An Interlacing Technique-Based Blind Video Watermarking Using Wavelet

B. Sridhar, C. Arun

Abstract—The rapid growth of multimedia technology demands the secure and efficient access to information. This fast growing lose the confidence of unauthorized duplication. Henceforth the protection of multimedia content is becoming more important. Watermarking solves the issue of unlawful copy of advanced data. In this paper, blind video watermarking technique has been proposed. A luminance layer of selected frames is interlaced into two even and odd rows of an image, further it is deinterlaced and equalizes the coefficients of the two shares. Color watermark is split into different blocks, and the pieces of block are concealed in one of the share under the wavelet transform. Stack the two images into a single image by introducing interlaced even and odd rows in the two shares. Finally, chrominance bands are concatenated with the watermarked luminance band. The safeguard level of the secret information is high, and it is undetectable. Results show that the quality of the video is not changed also yields the better PSNR values.

Keywords—Authentication, data security, deinterlaced, wavelet transform, watermarking.

I. INTRODUCTION

DUE to the growth of wireless communication, sharing of information is enormous, while sharing an unauthorized individual may effectively access the data; henceforth the safeguard of multimedia content is an essential task [1]. The digital information has null difference between in the original and its copy. Numerous scientists have been drilled down the solutions for copyright protection. Digital watermarking is deployed so as to prohibit illegal distribution of multimedia contents. Watermarking techniques are basically classified into the spatial and frequency domain. In Spatial domain, concealing the watermarks in the host directly by adjusting the gray levels of some pixels, yet the embedded data might be effectively located utilizing related systems. But in a frequency domain secret information is directly concealed into transform coefficients. Hence it is more robust and imperceptible, since in transforming domain rejection of watermark in an image is exceptionally troublesome [2]-[4]. Research in video watermarking introduces some difficulties which are not present in image watermarking. Due to the large amount of data and the high correlation between frames, also it is more chance to pirate attacks such as frame averaging, frame dropping, frame swapping, frame interpolation, statistical analysis and etc. According whether need the original video when extracting the watermark, video

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watermark can be divided into blind watermark and non-blind watermark [5]. If extracting the watermark without the original video, then known as blind watermark, on the contrary, called non-blind watermark. Imperceptibility, Robustness, Security and Capacity are the important features of a video watermarking system. Video watermarking is utilized as a part of insurance related applications like Copy control, fingerprinting, ownership identification, confirmation, and so on.

In [6] proposed a blind video watermarking based on DWT with scrambled watermarks based on scene changes for the authentication of digital video, which embeds different parts of a single watermark into different scenes of a video. The video watermarking algorithm is robust against the various attacks. In [7] proposed an approach, each video frame is divided into non-overlapping blocks and it is transformed into 2D-DCT. Further 1D DCT is applied to each coefficient in time domain. Embedding is performed into DCT intermediate frequency coefficients of the video frame. In [8] proposed a scene change analysis to embed the watermark into DWT coefficients of detecting motion scene frames. So every bit of the watermark is spread over the three dimensional wavelet coefficients of LH, HL and HH by using pseudo-random numbers. Results show the robustness and the invisibility of the embedded watermark against lots of attacks. The remaining section as organized as follows, our approach deals in Section II, results and conclusion are discussed in Sections III and IV.

II. OUR APPROACH

Our main objective is to embed a color watermark in a short video sequence using interlacing and deinterlaced techniques. In our schemes color watermark is split into small blocks, and add that piece into selective frames under wavelet domain. Let us consider the color watermark images $W (R, C, L)$ where R, C &L are the row, column and layer of the Image. Sectioned watermarks are $W (R_s, C_s, L)$. R_s and C_s are the new dimensions of the sectioned secret image. Since the host image is color image, so we need to convert the blocks of color watermark images into two dimensional forms, hence concatenate R, G and B plane it becomes $W_C (R_c, C_c)$.

A. Discrete Wavelet Transform

Wavelet is a degree of framework for translating the image information. Initially a signal is split into two high and low frequencies. The edge components of the signal are largely restricted in the high frequency part. The low frequency part is split again into two parts of high and low frequency. This

process is continued until the signal has been entirely decomposed or stopped by the application at hand. Furthermore, from the DWT coefficients, the original signal can be reconstructed; this process is called the inverse DWT (IDWT).

