Video Watermarking Technique using DWT,SVD and Frame Difference

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1 abstract

Internet is used in wide manner as it resulted in many new opportunities for the creation and delivery of content in digital form application includes like electronic advertising, real-time video and audio delivery, digital repositories and libraries, and Web publishing.Wide use of internet and its application arises an important issue of protection of the rights of all participants.

For these problems Digital Watermarking provides a solution. Digital Watermarking involves embedding secret symbols known as watermarks within video data which can be used later for copyright detection and authentication verification purposes and by this we can avoid the illegal copying of digital data to a great extent.

In this paper we use the SVD (singular value decomposition) and DWT (discrete wavelet transform) based video watermarking.

2 Introduction

Digital Watermarking use methods and technologies that hide information like a number or text and in digital media, such as images or video.

The embedding of secret symbols or watermark takes place by manipulating the content of the digital data, which means the information is not embedded in the frame around the data like for images this means that the modifications of the pixel values have to be invisible. A digital watermark is a message which is embedded into digital content (video, images or text) that can be detected or extracted later.

Application of video such as video broadcasting,video conferencing, DVD, video on-demand and high definition TV which has made a security issues, videos can be tampered, forged or altered easily which violate the copyright and the security in respect with cases of authentication.

Many Security techniques used for that like security based on cryptography that only provide assurances for data confidentiality, authenticity, and integrity during data transmission through a public channel. However, that type of 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 rapidly evolving field in the area of multimedia that used for protection of an Intellectual Property rights and copyright protection . The copyright data may be in the form of text, image, audio, and video. Watermarking may be visible or invisible depend on application.

Digital watermarking use a method of embedding watermarks in a multimedia documents and files in order to protect them from illegal copying and identifying manipulations and that embedded watermark is imperceptible and robust against attempts to degrade it or remove it from the digital object and thus avoid the thread of copying of the digital data.

Figure shows the general watermarking embedding procedure. In an original video with the help of embedding procedure watermark is embedded and then we get a watermarked video.

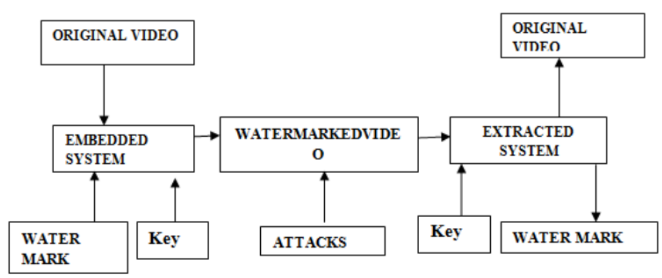

Figure 1: Block diagram of Video Watermarking

2.1 Background

The background used for this is discrete wavelet transform and singular value decomposition .

2.2 Discrete wavelet transform

Discrete Wavelet Transform (DWT) is any wavelet transform for which the wavelets are discretely sampled and it captures both frequency and location information (location in time).Discrete Wavelet Transform is used in 1D and 2D signal processing due to its advantages in signal and image processing applications like compression, de-noising, texture analysis and watermarking etc.

Discrete wavelet transform (DWT) unlike DFT or DCT represents a given signal with set of basic functions efficiently and flexibly by using filter banks, these basis functions are termed as wavelets.

The DWT of a input signal X is calculated by passing it through a series of filters. First the samples are passed through a low pass filter(LPF) with impulse response resulting in a convolution of these two and the output from low pass filter is known as approximation coefficient.The signal is also decomposed simultaneously using a high-pass filter(HPF) H and the output from this is know as detail coefficient. It is important that the two filters are related to each other and they are known as a quadrature mirror filter. In discrete wavelet transform signal can be viewed or analysed both in spatial domain and frequency domain simultaneously. the decomposition process the input signal where n is the number of levels must be a multiple of 2^n.

A 2D DWT can be implemented by applying 1D wavelet along the rows and then along the columns to result in 4 sub bands, each contains specific range of frequency coefficients. These can be used for any kind of applications and as well for watermarking, which uses these sub-bands either for inserting the watermark bits directly or for further processing .

Fig. 2 shows two level DWT filter design used for decomposition.

