International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Digital Video Watermarking with Multi-level Discrete 3-D Wavelet Transform

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Accepted 13 July 2014, Available online 01 Aug 2014, **Vol.4, No.4 (Aug 2014)**

Abstract

*Digital Watermarking is a method or technology that hides information in to a digital media. It is a two way process which involves embedding and extraction. Video watermarking technique is somehow similar to image watermarking. This mechanism is used to overcome the problem of security, copyright and content authentication of the digital media. The objective of this scheme is to create a watermarking system to make a video more secure. In this paper, we proposed a digital video watermarking technique with multi-level discrete 3-D wavelet transform using MATLAB. In the proposed method, first the video frames are extracted from the host video. Then, each frame get watermarked with multi-level discrete 3- D wavelet transform using key which is also known as embedding. After that each watermarked video frame get reconstructed. Watermarked video is obtained after reconstruction **of** watermarked video frame. The effectiveness of frame is evaluated using frame quality measures against some attacks.*

Keywords: *Digital Video Watermarking, Discrete Wavelet Transform, Video Frame, Watermark, MATLAB.*

1. Introduction

Digital watermarking is a passive protection tool.Piracy has become an increasing issue of the digital media sharing over Internet services or many storage technologies. Digital watermarking is a passive protection tool. Video watermarking algorithms normally prefers robustness. Mostly proposed technique for video watermarking schemes are based on image watermarking. Basically digital watermark is classified in to perceptible and imperceptible watermarks. Digital video watermarking include embedding which involve watermarking video frames extracted from host video using some secret symbol known as key which is used for content authentication, copyright detection purposes.

A digital watermark is robust with respect to transformations if the embedded information may be detected reliably from the marked signal, even if degraded by number of transformations. For video content, temporal modifications and MPEG compression often are added as degradation. Robustness of watermarking is important for many applications (Li Zhang et al, 2012). Robust imperceptible watermarks have been proposed as tool for the protection of digital content.

There are three factors (robustness, security, perceptual fidelity) which are necessary for video watermarking system. The watermark can be perceptual or non-perceptual in which perceptual watermark is subdivided into two categories; first is video independent perceptual (VIP) and second is video dependent perceptual (VDP). While watermarking technique can be classified into spatial domain and frequency domain on the basis of application. Spatial domain watermarking is performed by modifying values of pixel color samples of a video frame whereas watermarks of frequency domain techniques are applied to coefficients obtained as the result of a frequency transform of either a whole frame or single block shaped regions of a frame. Most commonly transforms are discrete fourier transform (DFT), discrete cosine transform (DCT) and discrete wavelet transform (DWT) (Gopika V Mane et al, 2013).

DWT Decomposition

In Fourier analysis, the Discrete Fourier Transform (DFT) decompose a signal into sinusoidal basis functions of different frequencies. No information is lost in this transformation; in other words, we can completely recover the original signal from its DFT (FFT) representation. In wavelet analysis, the Discrete Wavelet Transform (DWT) decomposes a signal into a set of mutually orthogonal wavelet basis functions. These functions differ from sinusoidal basis functions in that they are spatially localized – that is, nonzero over only part of the total signal length. Furthermore, wavelet functions are dilated, translated and scaled versions of a common function φ, known as the mother wavelet. As is the case in Fourier analysis, the DWT is invertible, so that the original signal can be completely recovered from its DWT representation. Unlike the DFT, the DWT, in fact, refers not just to a single transform, but rather a set of transforms, each with a different set of wavelet basis functions. Two of the most common are the Haar wavelets and the Daubechies set of wavelets.

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DWT with two dimensions

The two-dimensional DWT is of particular interest for image processing and computer vision applications, and is relatively straightforward extension of the one-dimensional DWT. First, a one-level, one-dimensional DWT along the rows of the image is applied. Second, a one-level, one-dimensional DWT along the columns of the transformed image from the first step is applied. The result of these two sets of operations is a transformed image with four distinct bands: (1) LL, (2) LH, (3) HL and (4) HH. Here, L stands for low-pass filtering, and H stands for high-pass filtering. The LL band tends to preserve localized horizontal features in the original image. Finally, the HH band tends to isolate localized high-frequency point features in the image.

2. Proposed Watermarking Technique

This section illustrates overall technique of the proposed technique for digital video watermarking based on multi-level discrete 3-D wavelet transform. Firstly, the formation of multi-level discrete 3-D wavelet transform is presented. Then, the proposed embedding process which includes video frame extraction and key generation technique is discussed in detail.

