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Robust Video Watermarking based on Discrete Wavelet Transform

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Abstract

Digitalvideoisone of the popular multimedia data exchanged in the internet. Due to their perfectly replicable nature many illegal copies of the original video can be made. Watermarking is relatively a new technology that has been proposed to solve the problem of illegal manipulation and distribution of digital video. It is the process of embedding copyright information in video bit streams. Our scheme embeds different parts of a single watermark into different scenes of a video under the Discrete wavelet domain. To increase robustness of the scheme, the watermark process is carried out in the video. Our video watermarking algorithm is robust against the attacks of frame dropping, averaging and statistical analysis, which were not solved effectively in the past. In video data embedding scheme the embedded secret data is randomly segmented and reconstructed without knowing the original host video. Secret data isembedded in individual video frames using the frequency domains of DWT. Finally the PSNR reading is compared for the Original Video & Watermarked Video.

Keywords: DataHiding,Digital,Video,Watermarking Interpolation Algorithm, Enhanced Robustness, DWT,Imperceptibility

1. INTRODUCTION

Due to the rapid development of networks, such as Internet, Intranet, wireless communication, global mobility networks, World Wide Web, and etc., and multimedia techniques, digital data such as text, image, video and audio has now been widely used. Many techniques have been developed to protect the property Copyright Protection is one of the major applications for watermarking. Robustness is the major property that is required for watermarking algorithms that are to be used for building copyright protection systems.Video watermarking introduces some issues not present in image watermarking. Due to large amounts of data and inherent redundancy between frames, video signals are highly susceptible to pirate attacks, including frame averaging, frame dropping, frame swapping, statistical analysis, etc.

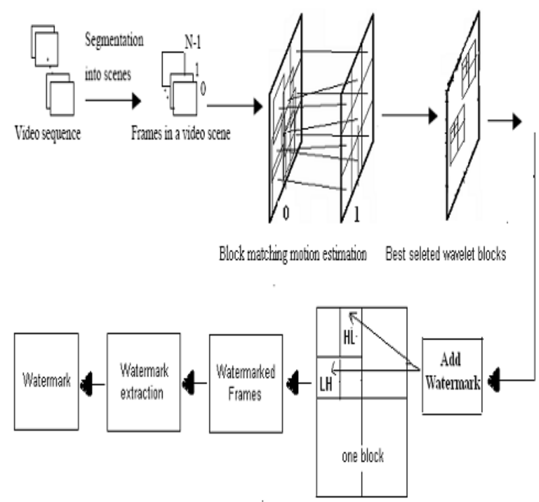

Figure.1Video Watermarking

A. Video Watermarking Terminology

Digital Video: Digital video is a sequenceor collection of consecutive still images.

Payload: The amount of information that can be embedded into the video sequence.

Security: In watermarking the security is assured in the same way as in encryption. Though the algorithm of watermarking process is public, security depends on the choice of the key. [2]].

B. Video Preprocess

The Video preprocessing stage consists of 3 parts: frame extraction, DWT and scene change detection. The video stream of the input video in the form of frames is extracted so that the watermarks can be embedded in the video channel. All frames are transformed to wavelet domain with four levels. DWT transforms a signal into coarse and detail signals by "averaging and differencing" on the coefficients. It breaks down the signal into a coarse coefficient

(DC component) and a hierarchy of detail coefficients (AC components).

The algorithm for digital video watermarking is proposed based on Discrete Wavelet Transform (DWT). The algorithm is to carry out analysis of the scene after the video frame through third DWT, and at its low-frequency region embed the watermark image with the genetic algorithm The complete process of digital video watermarking is described into four steps: Watermark insertion or embedding, Watermark transmission or distribution through a channel, Watermark extraction or detection and Watermark decision.

