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"Robust Video Watermarking using Discrete Cosine Transform and Third level Discrete Wavelet Transform"

Chitrasen[1], Tanuja Kashyap[2]
Department of Electronics and Telecommunication, Bhilai Institute of Technology, Durg, India[1,2]

ABSTRACT
Digital watermarking technique is becoming popular for copyright information. The watermark embedded in the digital video may be incorrectly detected and extracted due to lack of appropriate algorithm, so the main concern is to implement the algorithm which is more resistant to different types of attacks. In this paper, a Hybrid video watermark technique has been introduced where DCT and 3rd level of DWT, for adding more security, is used. PSNR, MSE and NC values of Hybrid technique are analyzed on the basis of different noises and attacks. Hybrid technique is robust against high stream, low stream, frame drop, frame trim attacks.
Keywords: DCT, Digital Watermarking, DWT, 3LDWT.

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I. INTRODUCTION

With the advent of internet and information technology, issues like delivery, Xeroxing and theft of digital data has grown up. Digital watermarking is the powerful solution in avoiding such illegal copyright of digital media in which information is embedded as watermark to protect from illegal copying and provide intellectual property rights. The feature of watermark is that it remains attached to the cover work even if it is copied. So, to prove ownership or copyright, watermark is extracted and tested.

II. TRANSFORMATION METHOD

2.1 Discrete Cosine transforms (DCT):

A discrete cosine transform (DCT) is a sum of cosine functions oscillating at different frequencies and related to Fourier series coefficients of a periodically and symmetrically extended sequence.

The general equation for (*N* * *M* frames) DCT is defined by:

$$C(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y) \times \cos 2x+1u2M \cos 2y+1v2N, \quad \ldots\ldots. (1)$$

IDCT transform is defined by:

$$f(x,y) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} \alpha(u)\alpha(v)C(u,v) \times \cos\left[\frac{\prod(2x+1)u}{2M}\right]\cos\left[\frac{\prod(2y+1)v}{2N}\right] \quad \ldots\ldots. (2)$$

where,

$$\alpha(u) = \begin{cases} \frac{1}{\sqrt{M}}, u = 0 \\ \sqrt{\frac{2}{M}}, u = 1,2,\ldots.,M-1 \end{cases}$$

$$\alpha(v) = \begin{cases} \frac{1}{\sqrt{N}}, v = 0 \\ \sqrt{\frac{2}{N}}, v = 1,2,\ldots\ldots,N-1 \end{cases}$$

Where, f (x, y) is the intensity of the pixel and F (u, v) is the DCT coefficient. Most of the signal energy lies at low frequencies as appeared in the upper left corner of the DCT. Lower right values represent higher frequencies and are often small enough to be neglected with little visible distortion.

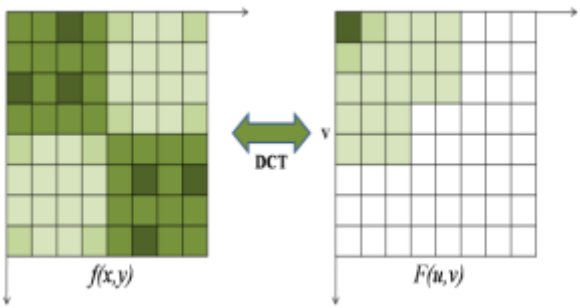

Fig.1: DCT Operation-Original picture and its corresponding DCT mapping.

2.2 Discrete wavelet transforms (DWT):

DWT transform frame pixels into wavelets. Wavelet transform represents an arbitrary function as a superposition of a set of baby wavelets or basis functions which are obtained from a single prototype mother wavelet. Signal is passed through a low pass and high pass filter respectively and then down sampled by a factor of two, constituting one level of transform. Repeating the filtering and decimation process on the low pass branch outputs make multiple levels. The resulting coefficients are called wavelet coefficients.

