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A HYBRID DWT-SVD METHOD FOR DIGITAL VIDEO WATERMARKING

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Abstract: Digital watermarking refers to embedding watermarks in a multimedia documents and files in order to protect them from illegal copying and identifying manipulations. We proposed a technique is Hybrid DW- SVD method for digital video watermarking. A proposed method is divided in 2 parts: embedding watermark and extracting watermark. In embedding and embedding process, we Compare Hybrid Method with DCT method, calculate PSNR ratio, elapsed time and check robustness, imperceptibility of video.

Keywords: DWT, SVD, elapsed time, Embedding, Extracting

I. INTRODUCTION

Watermarking is a concept of embedding a special pattern, watermark, into a multimedia document so that a given piece of copyright information is permanently tied to the data. It is an effective way to protect copyright of multimedia data even after its transmission. In few years image watermarking techniques are become mature. So the next challenging task is for digital video watermarking and it is becoming a current academic research topic. Digital watermarking is a process of embedding watermark into digital products, where watermark can be some binary data, a small image or a seed value. It can also be any random or serial number, ownership identifier, information about the creator, date etc [1], that would be inserted into the original digital products. Digital watermarking received increasing attention in the last decade due to massive digital artwork distribution via internet. Digital Watermarking is intended by its developers as the solution to the need to provide value added protection on top of data encryption and scrambling for content protection [2]. Digital watermark technique is widely applied to tampering detection, authenticity and/or ownership protection of digital images, audio, video or even texts.

II. BACKGROUND STUDY

Watermarking is the process that embeds data called a watermark or digital signature or tag or label into a multimedia object such that watermark can be **detected** or **extracted** later to make an assertion about the object. The object may be an **image** or **audio** or **video**. A simple example of a digital watermark would be a visible "seal" placed over an image to identify the copyright. However the watermark might contain additional information including the identity of the purchaser of a particular copy of the material.

In general, any watermarking scheme (algorithm) consists of three parts: [3]

- **The watermark**
- **The encoder** (marking insertion algorithm**)**
-**The decoder and comparator** (verification or extraction or detection algorithm)

Each owner has a unique watermark or an owner can also put different watermarks in different objects the marking algorithm incorporates the watermark into the object. The verification algorithm authenticates the object determining both the owner and the integrity of the object.

A. *Characteristics of Watermarking Schemes*

An effective watermarking scheme should have the following characteristics [4] :

1. Imperceptibility: In terms of watermarking, imperceptibility means that after inserting the watermark data, cover medium should not alter much. In other words, the presence of the watermark data should not affect the cover medium being protected.

2. Robustness: Robustness of the watermark data means that the watermark data should not be destroyed if someone performs the common manipulations as well as malicious attacks.

3. Fragility: Fragility means that the watermark data is altered or disturbed up to a certain extent when someone performs the common manipulations & malicious attacks. Some application areas like temper detection may require a fragile watermark to know that some tempering is done with his work. Some application may require semi-fragility too.

4. Resilient to common signal processing: The watermark should be retrievable even if common signal processing operations are applied to the watermarked cover medium data.

5. Resilient to common geometric distortions (image and video data): Watermarks in image and video data should also be immune from geometric image operations such as rotation, translation, cropping and scaling. This property is not required for audio watermarking.

6. Robust to subterfuge attacks (collusion and forgery): In addition, the watermark should be robust to collusion attack. Multiple individuals, who possess a watermarked copy of the data, may collude their watermark copies to destroy the watermark presence and can generate a duplicate of the original copy. [4]

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7. Unambiguousness: Retrieval of the watermark should unambiguously identify the owner. Furthermore, the accuracy of owner identification should not degrade much in the case of an attack. The Unzign and Stirmark [8] have shown remarkable success in removing data embedded by commercially available programs. Watermarking of watermarked image (re-watermarking) is also a major threat [4].

B. *Classification of watermarking techniques*

Watermarks and watermarking techniques can be classified according to their working domains, types of document, human perception, watermark detected/extracted and ability to resist attacks. Classification of digital watermarking techniques is as shown in below Figure.

Watermark can be embedded either in spatial or frequency/Transform domain. In frequency domain several other domains are also there, like Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Discrete Fourier Transform (DFT) [3], Hadamard Transform (HT) [4], Arnold Transform [5], Singular Value Decomposition (SVD), Spectral Domain etc.

Spatial domain techniques have better capacity of embedding and easier to implement, but that are limited to robustness while transform domain techniques are more robust and resistant to various attack.