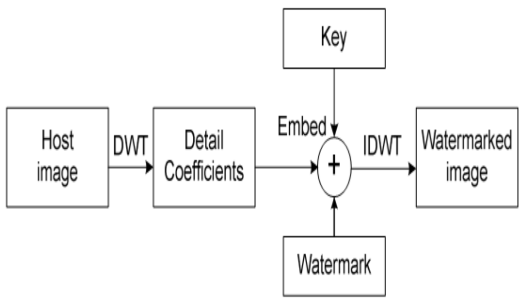

Figure. 2 General Embedding Processes

C. Properties of Video Watermark

For digital video watermark some most important properties of watermarking process are required. [2][3][6] Such as,

***Robustness*:**

The watermark should be impossible to remove from watermarked video, without the sufficient knowledge of an embedding process. The robust one is specially designed to withstand a wide range of attacks.8]

***Imperceptibility*:**

The watermark embedded into the digital video sequence should be invisible to Human Vision System (HVS).

***Unambiguous*:**

The extracted watermark should uniquely identify the original owner of the video.

***Computational Cost*:**

Digital video watermark system includes, embedding and detecting process both should be fairly fast and should have low computational complexity. .

***CBR (Constant Bit Rate)*:**

In the bit stream domain, watermarking should not increase the bit rate.

Random detection:

In video watermarking the detection of watermark can be done in any position of video.

Blind detection scheme:

Non-blind detection scheme require the original data, but for video sequence it is very inconvenient to use original data. Because of its huge content compare to image. While a blind detection scheme doesn't require a original data, so it is useful for video watermarking.

2. DWT

Discrete wavelet transform divides an image into 4 coefficient images in the single level. Each coefficient image contains one of low frequency bands and high frequency bands. With an M×N image, 2-D DWT generates four M/2×N/2 coefficients: LL, LH, HL, and HH, where LL represents a low frequency band, LH a horizontal high frequency band, HL vertical high frequency band, HH a diagonal high frequency band. The low frequency band is utilized to the net level of DWT. In DWT, the most prominent information in the signal appears in high amplitudes and the less prominent information appears in very low amplitudes.

Data compression can be achieved by discarding these low amplitudes. The wavelet transforms enables high compression ratios with good quality of reconstruction Wavelet transform iscapable of providing the time and frequency information simultaneously, hence giving a time-frequency representation of the signal. DWT is believed to more accurately model aspects of the HVS (Human Visual System) as compared to the FFT or DCT. This allows to use higherenergy watermarks in regions that the HVS is known to be less sensitive to.Inserting watermarks in these regionsincreasesthe robustness of watermark, additional impact on image quality. Experimentally it is being found that insertion in the LL portion of the DWT proves to be most robust against various kinds of attacks.

Multiresolution property of DWT helps in decomposition of images. The image is passed through various orthonormal filters like Daubechies, QMFs etc. so that the image gets divided into four non-overlapping multiresolution sub-bands. These subbands are LL, LH, HL, HH i.e. approximation, horizontal details, vertical details and diagonal details as shown . This is called first level wavelet decomposition of an image. The second level of decomposition, for e.g., is carried out on first level LL subband of the image which results into another level of decompositioneach row.After performing DWT for eachrow.

The DWT coefficients are transposed and again passed through the high pass and low pass filter in similar manner. The following flow chart is computing

the DWT is drawn below each row at a time. For this input of 4 samples we require two levels of decomposition.

3. IMPLEMENTATION OF DWT

The DWT is carried out for the input image of 8 X 4 by taking four samples from the each row at a time. For this input of 4 samples we require two levels of decomposition and we obtained outputs of four DWT coefficients. In this way DWT is computed taking 4 samples from each row.After performing DWT for each row, The DWT coefficients are transposed and again passed through the high pass and low pass filter in similar manner. The following flow chart is computing the DWT is drawn below.