DWT transform decomposed the video frame into 4 frequency zones that is one low frequency district LL (approximation) and three high frequency Districts LH (horizontal), HL (vertical), HH (diagonal). To obtain the next scaled wavelet coefficients, the sub band LL is further decomposed and critically sub sampled. The original video frame can be reconstructed from DWT coefficients.

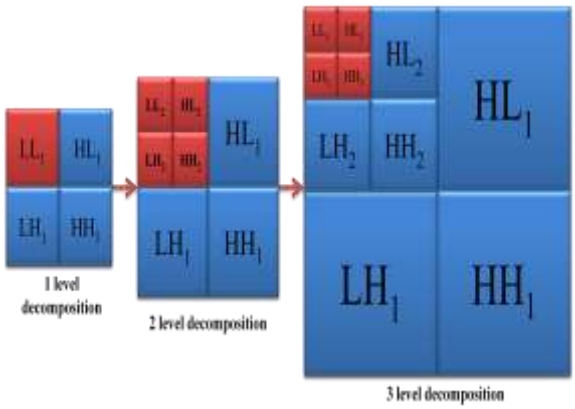

Fig.2: Image Decomposition levels.

The DWT is defined as:

$$W_{\varphi(j_0,k)} = \frac{1}{\sqrt{M}} \sum_x f(x) \varphi_{j_0,k}(x) \quad \text{…….. (3)}$$

$$W_{\psi(j,k)} = \frac{1}{\sqrt{M}} \sum_k f(x) \psi_{j,k}(x) \quad \text{…….. (4)}$$

The IDWT is defined as:

$$f(x) = \frac{1}{\sqrt{M}} \sum_k W_{\varphi(j,k)} \varphi_{j_0,k}(x) + 1 \; Mj{=}j0{\infty}kW\psi j \; , \; k\psi j \; , \; kx$$

..... (5)

where,

$f(x), \varphi_{j_0,k}(x)$ *and* $\psi_{j,k}(x)$are functions of the discrete variable *x=0,1,2,3,……,M-1*.

j=0, 1, 2 …, J-1.

k=0, 1, 2…, $2^j - 1$.

2.3 Hybrid transforms:

The objective of the hybrid algorithm is to exploit the properties of both DWT and DCT i.e. DCT containing most significant information in fewest coefficients and the multi resolution capability of DWT.

III. METHODOLOGY

3.1 Hybrid technique based embedding process:

Sample of a video named vipmen.avi and watermark image named BIT Durg.png taken as input. Read video object, Calculating number of frame, height and width and creating empty frame to store result value. Read watermark image and convert it into gray scale. Applying embedding process on each frames one by one and stores it in empty frame structure. Applying DCT function, Find DCT coefficient and merge it with watermarked image produces DCT based watermarked embedded frame. Applying DWT transforms on produced frame. HAAR wavelet filter generate four sub-bands, one low level and three high levels. After applying three-level Decomposition, LL3 sub-band generates. Merge DWT coefficient with watermarked image produces Hybrid technique based watermarked embedded frame.

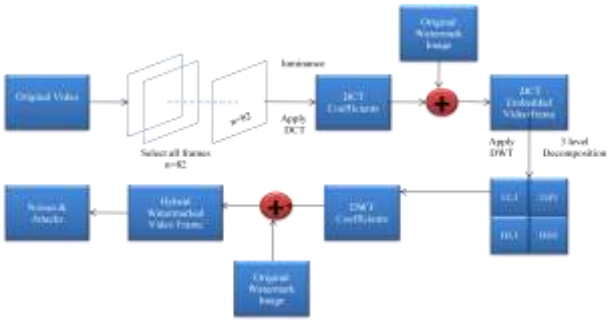

Fig 3: Embedding Algorithm

3.2 Hybrid technique based extraction process:

Noises and Attacks selected from channel and Applied on all frames of Hybrid technique based watermark embedded video. Applying DWT transforms. HAAR wavelet filter generate four sub-bands, one low level and three high levels. After applying three-level Decomposition, LL3 sub-band generates. Merge DWT coefficient with watermarked image, so only DCT technique based watermarked embedded frame remains. Applying DCT function, Find DCT coefficient and merge it with watermarked image produces extracted watermarked image and calculating Evaluation Parameters.