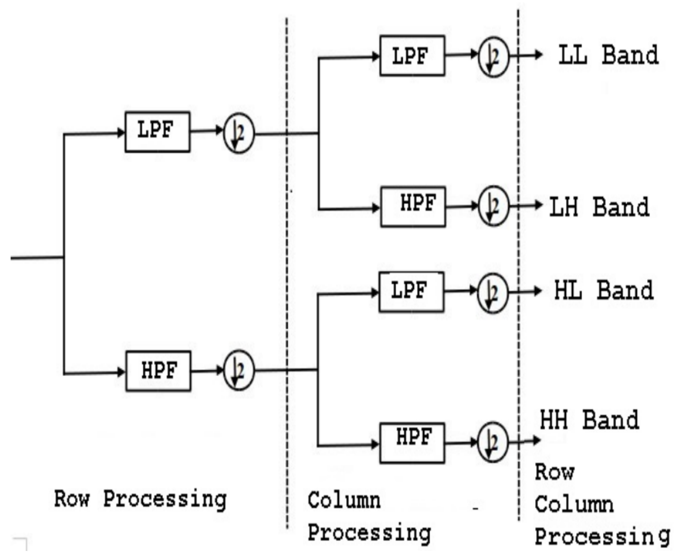

Figure 2: Block diagram of DWT decomposition

In Fig. 2, LPF represents the low pass filter whereas HPF represents conjugate filter such as high pass filter and together can be termed as filter banks.

Here we select Haar Wavelets due to its simplicity in-terms of operations and it decomposes the signal into four sub band signals.The haar wavelet is a sequence of rescaled "square-shaped" functions which together form a wavelet family or basis. Hungarian mathematician Alfred Haar introduced he Haar wavelets, which is similar to step function.

By using inverse discrete wavelet transformation original signal can be computed by doing inverse operation of the decomposition filter ,here we used up-sampling instead of down-sampling that will be used on the given four sab-band inputs

2.3 Singular value decomposition

Singular value decomposition (SVD) is generally used for decomposing the image into sub matrices for removing redundant data in compression applications and also used for watermarking. The Decomposition results in three matrices and they are left, right singular vector matrix and diagonal matrix.

The diagonal Matrix consists of singular values along its diagonal in decreasing order, where singular value represents the energy of the given signal these singular values is small and these are not effective that much hence they can be used for watermarking.

2.4 Organization

In our project this 1 section is discussed about using dwt and section 2 discuss about svd . let explain them in brief :

2.4.1 Discrete Wavelet Transform

In case of video an frame is continuously decomposes by Discrete wavelet transform (DWT) which is the multi-resolution explanation of an image.The signal is allocated in high and low frequency components by DWT .

High frequency part contains the edge components information. The low frequency part is again get divided into high and low frequency parts. An frame 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 frame .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.

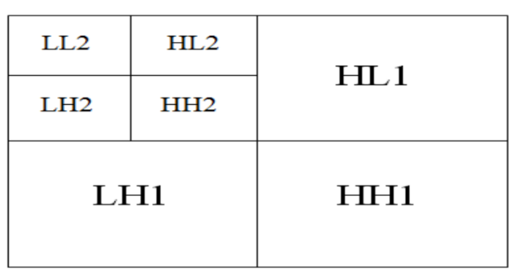

Figure 3: 2-level DWT sub-bands

Since human eyes are much more sensitive to the low-frequency part (the

LL sub band), 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 low-frequency bands i.e.LL sub band.

2.4.2 Singular Value Decomposition

The SVD is the matrix decomposition in a least square sense that it packs the maximum signal energy into as few coefficients and this split the system into a set of linearly independent components, each of them bearing own energy contribution. Frame can be represented in a matrix by using SVD. It also used in many application of image processing. The singular value decomposition of a complex matrix X is given by following equation

$$A = USV^T$$

Where U is real or complex unitary matrix (m $\times$ m) and it is an orthogonal matrix that rotates space, column vectors of this matrix are often referred to as left singular vectors., S is a diagonal matrix (m $\times$ n) (all elements that are not on the diagonal are zero, diagonal elements are called singular values), which scales space, and V* is real or complex unitary matrix (n $\times$ n) is an orthogonal matrix, which only rotates space. Row vectors of this are also known as right singular vectors.

