Copyright Protection using Video Watermarking based on Wavelet Transformation in Multiband

S. S. Bedi
Dept. of CS&IT
Institute of Engineering Technology,
MJP Rohilkhand University, Bareilly,
Uttar Pradesh, (India)

Rakesh Ahuja
Dept. of CS&IT
Moradabad Institute of Technology,
Moradabad, Uttar Pradesh, (India)

Himanshu Agarwal
Dept. of CS&IT
Moradabad Institute of Technology,
Moradabad, Uttar Pradesh, (India)

ABSTRACT

This paper presents a novel technique to protect the copyright information by embedding a bit map image as watermark into the frames of videos in such a way in could be extract to proof the ownership from the video contents. The proposed scheme produce a robust video watermarking scheme into two bands therefore named as multiband with strength α1 and α2 respectively, which result from applying the discrete wavelet transform of every video frame. The watermark is embedded into LLLL band obtained by second level wavelet decomposition and into HH band obtained by single wavelet transformation. Various attacks, such as gaussian noise addition, cropping and rotation, have been applied in order to test the robustness of watermark. Experimental results shown in table 1 and table 2 clearly indicate that we have extracted the watermark successfully from various types of attacked video frames.

General Terms

Digital Video Watermarking, Information Security

Keywords

Discrete Wavelet Transform, Multiband, Human Visual System

1. INTRODUCTION

More and more types of video products are coming in the market that may be used in diversified fields like advertising, video conferencing, electronic media, video movies, training and workshop, video calling, video chatting, online video games and so on. DVD, PC Video Files, Web Video Files and Streaming Video are the major categories of product available in the market. These digital video data can be easily and perfectly copied and rapidly transferred from one system to other remote PC only by having internet connection. This leads to wide interest of information security and multimedia copyright protection [1]. This could be achieve by embedding the special bit pattern as copyright information known as digital watermark in the original contents with the conditions that perceptibility i.e. quality of video should not be degraded and it must maintain the robustness i.e. watermark could be recovered successfully even some manipulation or attack on the digital contents. Since watermark is being applying in digital video contents therefore this named as digital video watermarking. There are numerous application areas, other than of copyright protection, of digital video watermarking. Some of them are described as follows. *Copy control* ensures not to produce unauthorized or illegal copying of digital video data. Since each copy of digital video data provides exact reproduction of the original one, therefore some mechanism must be designed to prevent to replicate the original one. It [2] describes the copy control by using the ticket concept based on embedding signal.

Broadcast Monitoring [3] is another vital application area of digital video watermarking in which the broadcast video signals are monitored by active or passive monitoring. This type of monitoring may be use by the advertisement companies to verify that allotted air time is aired in accordance for which they paid. In a nutshell, we can summarize that images or video sequences on a public network always at risk of burglary and amendment therefore the researchers needs to implement a technique to protect the digital contents in a more robust manner.

In the literature survey, different digital video watermarking algorithms [4,5,6] have been proposed. Some techniques embed watermark in the spatial domain by modifying the pixel values directly in each frame but these methods are not robust to attacks and common signal distortions. In contrast, other techniques are more robust to distortions when they add the watermark in the frequency domain. In these types of schemes, 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 rest of the paper is organized as follows: Section 2 describe DWT based watermarking, section 3 presents the proposed watermarking scheme. Section 4 introduces the experimental results, section 5 compares the state of art with the proposed scheme and finally section 6 concludes the paper.

2. DWT BASED WATERMARKING

Since DWT has added widespread recognition in signal processing and image compression. Therefore several researchers rigorous are using DWT technique.

The DWT is computed by successive low pass and high pass filters. High pass filter produces coarse-scale DWT coefficients while low pass filter creates fine scale of DWT coefficients. It decompose a video frame, a static image of a video contents, into four non-overlapping multi-resolution sub-bands (LL, LH, HL and HH1) which can be rebuild to make the original frame without error. The sub-band LL represents the coarse-scale DWT coefficients or lower level resolution, LH represent coefficients of vertical edges, HL represent coefficients of horizontal edges and finally HH represent diagonal coefficients. The whole concept of DWT technique is elaborated in diagram 1(a) and 1(b).

There are numbers of advantages to choose DWT as our proposed research work. Some of the advantages are described below.

1. Due to its excellent spatial localization, -frequency spread and multi resolution characteristics, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively.

