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Advance Digital Video Watermarking based on DWT-PCA for Copyright protection

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Abstract:
Now a days there is use of digital multimedia applications are increased. Digital image watermarking techniques can be classified into spatial or transform domains. The spatial domain methods are the simplest watermarking techniques but have low robustness against different attacks, unlike the transform domains watermarking methods are more complex and have high robustness against various attacks. Most commonly used methods of watermarking are discrete cosine transform (DCT), discrete wavelet transform (DWT).A hybrid digital video watermarking scheme based on Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA). These transform domain technique always give
more robust output than DCT and DWT The video frames are first decomposed using DWT and the binary watermark is embedded in the principal components of the low frequency wavelet coefficients Here in order to improve the robustness of water mark Haar filtering must be used in order to get PSNR as much as possible Experimental result shows no visible difference between the watermarked frames and original frame. It shows robustness on the watermarked video against various attacks. Peak signal to noise ratio (PSNR) is calculated to measure efficiency of this all methods. And this value must be increased up to the level.
Keywords: DWT, DCT, PCA, binary watermark.

I. Introduction

The basic popularity of multimedia applications [1] is to provide copyright protection to prevent illicit copying and distribution of digital video. Copyright protection means inserting authentication data such as data such as ownership information and logo in the digital video that we want to protect. The authentication data can also extracted from the video and it can be used as authoritative proof to prove the ownership. Hence Digital Video Watermarking for copyright protection [2,3] technique newly emerged in the field of research. Watermarking is the process in which data embeds called watermark into the video or any kind of object and it can also be detected and extracted from the video to make an assertion about video or object. Digital watermarking techniques provides criteria of imperceptibility as well as robustness against all attacks [4,5]. Many digital watermarking schemes have proposed for still images and videos [6]. Hence some of which operate on uncompressed videos [7-8], and others embed watermarks directly into compressed videos [7].Video watermarking can be classified into two categories which is based on the method of hiding watermark bits into the host video. These two categories are: Spatial domain & Transform domain. In Spatial domain watermarking, embedding and detection of watermark are performed by directly selecting the pixel intensity values of the video frame. On the other hand Transform domain [9] techniques, alter spatial pixel values of the host video according to a predetermined transform and it is observed that Transform domain more robust than spatial domain techniques.

In this paper, I propose the advance use of Discrete Wavelet transform[10,11] & Principle Component Analysis[12] in Digital Video Watermarking. There are different types of transforms which are DFT, DCT, DWT etc. The DWT is more fast & computationally more efficient than other transforms.DWT has excellent spatio-frequency properties hence it is used to identify the areas to which the watermark can be embedded imperceptibly. The watermark is embedded into the luminance component of the extracted frames as it is less sensitive to the human visual system (HVS).The paper is presented in the form of chapters as follows; as chapter I contains introduction, chapter II contains watermarking scheme with DWT & PCA, chapter III . contains system flow, algorithms and performance analysis with results and finally chapter IV contains conclusion.

II. PRESENT TECHNIQUES

Techniques used for Video Watermarking:

Video watermarking involves embedding information into the frames of the video. It is an extension of image watermarking and hence the techniques used for image watermarking can be applied to watermark video content as well. Video watermarking can be done on spatial domain; frequency domain. Spatial domain video watermarking is much simpler than frequency domain video watermarking however frequency domain watermarking is comparatively more robust and can withstand most of the unintentional attacks. Widely used frequency transforms are DFT (Discrete Fourier Transform), FFT(Fast Fourier Transform), DCT (Discrete Cosine Transform) and DWT (Discrete Wavelet Transform).

Domain

Different digital video watermarking algorithms have been proposed. Video watermarking techniques are classified according to their working domain .Some techniques embed watermark in the spatial domain by modifying the pixel values in each frame extracted from the video. These methods are not robust to attacks and common signal distortions. In contrast, other techniques embed the watermark in the frequency domain, which are comparatively more robust to distortions.
modifying the pixel values of the host image or video directly. In case of attacks destroying data, a single surviving watermark can be considered a success. Although they are robust to attacks like cropping, noise, lossy compression, etc, an attack that is set on a pixel to pixel basis can fully uncover the watermark, which is the major drawback of the system. The major advantages of pixel based methods are that they are conceptually simple and have very low computational complexities. Therefore they are widely used in video watermarking.

B. Frequency Domain Watermarking

In frequency domain techniques, the watermark is embedded by modifying the transform coefficients of the frames of the video sequence. The most commonly used transforms are the Discrete Fourier Transform (DFT), the Discrete Cosine Transform(DCT), and the Discrete Wavelet Transform (DWT).The watermark is embedded distributive in overall domain of an original data. Here, the host image/video is first converted into frequency domain by transformation techniques. The transformed domain coefficients are then altered to store the watermark information. The watermarked image/video is finally obtained by applying the inverse transform. Several researches concentrated on using DWT because of its multi resolution characteristics, it provides both spatial and frequency domain characteristics so it is compatible with the Human Visual System (HVS). Also the recent trend is to combine the DWT with other algorithms to increase robustness.