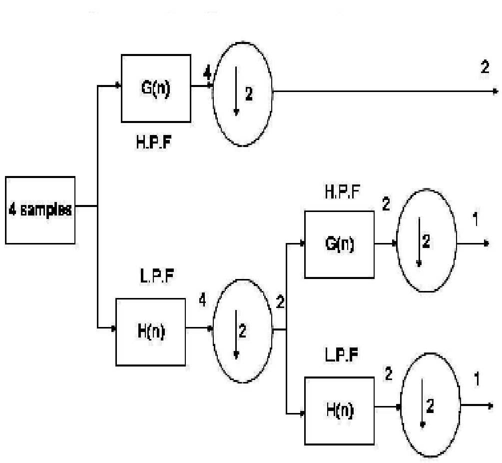

Figure.3 Two Level Decomposition of Image

A. Extraction Process

The extraction process is shown. The proposed watermark extraction method. The watermarked image is taken as the input. It is then decomposed to extract the watermark from its coefficients.

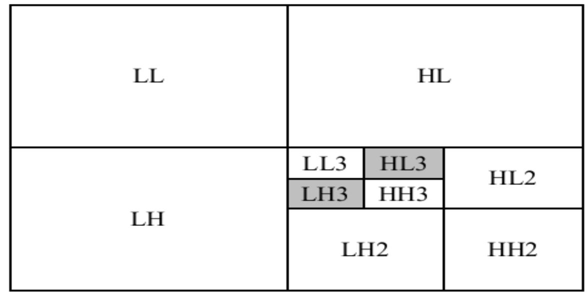

Figure 4. 3-level wavelet decomposed image representation in HH in LL2

B. Embedding Algorithm

The embedding process can be described in the following steps:
a) Convert the original image in vectors.
b) Set the gain factor K for embedding.
c) Read in the watermark message and reshape it into a vector.
d) Do DWT of the cover image.
e)Computes the approximatio coefficients matrix cA & details coefficients matrices cH,cVand horizontal,vertical,diagonal;respectively obtained by wavelet decomposition of the input matrix X. The'wname' string contains the wavelet name
f)Add PN sequence to cH and cV components
If (watermark = = 0)
cH1=cH1+K×pn_sequence_h;
cV1=cV1+K×pn_sequence_v;
g) Perform IDWT
watermarked_image=
idwt2(cA1,cH1,cV1,cD1,'wname',[Mc,Nc])

C. Reconstruction Algorithm:

To recover the watermark, the following steps are considered:
a) Convert back the watermarked image to vectors
b)Convert the watermark to corresponding vectors
c) Initialize watermark vectors to all ones
Watermark_vector = ones (1,MW×NW)
where, MW= Height of watermark, and
NW = Width of watermark.
d) Find correlation in H and V components of watermarked image
i.correlation_h()=corr2(cH1,pn_sequence_h);
ii.correlation_v()=corr2(cV1,pn_sequence_v);
iii.correlation(wtrmkd_img)=(correlation_h( ) + correlation_v( ))/2;
e)Compare the correlation with mean correlation if (correlation(bit)>mean(correlation))watermark_vecto r(bit)=0;
f)Reverse back the watermark_vector to the watermark_image.

4. IMAGE SEGMENTATION

Image segmentation is an important technology for image processing. There are many applications whether on synthesis of the objects or computer graphic images require precise segmentation. With the consideration of the characteristics of each object composing images in MPEG4, object-based segmentation cannot be ignored. Nowadays, sports programs are among the most popular programs, and there is noboundary of the target image. By combining these, the target image can be correctly segmented and represented.

A. Segmentation Basics:

Inorder to obtain color information of the target image and boundary extraction separately andsimultaneously apply thecharacter of HSI to acquire the information of the pixels of the target image. In the mean time, we use the Matlab "edge" and "imfill" command to extract the boundary and fill the imageregion whose boundaries make a closure. Afterwards, we combine them by getting the union of the two results. Finally the noiseis removed.

6. SIMULATION OUTPUT

The proposed technique works on gray-scale images. A binary image was used as a watermark. We performed three-level of DWT with the use of Haar filter wavelets. Figure 5 shows the best gain factor (K) with all regions. It embeds the watermark on the third level of DWT on the host image and to recover a complete watermark image with high quality. The Peak Signal to Noise Ratio (PSNR) at best K for the host image is presented at Figure 6.The relation between K and PSNR is shown at Figure 7 It is clear from the figure that, the PSNRdecreases as K increases. Then, the best PSNR corresponds to the lowest K that is equal to 0.5 in our study,the technique is tested under different values of K to make it more robust against the attacks.