B. Frame Interlacing and Deinterlacing Technique

In this approach only selected frames are undergone embedding process in wavelet domain. For concealing the information luminance band of the frames is taken for consideration, because it has a high sampling rate. Luminance layer has undergone the interlacing process here the band is grouped into odd and even rows of an image [9]. Let us consider the two shares are Y_e and Y_o, where m number of rows and n number of columns In even only the even rows are present. Similarly, in odd only odd rows are present in the image. Further, we remove the zero rows in the odd and even shares that process is said to be deinterlaced. Below algorithm describes the deinterlaced techniques of even and odd rows of a frame.

$$
Ye = \begin{pmatrix}
0 & 0 & . & . & . & . & 0 & 0 \\
y_{2,1} & y_{2,2} & . & . & . & . & y_{2,n-1} & y_{2,n} \\
0 & 0 & . & . & . & . & 0 & 0 \\
. & . & & & & & . & . \\
. & . & & & & & . & . \\
. & . & & & & & . & . \\
0 & 0 & . & . & . & . & 0 & 0 \\
y_{m,1} & y_{m,2} & . & . & . & . & y_{m,n-1} & y_{m,n}
\end{pmatrix}
$$

Algorithm 1: Frame Deinterlaced for even rows image

for i=1to(Rows/2) do
 for j=1toColumns do
 Read only even rows
 $Y_{ed}(r,c)=Y_e(2*i, j)$;
 *Move the rows to r=2*i-i*
 End for
 End for

$$
Yo = \begin{pmatrix}
y_{1,1} & y_{1,2} & . & . & . & . & y_{1,n-1} & y_{1,n} \\
0 & 0 & . & . & . & . & 0 & 0 \\
y_{3,1} & y_{3,2} & . & . & . & . & y_{3,n-1} & y_{3,n} \\
. & . & . & & & & . & . \\
. & . & . & & & & . & . \\
. & . & & & & & . & . \\
y_{m-1,1} & y_{m-1,2} & . & . & . & . & y_{m-1,n-1} & y_{m-1,n} \\
0 & 0 & . & . & . & . & 0 & 0
\end{pmatrix}
$$

Algorithm 2: Frame Deinterlaced for odd rows image

for i=1to(Rows/2) do
 for j=1toColumns do
 Read only odd rows
 $Y_{od}(r,c)=Y_o(2*i-1, j)$;
 *Move the rows to r=(2*i-1)-i+1*
 End for
 End for

$$
Y_{ed} = \begin{pmatrix}
y_{2,1} & y_{2,2} & . & . & . & y_{2,n-1} & y_{2,n} \\
y_{4,1} & y_{4,2} & . & . & . & y_{4,n-1} & y_{4,n} \\
y_{6,1} & y_{6,2} & . & . & . & y_{6,n-1} & y_{6,n} \\
. & & . & & & . & . \\
. & & & . & & . & . \\
. & & & & . & . & . \\
y_{m-2,1} & y_{m-2,2} & . & . & . & y_{m-2,n-1} & y_{m-2,n} \\
y_{m,1} & y_{m,2} & . & . & . & y_{m,n-1} & y_{m,n}
\end{pmatrix}
$$

where $Y_{ed}(r, c)$ and $Y_{od}(r, c)$ are the deinterlaced even and odd shares and $m/2$ is the number of rows and n number of columns.

$$[D]_{\frac{m}{2}xn} = [Y_{ed}]_{\frac{m}{2}xn} - [Y_{od}]_{\frac{m}{2}xn} \tag{1}$$

$$[Y_{ed}]_{\frac{m}{2}xn} = [D]_{\frac{m}{2}xn} + [Y_{od}]_{\frac{m}{2}xn} \tag{2}$$

$$[Y_{ED}]_{\frac{m}{2}xn} = [D]_{\frac{m}{2}xn} + [Y_{od}]_{\frac{m}{2}xn} \tag{3}$$

$$[Y_{ED}]_{\frac{m}{2}xn} = [Y_{ed}]_{\frac{m}{2}xn} \tag{4}$$

For Blind Watermarking technique, the original video is not required to extract the watermark. Before embedding the secret information in any one deinterlaced image, we equalize the coefficients of two shares. Because by using one share we can easily extract the watermark information.