C. **Discrete Wavelet Transform (DWT):** Discrete Wavelet Transform (DWT) is a transform based on frequency domain.

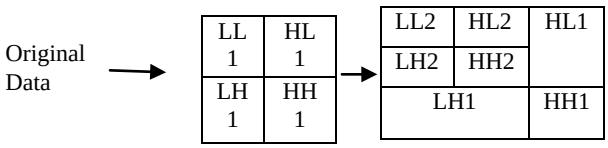

Figure 2.3 : Frequency distribution after DWT

As shown in above figure the distributions of the frequency is transformed in each step of DWT, where L represents Low frequency, H represents High frequency and subscript behind them represents the number of layers of transforms. Sub graph LL represents the lower resolution approximation of the original video, while high-frequency and mid-frequency details sub graph LH, HL and HH represents vertical edge, horizontal edge and diagonal edge details [7].

D. **Singular Value Decomposition (SVD):** Singular value decomposition is a numerical technique used to diagonalize matrices in numerical analysis. It is an algorithm developed for a variety of applications. Any matrix 'M' is decomposed into three sub matrices [u, s, v] such that: $M=u*s*v^{T.}$ Where 'u' and 'v' are the orthogonal matrices such that $u * u^T = I$ and $v * v^T = I$ where 'I' is the Identity matrix and 's' is the diagonal matrix × (s1, s2, s3……sN) such that s1>=s2>=s3……..s(N-1)>=sN [11].

These values are known as singular values, and matrices u and v are known as corresponding singular vectors [11]. The above decomposition is termed as Singular Value Decomposition. A SVD, applied to the image matrix, provides singular values (diagonal matrix's') that represent the luminance or color intensity of the image while the matrices 'u' and 'v' represents the geometry of the image. It has been scientifically proved that slight variation in the singular values doesn't change the visual perception of the image.

The work thus implements the SVD to provide better visual perception along with the robustness. The increased robustness is due to the stability of singular values. The stability of singular value indicates that, when there is a little disturbance with A, the variation of its singular value is not greater than 2-norm of disturbance matrix. 2-norm is equal to the largest singular value of the matrix. Singular values exhibit some more properties like rotation invariance, translation invariance, transposition invariance, etc. These all properties of SVD are much desirable in image watermarking.

III. PROPOSED METHOD

E. *HYbrid DWT-SVD method for digital video watermarking*

In this hybrid method of watermarking, we use Singular Value Decomposition (SVD) and Discrete Wavelet Transform.

In this proposed method of embedding the watermarking in video, first load the original video and watermark image. Get information about video's cover object and watermarked image. And adjust the co-efficient (alpha) value and take the first frame of video. Now Apply Single level (DWT) discrete 2-D wavelet transforms. After that resize the watermark image and apply SVD on the video frames. After that all frames convert in video format and saved it in hard disk.

The embedding algorithm of DWT-SVD is described as,

1. Load original video and watermark image. And adjust alpha value for result.
2. Read the watermarked image in double. And take information about first frame of video and double it.
3. Apply DWT2 as [CA,CH,CV,CD] = DWT2(X, 'wname') computes the approximation coefficients matrix CA and details coefficients matrices CH, CV, CD, obtained by a wavelet decomposition of the input matrix X. 'wname' is a string containing the wavelet name.
4. After that again resize watermarked image as per size of the co-efficient and apply SVD.
5. Than After convert all frames in to matlab movies format.
6. Matlab movie format converted in avi format and save in hard disk.

This proposed method of extraction algorithm used. First we read the watermarked video and get information about it. Take any one of the frame from the watermarked video and apply DWT as per embedding algorithm.

Now use SVD, and resize the S1 and get new values of SVD matrix. After that getting new watermark values and display recovered message.

The extracting algorithm of DWT-SVD is described as,

1. Load watermarked video.
2. Take any one of the frame from the watermarked video, double it and apply dwt.
3. Use switch case for SVD's value.
4. Getting new values of S1 and get new value of matrix.
5. After that get new value of watermark = (matrix-S1)/alpha.
6. Display recovered watermarked image.

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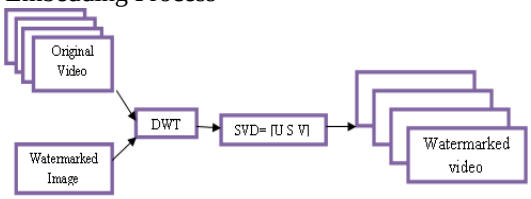
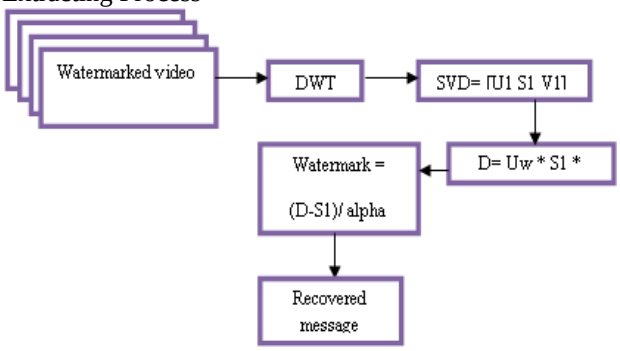
Embedding Process



Extracting Process



IV. SIMULATION AND RESULTS

E. *A Hybrid DWT-SVD method for digital video watermarking*

Here, we conclude the value of PSNR ratio between DCT based watermarked and Hybrid method (DWT-SVD) based watermarked below in table no.I

We can calculate comparison between PSNR values when alpha value is changed. We can see after this comparison hybrid method watermarking video's PSNR ratio is constantly decrease when alpha value is increased at minor level. But in DCT based watermarked video's PSNR ratio is same while alpha value is increased.

