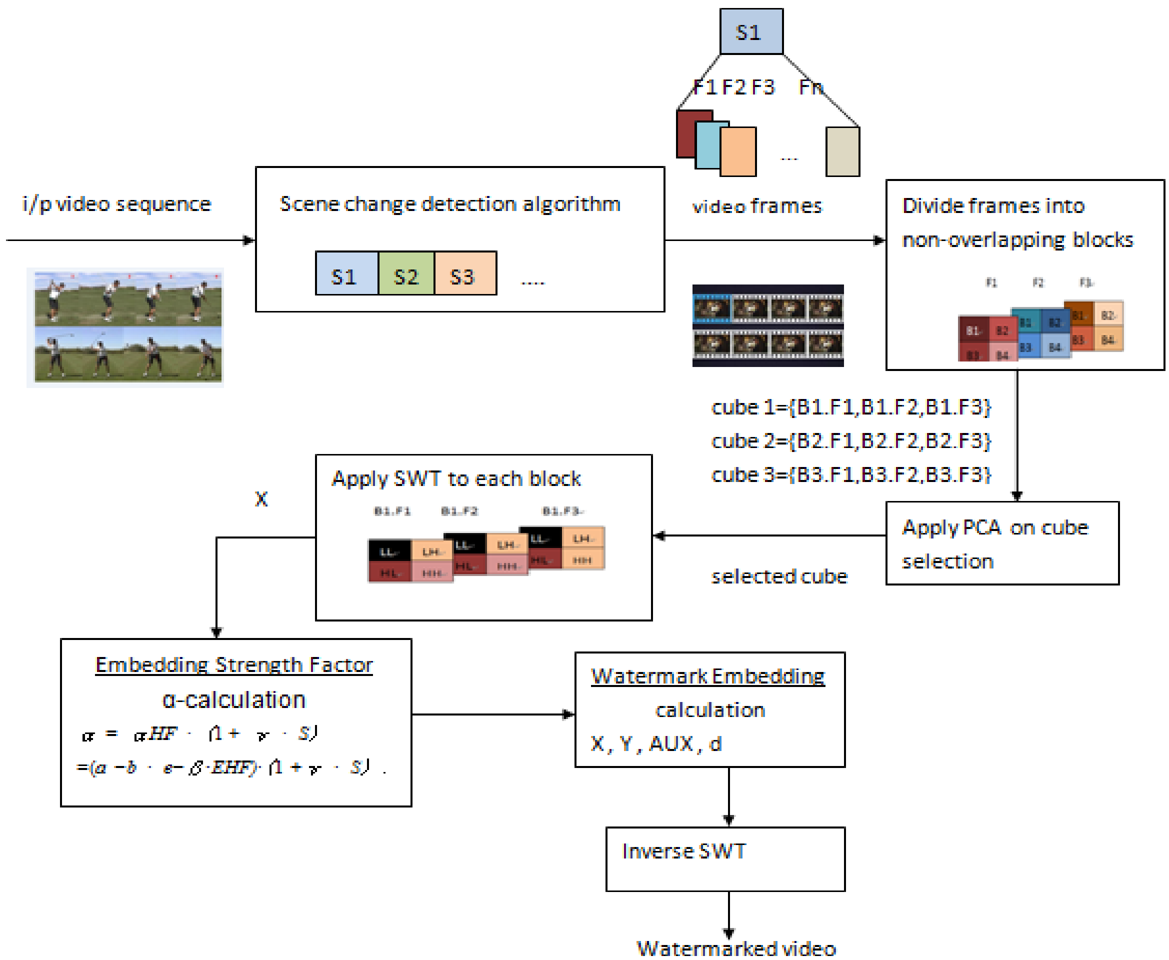

Figure-1. Watermark embedding.

Visual quality is given importance in analyzing the results –two reconstruction schemes were tested. The first one applies the inverse decimated wavelet transform without the up-sampling. The second one applies the traditional inverse transform at each level and then down sample the result in order to use it for the next level. The steps for this scheme are:

1. Compute the standard inverse transform for the final level. This gives an array that has double size in each direction.
2. Decimate (down sample) the result and use it for the next level. Decimation reduces the size of the array back to the original, so we can use it for computing the next level.