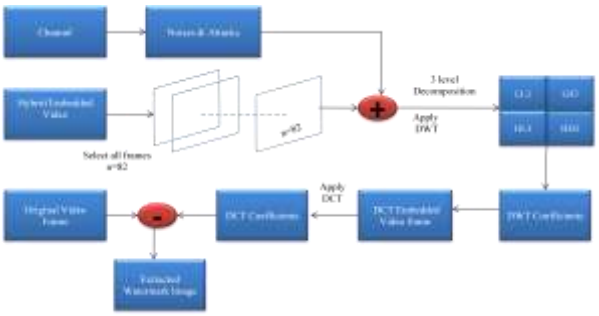

Fig 4: Extraction Algorithm

IV. RESULT AND ANALYSIS

Fig 5: Original video frame

Fig 6: Original Watermark Image

Fig 7: Embedded Video Frame (Hybrid)

8(a)

8(b)

8(c)

8(d)

Fig 8: Extracted Watermarked Image after applied (a) DCT, (b) 1LDWT, (c) 3LDWT, (d) Hybrid technique.

9(a)

9(b)

9(c)

9(d)

Fig 9: Reconstructed Watermarked Image after (a) Gaussian Noise (b) Poisson Noise (c) Salt & Pepper Noise (d) Speckle Noise.

4.1 Comparative Analysis:

The performance of algorithm can be measured in terms of its imperceptibility and robustness against the possible attacks. PSNR is used to measure deviation of the watermarked and attacked frames from the original video frames and is defined as

$$PSNR = 10 \log \left(\frac{255^2}{MSE}\right) \quad \text{…….. (6)}$$

Where, MSE (Mean Squared Error) between the original and distorted frames of size $(m \times n)$is defined as:

$$MSE = \frac{1}{mn} \sum_{i=1}^{m} \sum_{j}^{n} [I(i,j) - I'(i,j)]^2 \quad \text{…….. (7)}$$

Where, I and I' indicates the pixel values at location (i,j) of the original sample frame and watermarked frame respectively. PSNR is directly proportional to the imperceptibility. NC is used to compare the original watermark and extracted watermark.

$$NC = \frac{\sum_i \sum_j W(i,j).W'(i,j)}{\sum_i \sum_j W(i,j)^2} \quad \text{…….. (8)}$$

Where, W denotes the original watermark and W′ denotes extracted watermark.

Table 1: Performance Analysis of Hybrid Technique.

ALGORITHMS	PSNR	MSE	NC
DISCRETE COSINE TRANSFORM	36.4806	25	0.854167
FIRST LEVEL DISCRETE WAVELET TRANSFORM	37.5342	22.5	0.76875
THIRD LEVEL DISCRETE WAVELET TRANSFORM	38.712	20	0.683333
HYBRID TRANSFORM	40.0473	17.5	0.597917

Table 2: Noise Performance Analysis of Hybrid Technique.

NOISE	PSNR	MSE	NC
WITHOUT NOISE	40.0473	17.5	0.597917
GAUSSIAN	36.8416	24.1135	0.502365
POISSON	36.8401	24.1171	0.50244
SALT & PEPPER	36.8403	24.1166	0.50243
SPECKLE	36.8401	24.1171	0.50244

Table 3: Performance of Hybrid Technique with Attacks.