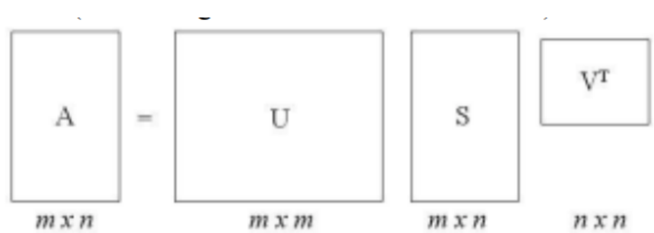

Figure 4: General SVD manipulation matrices

Singular value eventually conserves most energy and it also gives better quality result after applying various attacks .This SVD has many advantage such as maximum energy packing which is usually used in compression, ability to manipulate the image in base of two distinctive subspaces data and noise subspaces, which is usually uses in noise filtering and also was utilized in watermarking applications.

To calculate inverse SVD for decompressing we make a new matrix as

$$B = USV^T$$

here for constructing B we use first m columns of the matrix U matrix and S as a singular value of frame after adding with the singular value of logo image and then take first n rows of the matrix V^T.

3 Datasets used

here we used one video file for watermarking and one logo file.

Figure 5: Random Frame of video

Figure 6: Logo Image

4 Literature

Multiple methods on DWT for video watermarking exist, each method had its own advantages and disadvantages.Various video watermarking techniques have been developed on wavelet domain. Few of them are:

4.1 Previous methods

4.1.1 Method 1 : Hongmei Liu [3]

In this embedded the watermark directly to the DWT coefficients of LL band of three level DWT, in addition this method used the BCH error correcting codes and also applied 3-D interleaving in order to reduce burst errors.

4.1.2 Method 2 : H. Tian [4]

In this he applied 1D wavelet transform on two consecutive frames, then low frequency part was partitioned into equal size blocks to embed watermark bit based on average pixel value of the block and then same procedure was employed to detect the watermark

4.1.3 Method 3 : F. Akhlaghian and Z. Bahrami[1]

In this a embed watermark, where a watermark signal was split into small watermarks based on number of video frames in each shot. Each small watermark was used to generate owner's share which was inserted.

4.2 Research gaps or loopholes in the previous methods

Loopholes in the above previous methods are :

4.2.1 In method 1

This method may fail against high pass filtering since watermark was inserted in low frequency LL band. Modifying least significant bits of DWT coefficients makes system less robustness against filtering attacks such as sharpening and Gaussian filtering.

4.2.2 In method 2

this method worked well for various compression ratios of mpeg compression, Gaussian noise but will not work against frame drop attack as watermark bit was embedded using two consecutive frames in DWT domain.

4.2.3 In method 3

This method fails to extract watermark against frame drop attack and also this requires synchronization method to find start position of small watermark.

4.3 Proposed Method

Now ,we propose a method to eliminate these disadvantages using multilevel DWT and singular values obtained using SVD. Complete watermark is inserted into single frame rather than distributing into multiple frame to overcome the frame drop attack, hence this method eliminates the usage of synchronization codes to locate starting of the watermark bit. this is mainly used because compared to state of art is computing of four singular value matrices of four sub-bands of DWT instead of one sub band in two level DWT to make it robust against filtering attacks and the way we applied secret sharing to singular values, so that watermark can be retrieved successfully even though two sub bands are filtered out.

5 Methodology

This section deals with watermark embedding and extraction algorithm and difference of frames along with corresponding block diagrams.In this method , the stability of the singular values of an image is combined with the adaptive nature of DWT. To increase the efficiency of the algorithms , a basis frame is identified to be watermarked.

5.1 Algorithms

5.1.1 Watermark embedding Algorithm:

Steps :

1. Load the original video and watermark image.
2. A frame is choose randomly from the video sequence.
3. In order to obtain the motion parts , random frame is subtracted from all frames over all channels .
4. DWT is applied to the basis frame .
5. The LL band is chosen and transformed further using DWT.
6. Then the HH sub band in the double transformed image is chosen and further processed using SVD.
7. The watermarked image(logo image) is also transformed using DWT , here DWT is applied only once on watermarked image .
8. SVD is applied on watermarked image on the HH sub band.
9. The frame's modified singular value are obtained by adding the watermarked singular values.
10. Using these singular value , the high frequency sub band is reconstructed.
11. The low frequency sub band is reconstructed using IDWT.
12. Using this low frequency sub band, the watermarked frame is reconstructed .