2. DWT has an ability to analyze the signals in both frequency and time domain concurrently.

3. If we embedding the watermark in a spatial domain, it is limited to some pixels values but in case of frequency domain all the pixels values could be used to embed the watermark which result to increase the robustness.

4. Since most of the video product appearing in the market in compressed form therefore we need such technique that is compatible with these standards. DWT is one of that method to handles such situations.

5. This domain supports some of the features of the human perceptual system to be integrated into the encoding process.

6. The major advantage of using wavelet Transform is computationally efficient and can be implemented by using simple filter convolution.

In general the wavelet transform [5,6] decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal. Another property of wavelet is that it reflects the anisotropic properties of HVS (Human Visual System) more precisely.

3. PROPOSED SCHEME

Till now the researchers uses the DWT technique to embed the watermark either at single or double level decomposition. In the existing schemes if they embed the watermark at single level, only perceptibility is maintained but not robustness. And at the second level of decomposition robustness is maintained but perceptibility degraded. Since high as well as low resolution, having its own unique properties therefore we use both of them to embed the watermark in a same approach. Hence in this approach the same watermark is embedded twice time i.e. at second level lower sub band (LLLL) and singular level higher sub band (HH) to achieve perceptibility and robustness as shown in the block diagram of fig. 1(a) and fig. 1(b).

In this paper, a new video watermarking scheme which is based on DWT in multiband to develop a new non-blind scheme that is resistant to a variety of attacks. The watermark is embedded in the luminance component of each frame of the original video because the luminance component as comparison chrominance components is less sensitive to human eye. Why DWT is chosen? It is best described in section II. In our approach the lowest (LL) and the highest (HH) frequency bands are selected to apply wavelet transformation to embed the watermark.

Video frames are taken as the input, and watermark is embedded in each frame by altering the wavelet coefficients of selected DWT sub bands.

3.1 Watermark Embedding

The proposed watermarking process shown in Fig. 1(a) is broadly classified into two steps described as follows:

Step 1: Convert the 32x32 binary watermark into a vector of '0's and '1's.

Step 2: Divide video into frames and convert RGB frames into YUV components. For each frame, choose the luminance Y component and apply the DWT to decompose the Y frame into four multi resolution sub bands: LL, HL, LH, and HH. Again DWT applied on lower frequency band (LL) to decompose it into sub-bands: LLLL, LLHL, LLLH, and LLHH. Embed the watermark into LLLL and HH bands by following ways. For LLLL band, the watermark bits are embedded with strength α1 into the YL. For each YL the embedding equation:

$$YL' = YL + \alpha 1W$$

(1)

For HH band, the watermark bits are embedded with strength α2 into the YH. For each YH the embedding equation:

$$YH' = YH + \alpha 2W$$

(2)

α1 and α2 are chosen in order to maintain the balance between robustness and perceptibility.

Step 3: Now apply the inverse DWT to produce the watermarked luminance component of the frame. Then reconstruct the watermarked frame. Finally combined all watermarked frames to make video as a single digital file.

The result is now each frame is watermarked twice time to increases the robustness and to maintain the perceptibility.
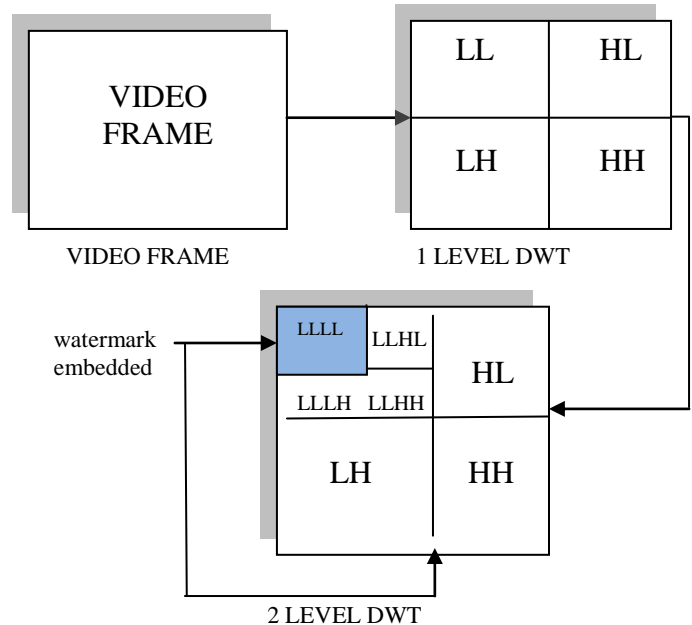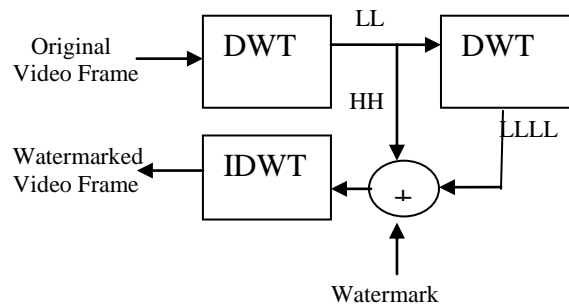