ATTACKS	PSNR	MSE	NC
HIGH STREAM (FR=0.01sec)	40.047	17.5	0.5979
LOW STREAM (FR=0.1 sec)	40.047	17.5	0.5979
FRAME DROP (20 frame dropped)	40.047	17.5	0.5979
FRAME TRIM (Last 30 frame trimmed)	40.047	17.5	0.5979

PSNR value increases in each step and Developed Hybrid algorithm has highest PSNR. MSE value decreases in each step and Developed Hybrid algorithm has lowest MSE value. Hybrid algorithm is distortion-less and imperceptible than other techniques as it provide highest PSNR of 40.04dB. Hybrid algorithm is robust against High-stream, low-stream, frame-drop and frame-trim attacks since there is no parameter variation when applying these attacks because embedding is done in all frames. DCT provides highest correlation between original watermark and extracted watermark. When increasing the embedding level, security increases but correlation decreases.

V. CONCLUSION

This work is a study of various video watermarking techniques given by researcher till now. For protecting the digital video copyright, a robust video watermarking algorithm is developed based on DCT and 3rd level of DWT technique which makes the embedding and extracting process more robust and efficient. When the embedding strength is stronger, the robustness is greater but visual experience is worse. The result shows that the proposed algorithm has a strong ability to resist different watermark attacks.

VI. FUTURE WORK

Watermarking level can further be increases in future. Watermark can be hidden incorporated to provide more security. Digital Signature, Barcode or Key along with watermark may also be incorporated.

VII. REFERENCES

[1] Jie Sang, Qi Liu, and Chun-Lin Song, "Robust Video Watermarking using a Hybrid DCT-DWT approach", Journal of Electronic Science and Technology, February 2017

[2] Prof. Varsha Gaikwad, Rehana Shikalgar, Shubhangi Sagare, Shital Shendage, "Analysis of Attacks on Video Watermarking", International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) , April 2017

[3] Alavi Kunhu, Nisi K, Sadeena Sabnam, Majida, "Hybrid DWT-DCT Video Watermarking Algorithm for Copyright Protection of Multimedia Colour Videos", International Journal of Advanced Research in Computer and Communication Engineering, June 2015

[4] Mayank Mishra, Dr. Nirmal Kumar Rout, "Copyright Protection of Images By Reversible, Invisible and Robust Digital Watermarking Using 3rd And 4th Level Discrete Wavelet Transform", International Journal Of Engineering And Technology (IJET), Apr-May 2017

[5] Sadik A.M. Al-Taweel, Putra Sumari, "Robust Video Watermarking based on 3D-DWT Domain", IEEE Communications, 2009.

[6] Min-Jeong Lee, Dong-Hyuck Im, Hae-Yeoun Lee, Kyung-Su Kim, Heung-Kyu Lee, "Real-Time Video Watermarking System on the Compressed Domain for High-Definition Video Contents: Practical Issues", Digital Signal Processing, 2012.

[7] Suppat Rungraungsilp, Mahasak Ketcham, Tanee Wiputtikul, Kanchana Phonphak and Sartid Vongpradhip, "Data Hiding Method for QR Code Based on Watermark by comparing DFT with DWT Domain", International Conference on Computer and Communication Technologies (ICCCT), May 2012.

[8] Alka N. Potkar, Saniya M. Ansari "Review on Digital Video Watermarking Techniques, International Journal of Computer Applications, November 2014.

[9] Ankita A. Hood "A Review on Video Watermarking and Its Robust Techniques" International Journal of Engineering Research & Technology (IJERT), January-2013.

[10] 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, August 2011.

[11] S.Nafees Ahmed, B.Sridhar, Dr.C.Arun, "Robust Video Watermarking based on Discrete Wavelet Transform" International Journal of Computer Network and Security (IJCNS) , Jan-Mar 2012.

[12] Gopika V Mane, G. G. Chiddarwar, "Review Paper on Video Watermarking Techniques" International Journal of Scientific and Research Publications, April 2013

[13] Mohan Durvey, Devshri Satyarthi, "A Review Paper on Digital Watermarking" International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), July-August 2014

[14] Vinita Gupta, Mr. Atul Barve, "A Review on Image Watermarking and Its Techniques", International Journal of Advanced Research in Computer Science and Software Engineering, January 2014

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