13. All these respective frame difference are added to this watermarked frames to obtain all the video frames .

14. These video frames are then used for obtaining watermarked video.

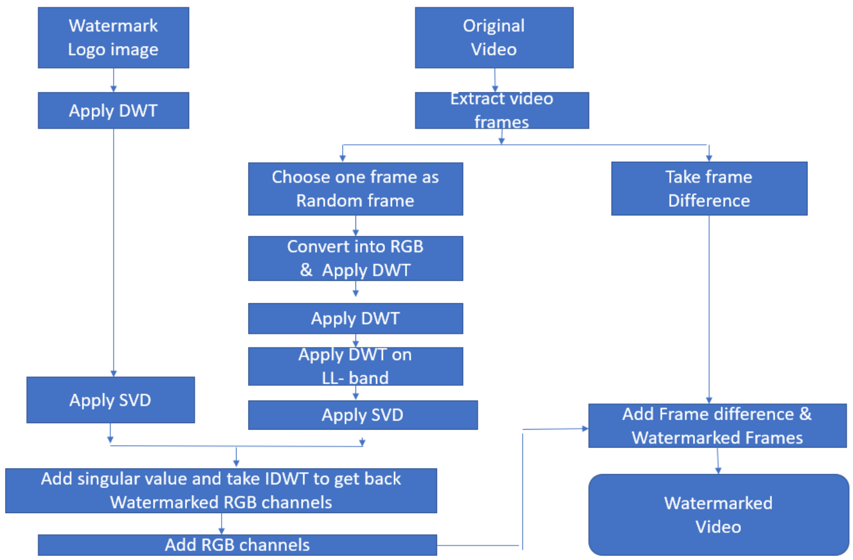

Figure 7: Watermark inserting process into a video

5.1.2 Extraction of watermark Algorithm:

Steps :

1. Upload watermarked video.
2. The watermarked video frames are divided into RGB channels.
3. Apply DWT on these frames .
4. The DWT is applied to the low frequency sub band (LL)
5. SVD is applied to second level high frequency sub band (HH).
6. The singular value obtained are subtracted from the original singular value .
7. These singular value are then used to extract the watermarked from the watermarked video by applying IDWT.
8. Get the watermarked and save it .

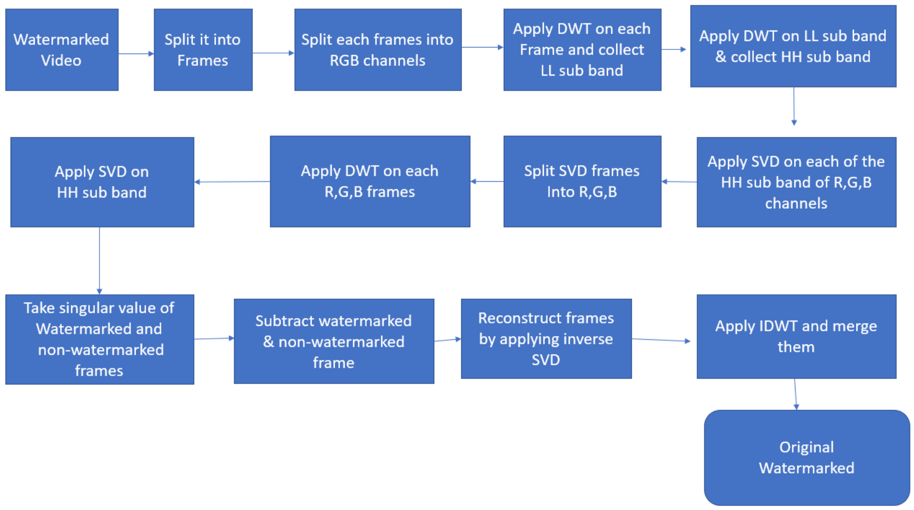

Figure 8: Watermark extraction process from a video

5.2 Plots outputs

The figure shows the original video, watermarked video and the watermark is removed from the watermarked Image.

Figure 9: Original Video frame

Figure 10: Watermarked Video frame

Figure 11: Watermarked extracted frame

6 Conclusions

In this paper we proposed method of digital video watermarking based on the concept of DWT - SVD. The DCT based method is very time consuming when compared to the DWT - SVD though it offers the better capacity and imperceptibility. This method was found to satisfy all the aspects like robustness, imperceptibility and fast processing time.

The technique of adding a watermark to all the frames we actually adding it to only a single frame, which is selected randomly, is the novelty of this algorithm. Since this scheme embeds watermark in all the color channels of all the frames, it survives temporal attacks like FDAS (frame dropping, averag ing and swapping).

This watermarked can be extracted from any of the frames to prove the authenticity of the media being transmitted even if multiple frames are dropped

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[3] [4] [1] [2]

References

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