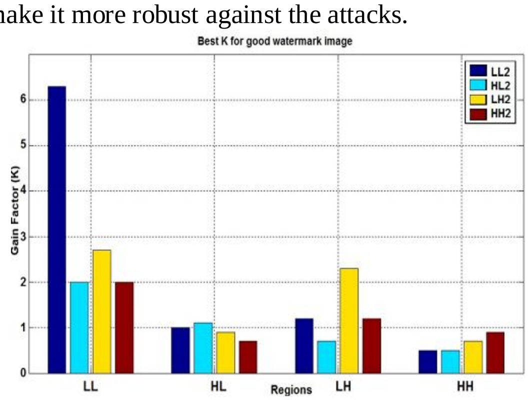

Figure 5 Best K to recover watermark image

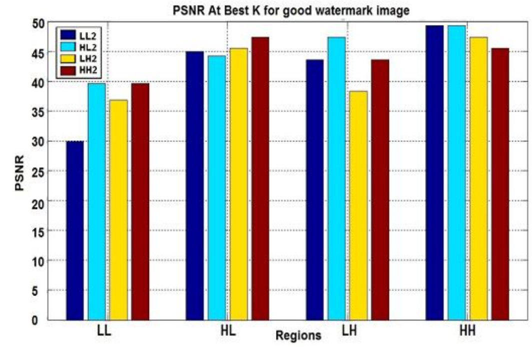

Figure 6 PSNR at best K for recovering

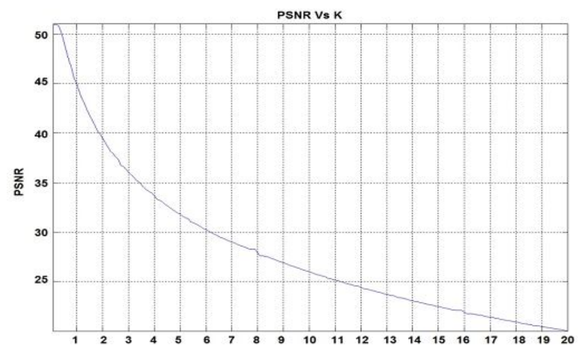

Figure 7 PSNR versus K for the host image

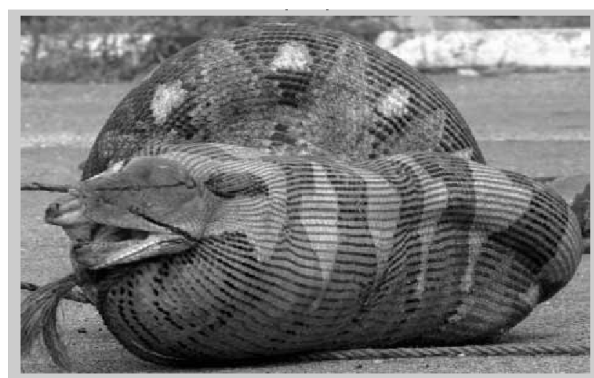

Figure 7 Watermarked Image

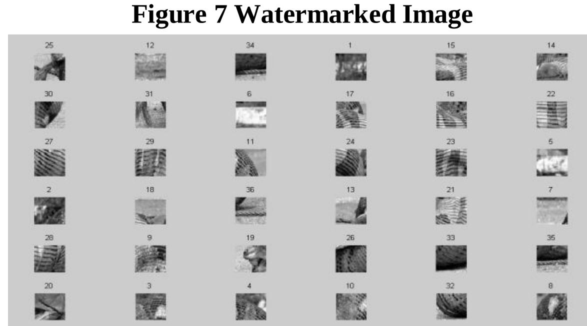

Figure 8 Randomly Segmented Watermarked image

First original frame

First frame with watermark

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