Fig. 1(a) Watermark embedding algorithm

Fig. 1(b) Watermark embedding algorithm

3.2 Watermark Extraction

The watermark extraction process shown in Fig. 2 is the inverse procedure of the watermark embedding process. Since the proposed algorithm is a non blind algorithm i.e. the original video sequence is required at the time of extracting the watermark. The watermark extraction procedure is as follows:

Step 1: Convert the 32x32 binary watermark into a vector of '0's and '1's.

Step 2: Convert the watermarked (and may be attacked) video into frames then convert the RGB frames into YUV components For each frame, choose the luminance Y component and apply the DWT to decompose the Y frame into four multi resolution sub bands. *Again a*pply DWT on LL band

to decompose it into sub bands: LLLL, LLHL, LLLH, and LLHH. For the LLLL band, the watermark bits are extracted from the each YL by:

$$WL' = (YL' - YL)/\alpha 1$$

(3)

For the HH band, the watermark bits are extracted from the each YH by:

$$WH' = (YH' - YH)/\alpha 2$$

(4)

After extracting the watermark from LLLL and HH bands, similarity measurements of the extracted watermark W' and the referenced watermark W is used for objective judgment of the extraction fidelity NC which is given by:

$$NC = \frac{\sum i \sum j. W_{ij} * W'_{ij}}{\sqrt{\sum i \sum j (W_{ij})^2} \sqrt{\sum i \sum j (W'_{ij})^2}}$$
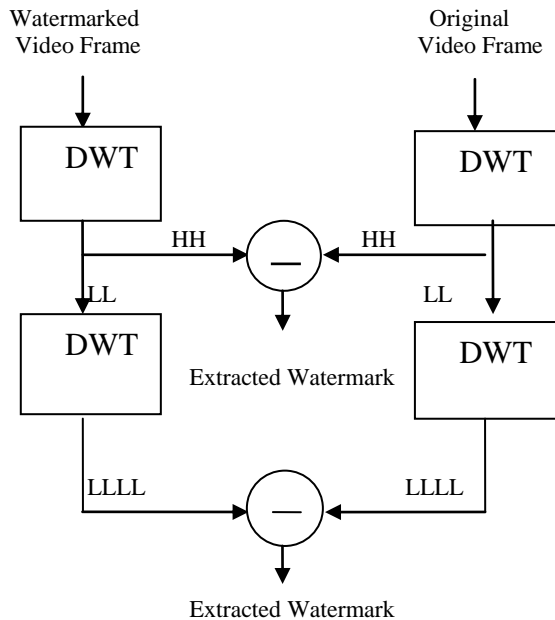
(5)

Fig.2. Watermark extraction algorithm

4. EXPERIMENTAL RESULTS

The performance of the proposed approached has been tested on the video sequences. The performance has been evaluated in terms of the imperceptibility and robustness against various attacks. The Normalized correlation (NC) is used to measure the visual quality of watermarked and attacked frames.

The first 36 frames of size 352 x 240 from the video (hahk.avi) sequence have been tested. During the test procedures only the luminance components of the different frames are watermarked. The watermark is a binary image with size 32x32 resizes to fit into the y component of video frames. We choose α1 =0.1 for embedding into LLLL band and α2 = 0.01 for embedding into HH band to balance the tradeoff between the robustness and imperceptibility. Different kinds of image processing attacks have been applied in order to test our DWT in multiband based watermarking scheme.