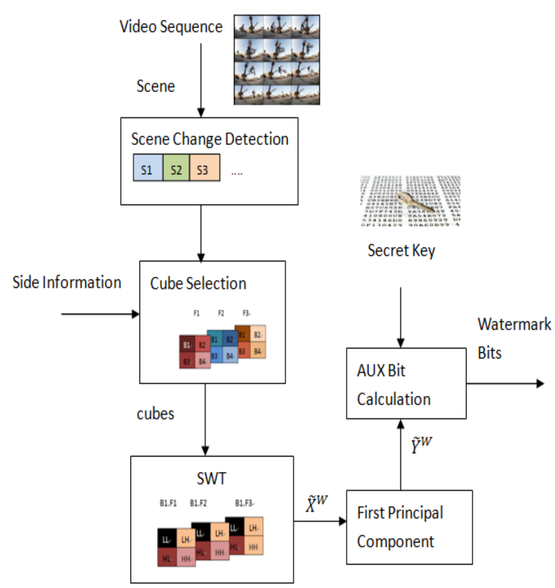

Figure-2. Watermark decoding.

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d) E-Decimated Wavelet Transform

- In DWT, the signal is convolved and decimated.
- Odd indices are chosen by carrying out the decimation.
- We will have 2J decompositions for J decomposition levels, which possible DWTs of the signal is performed in all ways.
- Let us denote 2j = 1 or 0 the choice of odd or even indexed elements at step j. Every ε decomposition is represented as sequence of 0's and 1's. This transform is known as ε-decimated DWT.

$$d^{j} = D_{\epsilon_j} G D_{\epsilon_{j+1}} H D_{\epsilon_{j+2}} H \ldots D_{\epsilon_{J-1}} H_{c^J} = D_0 S^{\epsilon_j} G D_0 S^{\epsilon_{j+1}} H D_0 S^{\epsilon_{j+2}} H \ldots D_0 S^{\epsilon_{J-1}} H_{c^J} = D_0 G (D_0 H)^{J-j-1} S^{S_2} C^{J} \quad (1)$$

$$S^{S_1} d^{j} = S^{S_1} D_0 G (D_0 H)^{J-j-1} S^{S_2} C^{J} = D_0 G (D_0 H)^{J-j-1} S^{S} C^{J} \quad (2)$$

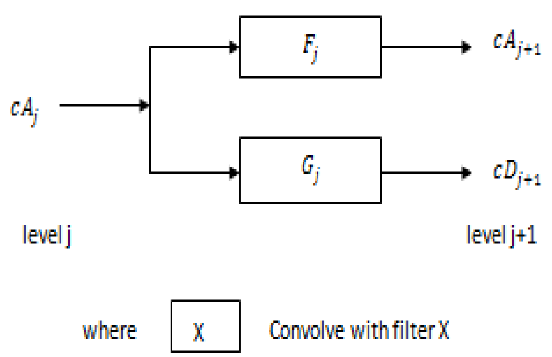

Figure-3(a). Decomposition step.

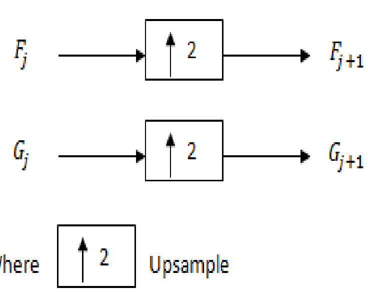

Figure-3(b). Filter computation.

$$cA_0 = sF_0 = L_0\_DG_0 = H_i\_D$$

Figure-3(c). Initialization.

Figure-3. One-Dimensional SWT.