C. Video Watermarking Algorithm

Our proposed scheme adds the watermarks to the deinterlaced image (Y_{ed}) under wavelet domain. The main steps performed in the proposed watermarking system are to read a deinterlaced image (Y_{ed}). Next, apply the one level Wavelet Transform to the input image and obtained the sub bands of (Y_{ed}). To add the piece of watermark images W_C with the transformed cover image we need to resize the watermarks as such of host image. Further scaling factor is multiplied with secret image, which provides the embedding strength. Scaled watermarks are added to the *LL* sub band frequencies of the host image.

$$[Y_{ed}]_{\frac{m}{2}xn} \xrightarrow{DWT} \begin{bmatrix} Y_{ed}^{ll} & Y_{ed}^{lh} \\ Y_{ed}^{hl} & Y_{ed}^{hh} \end{bmatrix}_{\frac{m}{2}xn} \tag{5}$$

$$[S]_{\frac{m}{4}x\frac{n}{2}} = [Y_{ed}^{ll}]_{\frac{m}{4}x\frac{n}{2}} + \alpha * [W_C]_{\frac{m}{4}x\frac{n}{2}} \tag{6}$$

$$\begin{bmatrix} S & Y_{ed}^{lh} \\ Y_{ed}^{hl} & Y_{ed}^{hh} \end{bmatrix}_{\frac{m}{2}xn} \xrightarrow{IDWT} [Y_{ed}^{'}]_{\frac{m}{2}xn} \tag{7}$$

Apply the inverse of the DWT (IDWT) to transformed image and obtain the deinterlaced watermarked shares $Y_{ed}^{'}$. In order to retain the normal image again introduced the interlacing procedure with two shares $Y_{ed}^{'}$ and Y_{ED} add the two

images. At last concatenate the watermarked layer *Y'* with chrominance layers and obtain watermarked frame *Fk'*.

D. Extracting Secret Information from Video

From the extracting side identify the watermarked frames further divide the watermarked frames into odd, and even shares next proceed with interlacing and deinterlaced methods as follows in the embedding side. Now apply wavelet transform to Y_{ed} and Y_{ED}, further recover the original watermark. Below equations show the procedure of the extracting secret information.

$$[Y'_{ed}]_{\frac{m}{2}xn} \xrightarrow{DWT} \begin{bmatrix} S' & Y^{lh}_{ed} \\ Y^{hl}_{ed} & Y^{hh}_{ed} \end{bmatrix}_{\frac{m}{2}xn} \quad (8)$$

$$[Y_{ED}]_{\frac{m}{2}xn} \xrightarrow{DWT} \begin{bmatrix} Y^{ll}_{ED} & Y^{lh}_{ED} \\ Y^{hl}_{ED} & Y^{hh}_{ED} \end{bmatrix}_{\frac{m}{2}xn} \quad (9)$$

$$[W_C]_{\frac{m}{4}x\frac{n}{2}} = \frac{[S']_{\frac{m}{4}x\frac{n}{2}} - [Y^{ll}_{ED}]_{\frac{m}{4}x\frac{n}{2}}}{\alpha} \quad (10)$$

Removing the concatenation, resize and stack the three layers of secret information *W '(R_S, C_S, L)* is obtained. This process is repeated till all the sectioned pieces are extracted in the selected frames.

III. RESULTS

In MATLAB simulation, we used standard test video sequences like Mother_Daughter, as cover video of 4:2:0 formats. Interlaced and Deinterlaced video frames, watermarked frames and an extracted watermark are listed in Fig. 1.
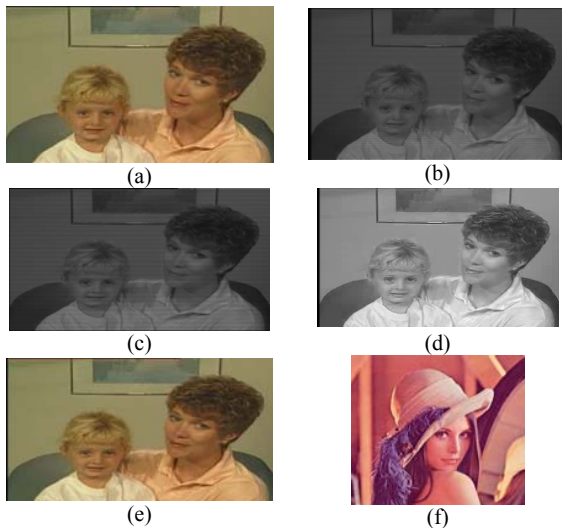

Fig. 1 (a) Original Video Frame, (b) Even share, (c) Odd share, (d) Deinterlaced share, (e) Watermarked Frame and (f) Extracted Watermark

Average MSE of our proposed method is 0.1322. Peak signal to noise ratio (PSNR) is used to measure the quality of the video. The correlation coefficient is another measure used to evaluate the robustness of the watermarking algorithm against the possible attacks. If the two images are identical, then the correlation value will be reached unity. The correlation co-efficient between the original watermark and extracted watermark after possible attack is computed using (13) where O and $\overline{E}$ is the mean of the original and extracted watermark.