Fig. 3(a) shows the original sampled frame from video sequence and Fig. 3(b) shows the corresponding watermarked frame. Both the frames appears visually identical, therefore imperceptibility is obviously maintained. The original watermark and the extracted watermark from LLLL band and

HH band are shown in Fig. 4(b) for the case of no attack. The NC value of the watermark in the two bands are 1 and 0.9964 respectively, this indicate the exact extraction.

Fig. 3 (a) Original Frame   Fig. 3(b) Watermarked Frame

Fig. 4(a) Original Watermark

NC(HH) = 0.9964   NC(LLLL) = 1

Fig. 4(b) Extracted Watermark

Table 1, illustrates the NC values of 36 watermarked frames of video with various Signal to Noise ratio (SNR). This table shows that normalized correlation value is increases in both band, second level sub-bands of DWT (LLLL) and single level sub-bands (HH), as the value on signal to noise ratio increases.

To measure the robustness, several experiments had been done. The watermarked frame was subjected to different attacks. The chosen attacks were rotation, Gaussian noise and cropping. Table 2 indicates the attacked frames by all three above types of attacked.

First attack is rotation attack in which every frame is rotated by 0.5° and then watermark is extracted with high correlation value NC=0.8513 and very low correlation value NC=0.38208 at second level (LLLL) and first level (HH) decomposition of DWT respectively. The non-correlation value (NC) indicate that we have successfully recovered the watermark at second level decomposition of low frequency band of luminance Y component after rotation attack but the same watermark could not be recovered at first level decomposition of high frequency band of luminance Y component

Second attack is adding the Gaussian noise attack in which every frame is added noise in such a way that the SNR value is to be reach by 23 and then watermark is extracted with high correlation value NC=0.8293 and also high correlation value NC=0.98539 at second level (LLLL) and first level (HH) decomposition of DWT respectively.

Third attack is the crop attack in which first 10 columns has been removed from the embedded watermark video sequence and then extracted the watermark with lower correlation value NC=0.7715 and also lower correlation value NC=0.7253 at second level (LLLL) and first level (HH) decomposition of DWT respectively.
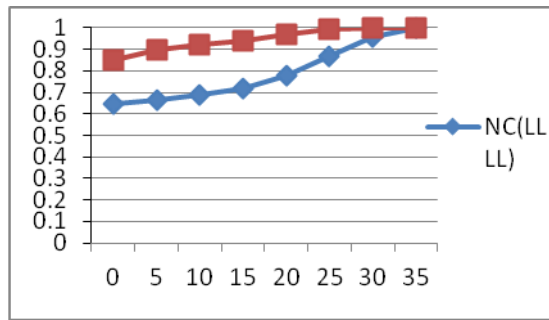
Fig. 5 NC Values as a function of applied SNR value

Table 1. NC values of 36 watermarked frames of the video

SNR	0	5	10	15	20	25	30	35
NC(LLLL)	0.6445	0.66187	0.68658	0.71995	0.77681	0.86736	0.95663	0.99688
NC(HH)	0.84909	0.89717	0.91944	0.94215	0.96938	0.99298	0.99964	0.99961

Table 2. Attacks on Video

Attack	Rotation=0.5°	Gaussian Noise SNR=23	Cropping
Attacked frame			
Extracted Watermark	NC(LLLL)=0.8513 NC(HH)=0.38208	NC(LLLL)=0.8293 NC(HH)=0.98539	NC(LLLL)=0.7715NC(HH)=0.7253

5. STATE OF ART VS PROPOSED SCHEME

Results obtained through table 2 are compared with the state of arts which shows in table 3. Superiority of the proposed work is carried out by comparison with the state of art which reveals the efficiency of the proposed scheme.

Table 3. Comparison between correlation values of the proposed scheme and the state of art.

Attack	Sanjana et al. [7]	Mahesh et al. [8]	Himanshu et al. [9]	Proposed Scheme
Rotation 0.5°	0.6510	0.6000	0.8500	0.8513
Gaussian Noise	0.6861	0.6300	-	0.98539
Cropping	0.6801	0.8820	-	0.7715

6. CONCLUSIONS

We have seen from experimental results that before applying attacks, almost we have extracted the watermark successfully. The results are also better for one group of attack such as Gaussian attack, then another group of attacks (Rotation and Cropping) on the watermark embedded in video frames. Since applying DWT coefficients of multiband increases the robustness [10,11,12,13,14,15] of the algorithm. So, the proposed scheme satisfies the requirement of imperceptibility and robustness for a feasible watermarking scheme. Furthermore, the advantage of the proposed scheme is that we can embed the watermark in LLLL band without the high degradation of the other DWT watermarking schemes. In the future research work, we will incorporate other attacks like sharpening, brightening compression, resize, and many more to get more robustness towards the digital watermark extraction.