4. RESULTS

a) Peak Signal to Noise Ratio (PSNR)

The deviation of the watermarked video frames is measured using The Peak-Signal-To-Noise Ratio (PSNR) and is defined as:

$$PSNR = 10 log_{10}(255^2/MSE) \quad (3)$$

Where MSE (mean squared error) between the original and distorted frames (size m x n) is defined as:

$$MSE = (1/mn) \sum_{i=1}^{m} \sum_{j=1}^{n} [I(i,j) - I'(i,j)] \quad (4)$$

Where *I* and *I′* are the pixel values at location (i, j) of the original and the distorted frame, respectively. Higher values of PSNR indicate more imperceptibility of watermarking. It is expressed in decibels (dB).

b) Median filter

To decide whether or not it is representative of its surroundings it replaces it with the *median* of those values, each pixel in the image considers median filter. The *mean* of neighboring pixel values can replace by pixel value. The surrounding neighborhood pixel values sorted into numerical order the median is calculated and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration has an even number of pixels, The average of the two middle pixel values is used).The noise and the fine detail are removed by median filter. The median filter can't distinguish fine detail from noise.

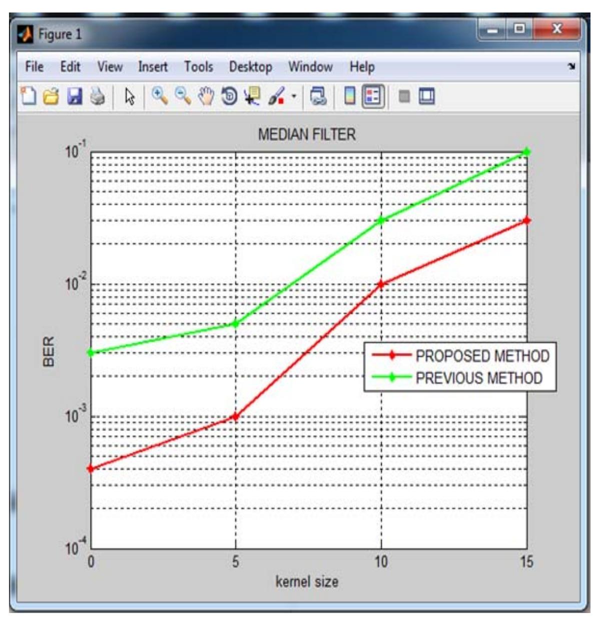

Figure-4. Uniform noise.

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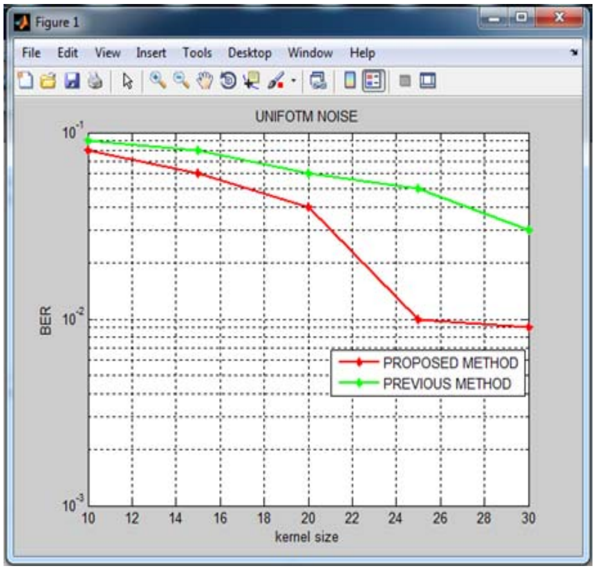

Figure-5. Uniform noise.

5. CONCLUSIONS

Original quality of video will not get affected. Due to multi resolution characteristics of SWT this scheme is robust against several attacks. In this process the PSNR value is same for per attack. PSNR & MSE values are depending on strength. When strength value have minimum then PSNR will be more & MSE will be less. Otherwise when strength value have maximum then PSNR will be less & MSE will be more. The maximum coefficient of the PCA block embedded in watermark so we get high imperceptibility where there is no noticeable difference between the watermarked video frames and the original frames.

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