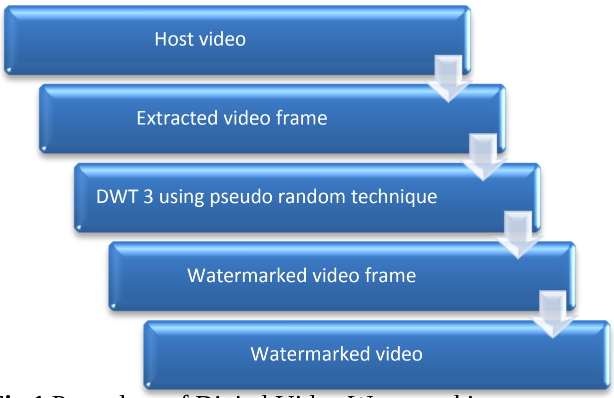


Fig.1 Procedure of Digital Video Watermarking

Multi level discrete 3-D wavelet transform

The basic idea of discrete wavelet transform is to multi-differentiated decompose the frame into sub-frame of different spatial domain and independent frequency district (Mei Jiansheng et al, 2009). Discrete wavelet transform offers multi-resolution representation of frame and gives perfect reconstruction of decomposed frame (Baisa L. Gunjal et al, 2011). It decompose a frame in basically three spatial directions i.e., horizontal, vertical and diagonal in result separating the frame into four different components namely LL, LH, HL and HH. 3-D discrete wavelet transform decomposes a signal in to high and low frequency. At each level there are four sub-bands. In first level of decomposition, there are four sub-bands: LL1, LH1, HL1 and HH1 in which LL1 is a low frequency sub-band which is used for further decomposition. To achieve second level of decomposition, LL1 will have four sub-bands: LL2, LH2, HL2 and HH2. Now, the discrete wavelet transform is applied again to the low frequency band i.e., LL2. At third level of decomposition, there will have again four sub-bands of low frequency signal which is LL2. And the four sub-bands are LL3, LH3, HL3, HH3.

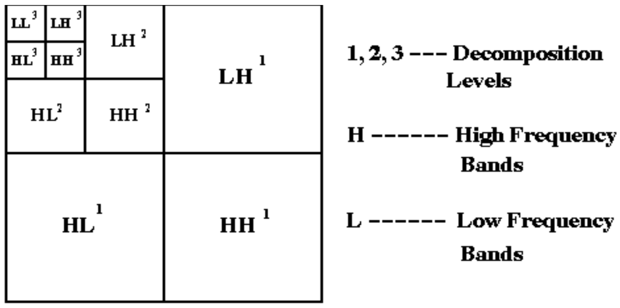


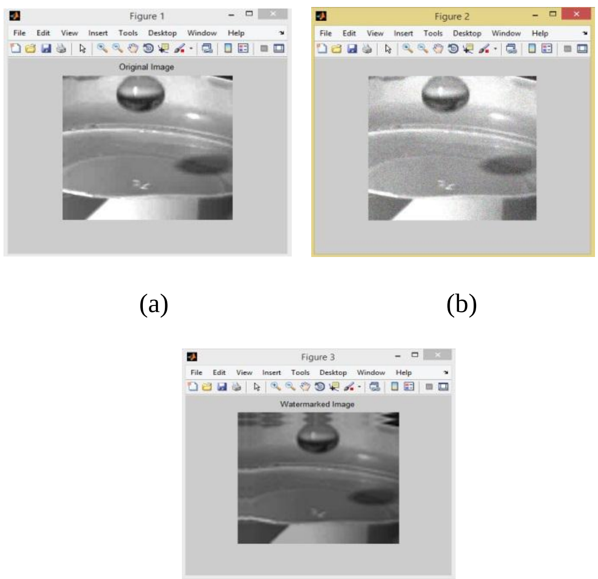
Fig.2 Decomposition levels of discrete wavelet transform

Embedding Method based on multi-level 3-D DWT

Watermarking in the DWT domain can be split into the two procedures:

Embedding of the watermark
Extraction of the watermark

For embedding mechanism, firstly the host video or sample video is required for the extraction of video frames which is obtained from the host video itself. After extraction of frames, a key is generated using uniformly pseudo random number technique and is embedded with the original video frame that is extracted from the host video. Then, each video frame is decomposed in to several bands using the multi-level discrete 3-D wavelet transform. Decomposition is performed through three decomposition level using the "Daubechies filter". After that reconstruction of frame is done using multi-level discrete 3-D wavelet transform. In the end, watermarked video frame is obtained.