7. ACKNOWLEDGEMENTS

8. REFRENCES

[1] Mrs. Rashmi G. Dukhi, "Watermarking: A Copyright Protection Tool", Proc. of the IEEE 2011, pp. 36-39

[2] J.-P. Linnartz, The Ticket concept for copy control based on embedded signaling, in: Proceeding of the Fifth European Symposium on Research in Computer Security. Lecture Notes in Computer Science, Vol. 1485, Springer, Berlin, 1998, pp. 257-274

[3] G. Depovere, T. Kalker, J. Haitsma, M.Maes, L. De Strycker, P. Termont, J. Vandewege, A. Langell, C. Alm, P. Normann, G. O'Reilly, B.Howes, H. Vaanholt, R. Hintzen, A. Hudson, P. Donnely, Digital Watermarking for Broadcast Monitoring, in: Proceeding of the IEEE International Conference on Imager Processing, Vol. 2, 1999, pp. 202-205

[4] Xing Chang, Weilin Wang, Jianyu Zhao, Li Zhang, " A survey of Digital Video Watermarking", Proc. of the IEEE seventh international Conference on Natural Computation, 2011.

[5] Thai D Hien, Yen-Wei Chen and Zensho Nakao, "PCA Based Digital Watermarking",Lecture notes in Artificial Intelligence, 2003,pp. 1427-1434

[6] Hanane H. Mirza, Hien d. thai, yasunori Nagata and Zensho Nakao," Digital Video Watermarking Based on Principal Component Analysis", proc. of IEEE 2007

[7] Sanjana Sinha, Prajnat Bardhan, Swarnali Pramanick, Ankul Jagatramka, Dipak K. Kole, Aruna Chakraborty, "Digital Video Watermarking using Discrete Wavelet Transform and Principal Component Analysis" International Journal of Wisdom Based Computing, Vol. 1 (2), August 2011

[8] Mahesh R. Sanghavi, Archana M. Rajurkar, Rajeev Mathur, Kainjan S. Kotecha, "A Robust Scheme for Digital Video Watermarking based on Scrambling of Watermark" International Journal of Computer Applications (0975 – 8887) Volume 35– No.2, December 2011

[9] Himanshu Agarwal, Rakesh Ahuja, S.S.Bedi,"Highly Robust and Imperceptible Luminance Based Hybrid Digital Video Watermarking Scheme for Ownership Protection" I.J. Image, Graphics and Signal Processing, DOI:0.5815/ijigsp.2012.11.07 ,pp 47-52

[10] Yusnita yusof and Othman O.khalifa, " Digital Watermarking for Digital Images using Wavelet Transform, Proc of the 2007 IEEE International Conference of Telecommunications and Malaysia International Conference on Communication, Penang Malaysia, pp 665-669

[11] Yang Gaobo SUN Xingming, Wang Xiaojing, "A Genetic Algorithm based Video Watermarking in the DWT Domain", Proc. Of the 2006 IEEE Digital Object Identifier ./ICCIAS.6.5, pp. 1209-1210

[12] M.EL, Hajji H. Douzi, R. Harba, "A Robust Wavelet – Based Watermarking Algorithm Using Mixed Scale", Proc. of the IEEE, 2010

[13] Ahmed Salama, Randa Atta, Rawya Rizk, Fayez Wanes, " A Robust Digital Image Watermarking Technique Based on Wavelet Transform", IEEE international conference on System Engineering and Technology, 2011, pp. 100-104

[14] Maher EL'ARBI, Chokri BEN AMAR1 and Henri NICOLAS2, "A Video Watermarking Scheme Resistant To Geometric Transformation", IEEE international conference on Image Processing, ICIP'07, Vol. 55, 2007

[15] Maher Beelhaj, Mihai Mitrea, Francoise Preteux, "MPEG-Perceptual Masking Case Study: Robust Video Watermarking", 15 InternationaL Symposium on Consumer Electronics", IEEE International Symposium on Consumer Electronics, 2011, pp. 598-600