In PSNR ratio of video (demo_video.avi) embedded video by DCT and Hybrid (DWT-SVD) method with copyright.bmp with different coefficient

Alpha = 0.001					
DCT based watermark video			**Hybrid method based watermark video**		
Time	=	110.8075	Time	=	54.6160
Original PSNR	=	3.7273 db	Original PSNR	=	2.2234 db
DCT PSNR	=	56.3543 db	Hybrid PSNR	=	15.3171 db
Alpha = 0.0012					
Time	=	102.05	Time	=	69.13
Original PSNR	=	3.7273 db	Original PSNR	=	2.2234 db
DCT PSNR	=	56.3543 db	Hybrid PSNR	=	14.2489 db
Alpha = 0.0013					
Time	=	110.49	Time	=	55.22
Original PSNR	=	3.7273 db	Original PSNR	=	2.2234 db
DCT PSNR	=	56.3543db	Hybrid PSNR	=	13.7940 db
Alpha = 0.0014					
Time	=	100.0434	Time	=	59.03
Original PSNR	=	3.7273 db	Original PSNR	=	2.2234 db
DCT PSNR	=	56.3543db	Hybrid PSNR	=	13.3809 db
Alpha = 0.0015					
Time	=	107.7187	Time	=	56.7844
Original PSNR	=	3.7273 db	Original PSNR	=	2.2234 db
DCT PSNR	=	56.3543db	Hybrid PSNR	=	13.0013 db

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Here, we get some snapshot of embedded video frame, original watermark and recovered watermark
Here, we see snapshot of comparison between embedding video frame of video of demo_video.avi, original watermark and recovered watermark of different image in below table. We conclude that original watermark and recovered watermark is approximating same.

Snapshot of embedding video frame of demo_video.avi, Original watermark and recovered watermark of copyright.bmp

Snapshot of embedding video frame of demo_video.avi, Original watermark and recovered watermark of cameraman.tif

Snapshot of embedding video frame of demo_video.avi, Original watermark and recovered watermark of 019.gif

Snapshot of embedding video frame of demo_video.avi, Original watermark and recovered watermark of 01.gif

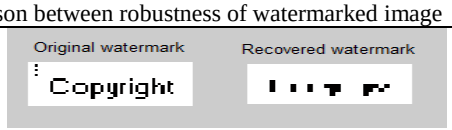
Some comparison of Hybrid and DCT method digital video watermarking:
Here, we compare Hybrid DWT-SVD and DCT method for demo_video.avi video and watermarked

image is copyright.bmp and get result are below:

❖ **Robustness:**

Robustness of the watermark data means that watermark data should not be destroyed, we can see in Table no.II

Table no II
Comparison between robustness of watermarked image

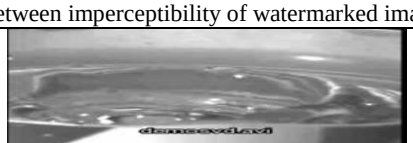
DCT Method	
Hybrid Method	

In Table no.II, we check the robustness of watermarked image by DCT and Hybrid DWT-SVD method and conclude that Hybrid DWT-SVD method is better than DCT method.

❖ **Imperceptibility:**

Imperceptibility means after insert a watermark data in image or video, its quality may alter which the owner of the image or video will never like that. We can see in Table no.III

Table no. III
Comparison between imperceptibility of watermarked image

DCT Method	
Hybrid Method	

In Table no.III, we check the imperceptibility of watermarked video by DCT and Hybrid DWT-SVD method and conclude better result of imperceptibility of video is better in Hybrid DWT-SVD method.

❖ **Time:**

Here we calculate elapsed time, it means elapsed time = cpu_time - start_time. We can see in Table no.IV

Table no.IV
Comparison between elapsed time

DCT Method	Embedded process: 201.61 sec Extracted process: 202.91 sec
Hybrid Method	Embedded process: 87.76 sec Extracted process: 1.02 sec

In Table no.IV, we calculate elapsed time of embedding and extracting watermark and conclude DCT method is time consuming watermark method.