(a) (b)

(c)

Fig.3 (a) Original frame, (b) Embedding of key with the original frame and (c) Watermarked frame after multi-level 3-D DWT

For extraction of the watermark, wavelet reconstruction is applied. In watermark extraction procedure, the original video frame is decomposed to three levels assuming that the original frame is known for extraction.

3. Evaluation and Results

Multi-level discrete 3-D wavelet transform is applied on a sample video sequence a.avi of RGB24 format with speed 30 frame per second and resolution 240*256. The original extracted frame from sample video and its corresponding watermarked frame appears somehow visually identical which is shown in figure.

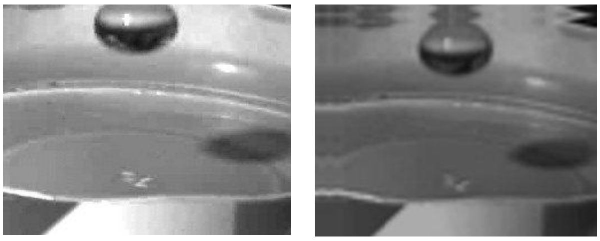


Fig.4 Watermarking mechanism for video

In order to verify the effectiveness of digital video watermarking technique, various factors like robustness, imperceptibility is evaluated.

To estimate the efficiency of different video frames, the frame is attacked like guassian, image processing, geometrical attack. Fig shows the different attacks that is performed on video frame like histogram equalization, rotation by 45, contrast, average noise as well the original video frame and extracted frame

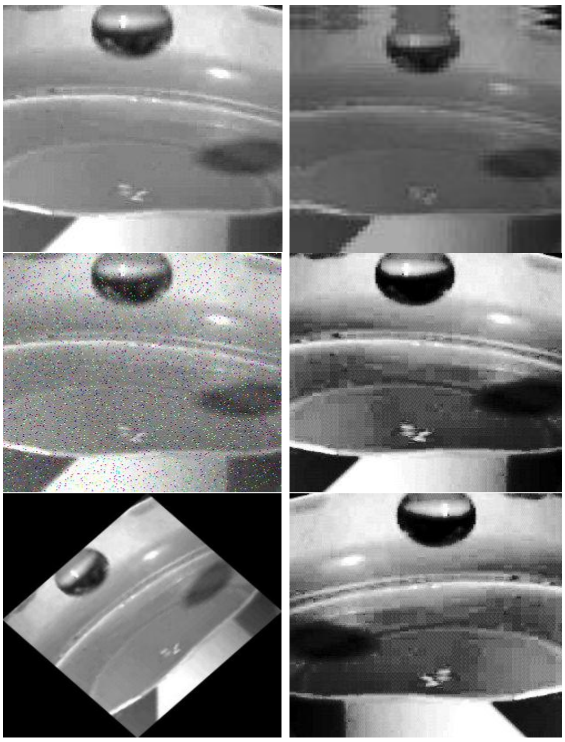


Fig.5 (a) Original video frame, (b) Watermarked frame, (c) Average noise (d) Contrast, (e) Rotation, (f) Histogram equalization

For frame quality measures, peak signal-to-noise ratio, mean squared error, normalized cross-correlation, normalized absolute error is evaluated for original video frame, watermarked frame and distorted frame. Table I shows the values for the quality measures check for watermarked video frame.

Table1 Various image quality measures of watermarked frame

Frame/Frame Quality Measures	**PSNR**	**NAE**	**NCC**	**MSE**	**AD**	**MD**	**SC**
Watermarked	19.731	0.1794	0.8073	691.83	12.025	67.967	1.3816

Table 1 shows the values for the quality measures check for video frames after performing various attacks against video frames. This task is performed to check the robustness of frames.

Table 2 Various image quality measures after various attacks performed on frame

Attacks/frame quality measures	**PSNR**	**NAE**	**NCC**	**MSE**	**MD**	**SC**
Histogram Equalization	19.992	0.1738	1.072	651.5	5.3848	0.8021
Rotation (45)	17.931	0.2822	1.1441	1.0470e+03	3.0175	0.6881
Contrast	18.635	0.2852	1.1592	890.32	1.2956	0.6855
Average Noise	17.718	0.2903	1.1486	1.0998e+03	3.0175	0.68

Conclusion

This paper focuses on the digital watermarking techniques performed on video using multi-level discrete 3-D wavelet transform. Video is watermarked using watermarking technique to make a video more secure for copyright protection and content authentication. To evaluate the effectiveness of video frame various tasks is performed. This work could further be extended for the watermarking purpose of content like movie.

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