III. WATERMARKING SCHEME WITH DWT & PCA

The watermarking scheme contains algorithm which is implemented by using DWT & PCA. So, let us discuss about DWT & PCA.

1.Discrete Wavelet Transform

Discrete Wavelet Transform mostly used in the applications of signal processing. A single stage wavelet transformation consist of filtering operation that decomposes an image into four frequency bands as shown in (fig 1). It is 2D-DWT which is an application of 1D-DWT in horizontal & vertical directions. The top-left corner of the transformed image („LL‟) is the original image. The top-right corner(„HL‟) consists of residual vertical frequencies , the bottom-left corner („LH‟) contains residual horizontal frequencies and the bottom-right corner („HH‟) contains residual diagonal frequencies. The wavelet decomposition has some important properties. First, the number of wavelet „coefficients‟ is the same as the number of
pixels in the original image and so the transform is not inherently adding or removing information. Second, many of the coefficients of the high-frequency components(„HH‟, „HL‟ and „LH‟ at each stage) are zero or insignificant. This reflects the fact that much of the important information in an image is low-frequency. Third, the decomposition is not restricted by block boundaries (unlike the DCT) and hence may be a more flexible way of de-correlating the image data (i.e. concentrating the significant components into a few coefficients) than the block-based DCT. Since the HVS is less sensitive to high frequencies, embedding the watermark in high frequency sub-bands makes the watermark more imperceptible while embedding in low frequencies makes it more robust against
Various attacks

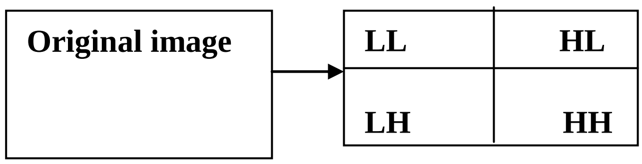

Figure:2D Dwt bands

Principle Component Analysis :

PCA is a useful statistical technique that has found application in fields such as face recognition and image compression, and is a common technique for finding patterns in data of high dimension[13]. It uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of uncorrelated variables called principal components. PCA is used for identifying patterns in data and expressing it by their similarities and differences. The advantages that PCA is powerful tool in the analysis of data, also once patterns in data get identified data can be compressed by reducing number of dimensions without loss in information. It covers standard deviation, covariance, eigenvectors and eigen values[13]. The data with maximum covariance are plotted together and is known as the first principal component. The first principle component contains maximum energy concentration.

Standard Deviation :

The average distance from the mean of the data set to a point. The way to calculate it is to compute the squares of the distance from each data point to the mean of the set, add them all up, divide by n-1 and take the positive square root[13].

Covariance :

Covariance is such a measure. Covariance is always measured between 2 dimensions. A measure of how much each of the dimensions varies from the mean with respect to each other [13].

Eigen vectors :

Eigenvectors can only be found for square matrices. And, not every square matrix has eigenvectors. For n x n matrix there are n eigenvector[13].