$$MSE = \frac{1}{XY}\sum_{x,y}(O(x,y) - E(x,y))^2 \quad (11)$$

$$PSNR = 10\log_{10}(255^2/MSE) \quad (12)$$

$$r = \frac{\sum_x\sum_y(O_{xy} - \overline{O})(E_{xy} - \overline{E})}{\sqrt{\left(\sum_x\sum_y(O_{xy} - \overline{O})^2\right)\left(\sum_x\sum_y(E_{xy} - \overline{E})^2\right)}} \quad (13)$$

A. Performance Analysis

In our strategy, noise attacks like Salt & pepper, Speckle, Gaussian and Poisson are introduced in watermarked frames and measure the robustness of the proposed approach. In geometrical attacks like frame rotation and frame cropping apply to the watermarked video frames and measure the quality of the watermarked frame and retrieving the watermark.

Additionally, we apply the median filtering to the watermarked frames and evaluate the quality of the embedded frames. Fig. 2 sketches the PSNR values of each watermarked frame.In our proposed method we set the embedding strength (α) is 0.01. If we increase above 0.01 issues the performance of the system is reduced or if we decrease the scaling factor less than 0.01 sizes of the watermarked video is extremely high. Hence, we set an optimum value of the scaling factor. Table I shows the performance values of our approach.

By comparing the proposed method with existing methods, the proposed method PSNR is 47.9288 dB. Which is greater than the PSNR reported by Majid Masoumi (36.77dB) and Niranjan Babu (43.05 dB).

TABLE I
PERFORMANCE VALUES OF OUR APPROACH

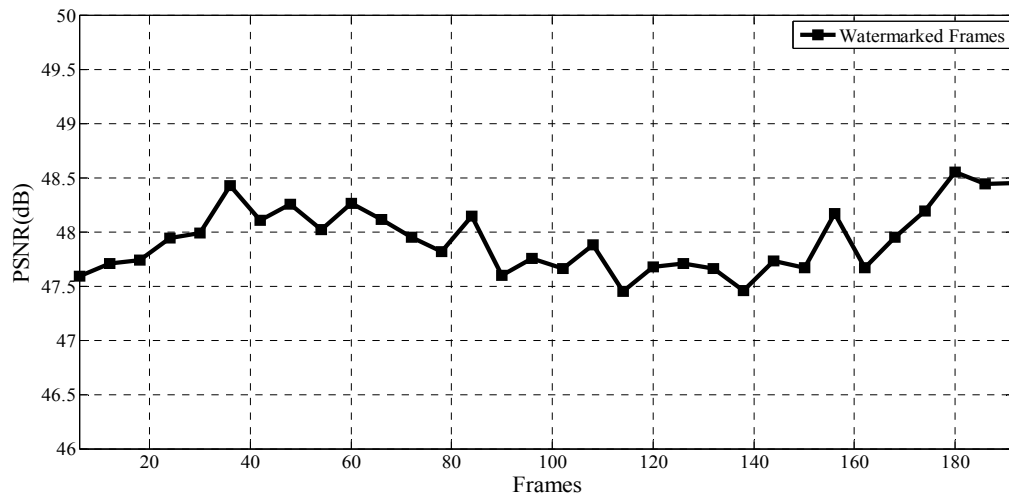| Attacks	Watermarked Frame		Extracted Watermark	
	PSNR(dB)	CC	PSNR(dB)	CC
No Attacks	47.9288	0.9980	36.8269	0.9956
Median	41.1131	0.9912	27.6877	0.9910
Salt & Pepper	38.8164	0.8264	24.0920	0.8034
Poisson	32.0167	0.9754	24.0931	0.8545
Speckle	28.7931	0.8758	24.0905	0.8528
Gaussian	28.9311	0.8799	24.0919	0.8619
Rotation	28.8531	0.4790	26.1401	0.7995
Cropping	29.0079	0.5340	25.8768	0.6110

Fig. 2 PSNR values of Watermarked Frames

IV. CONCLUSION

In our approach, wavelet-based blind video watermarking technique is proposed. Results are achieved the watermarked video quality is almost as same as original video, so it is difficult to estimate the controversy between the original video and the watermarked video. Also, we achieve higher value of PSNR and the correlation value of watermarked video streams. Proposed scheme shows the degree of invisibility against the noise and geometrical attacks is more. The improvement of this algorithm and the property of real time have been emphasized in our ongoing work.

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