IV. SYSTEM FLOW

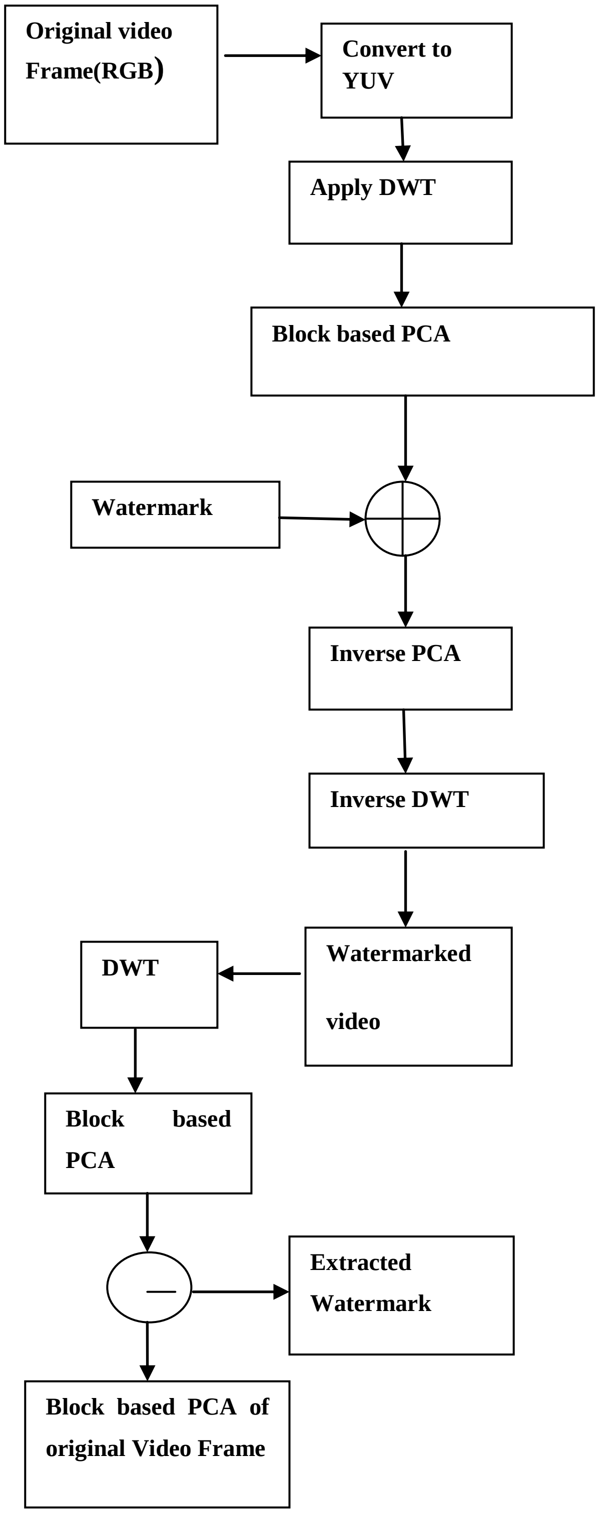

Figure: Block Diagram of Watermarking

It consist of two algorithms ,Algorithm 1and Algorithm 2 Algorithm 1 consist of embedding and extraction algorithms respectively.

Algorithm 1:
Embedding algorithm:

Step 1: The original input video contains n number of frames, convert into binary frame of „0"s & „1" Step 2: Take one frame and convert from RGB to YUV colour format

Step 3: Take luminance component of one frame and apply DWT we obtain four sub bands as shown in above diagram.

Step 4: Take LL component and apply PCA .

Step 5: From algorithm 2 obtain the principle component PC and watermark bits are embedded with factor α. The embedding is carried out by equation

$PC_i^{'}=PC_i+\alpha w$

where PC_i represents the principal component matrix of the i^{th}

sub-block.

Step 6: Apply inverse PCA to the sub-blocks of the LL sub-band to obtain the modified wavelet coefficients.

Step 7: Apply inverse DWT we obtain the watermarked luminance component of the frame. The frame is in YUV format then convert into original RGB component.

Extraction algorithm

Step 1:The Extraction process is totally reverse process of embedding procedure.

Step 2: And finally watermark bits are extracted from the principal components of each sub-block as in equation

$w_i^{'}=\frac{PC_i^{'}-PC_i}{\alpha}$

where $w_i^{'}$ is the watermark extracted from the i^{th} sub block.

Algorithm 2

The LL sub-band coefficients are transformed into a new coordinate set by calculating the principal components of each sub-block (size n x n).

Calculate vector PC_i as

$PC_i = Z \times coefficient$

where PC_i represents the principal component matrix of the i^{th} sub-block.

Where $Z=\frac{(D-\mu)}{\sigma}$ where D –row vector and µ-mean and **σ** standard deviation.

Performance Analysis:

The performance of the algorithm has been measured in terms of its imperceptibility and robustness against the possible attacks like noise addition ,filtering, geometric attacks etc. by using the nature of PSNR & NC

The PSNR is calculated by the following formula

$$PSNR = 10\log_{10}\left(255^2/_{MSE}\right)$$

Where MSE (mean square error) between the original and distorted frames

Higher values of PSNR indicate more imperceptibility of watermarking. it is expressed in decibels.

NORMALIZED COEFFICIENT:

The normalized coefficient represents the robustness of watermarking and its peak value is 1.

V. Results

The proposed algorithm is applied to a "demo_video.avi". sample video sequence "demo_video.avi" using a 2.01 kb watermark logo below figures shows the original and watermarked frames respectively.

(a)

(b)

Original video frame (b) watermarked frame

Figure: Original and recovered watermark

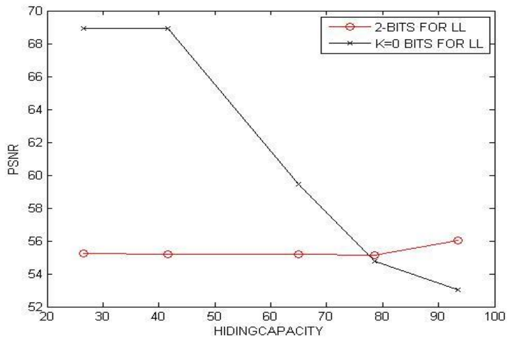

Figure: PSNR Vs Hiding Capacity

Table1:

Alpha	Gaussian noise	Cropping noise	Rotate noise	NC
10	0.927	0.9726	0.9726	0.9726
30	0.9852	0.9852	0.9853	0.9852
50	0.9913	0.9913	0.9914	0.9913
90	0.9956	0.9986	0.9957	0.9995
150	1	1	1	1

VI. CONCLUSION

The Digital Video Watermarking using DWT-PCA is robust and imperceptible in nature and embedding the binary watermark in the low LL sub band helps in increasing the robustness of the embedding procedure without much loss of information and quality of video. And addition to this using of Haar- filter filters the noise component at the detection .As a future work the video frames can be subject to scene change analysis to embed an independent watermark in the sequence of frames forming a scene, and repeating this procedure for all the scenes within a video. The future scope of this is used as Owner Identification ,Proof of Ownership ,Transaction Tracking, Content Authentication ,Broadcast Monitoring ,Device Control ,Automatic monitoring of copyrighted material on the Web etc.

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