❖ **PSNR:**

Here we calculate PSNR ratio, the peak signal-to-noise ratio (PSNR) is the ratio between a signal's maximum power and the power of the signal's noise. PSNR to measure the quality of reconstructed images that have been compressed. Each picture element (pixel) has a color value that can change when an image is compressed and then uncompressed. Signals can have a wide dynamic range, so PSNR is usually expressed in decibels, which is a logarithmic scale. We can see comparison in Table no.4.15

Table no.V
Comparison between PSNR value of watermarked video

DCT Method	PSNR_wat = 56.3543 db
Hybrid Method	PSNR_wat = 15.3171 db

In Table no.V, we calculate PSNR ratio of watermark video and conclude hybrid DWT-SVD method is more efficient than DCT method.

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V. CONCLUSION

A proposed approach of digital video watermarking based on hybrid concept of DWT and SVD. This method can be used for authentication and data hiding purposes. The DCT based method is very time consuming though it offers better capacity and imperceptibility. A Hybrid DWT-SVD method is found to be better than DCT method. The new method was found to satisfy all the requisites of an ideal video watermarking scheme such as imperceptibility, robustness and fast processing time.

REFERENCES

[1] Saraju Prasad Mohanty , " Watermarking of Digital Images ", guided by Prof. K. R. Ramakrishnan Department of Electrical Engineering, INDIAN INSTITUE OF SCIENCE, BANGALORE-560 012, INDIA,JANUARY, 1999.
[2] Sourav Bhattacharya, T. Chattopadhyay and Arpan Pal, "A Survey on Different Video Watermarking Techniques and Comparative Analysis with Reference to H.264/AVC", Consumer Electronics.ISCE '06, pp-1-6.
[3] Xing Chang, Weilin Wang, Jianyu Zhao, Li Zhang, "A Survey of Digital Video Watermarking", IEEE,2011 Seventh International Conference on Natural Computation, pp 61-65.
[4]Saeid Saryazdi, Hossein Nezamabadi-pour, "A Blind Digital Watermark in Hadamard Domain", World Academy of Science, Engineering and Technology, 2005, pp-126.
[5] SHI Hongqin, LV Fangliang., "A Blind Digital Watermark Technique for Color Image Based on Integer Wavelet Transform", 978-1-4244-5316-0/10/$26.00 ©2010 IEEE.
[6] Lin Liu, "A Survey of Digital Watermarking Technologies".
[7] Mona M El-Ghoneimy, "Comparison between two Watermarking Algorithms Using DCT Coefficient and LSB Replacement", Journal of Theoretical and Applied Information Technology, 2008, pp132-139.
[8] Ze-Nian Li, Mark S. Drew, "Fundamentals of Multimedia".
[9] Tsung-Li Wu, S. Felix Wu," Selective Encryption and Watermarking of MPEG Video", submitted to International Conference on Image Science, Systems, and Technology, CISST'97, pp2-10.
[10] Huang Liang, "Research on the MPEG-2 Video Watermarking Scheme Based on Spread Spectrum Technology" International Conference on Computer Engineering and Technology,2009, pp408-411.
[11] S S Bedi, Ashwani Kumar, and Piyush Kapoor," Robust Secure SVD Based DCT – DWT Oriented Watermarking Technique for Image Authentication " International Conference on IT to Celebrate S. Charmonman's 72nd Birthday, March 2009.
[12] Chiou-Ting Hsu' and Ja-Ling Wu**, "**Dct-Based Watermarking For Video", Communication and Multimedia Lab,Department of Computer Science and Information Engineering,National Taiwan University,Taipei, Taiwan, IEEE Transactions on Consumer Electronics, Vol. 44, No. 1, FEBRUARY 1998, pp206-216.
[13] Satyanarayana Murty. M.Uday Bhaskar, Rajesh Kumar, "A Semi-Blind Reference Watermarking Scheme Using DWT-DCT-SVD for Copyright Protection", International Journal of Computer Science & Information Technology (IJCSIT) Vol 4, No 2, April 2012
[14] F. Hartung, B. Girod, "Watermarking of uncompressed and compressed video", Signal Processing, vol. 66, no. 3, pp. 283-301, May 1998.
[15] Navas K A, Ajay Mathews Cheriyan, Lekshmi.M, Archana Tampy.S, Sasikumar M., "DWT-DCT-SVD Based Watermarking" Electronics and Communication Engineering Dept. College of Engineering Trivandrum,Kerala, India
[16] Hongmei Liu, Nuo Chen, Jiwu Huang, Xialing Huang, Yun Q. Shi, "A Robust DWT-Based Video Watermarking Algorithm" 0-7803-7448-7/02/$17.00 02002 IEEE,pp631-634.
[17] Yuanjun Dai Lihe Zhang Yixian Yang,"A New Method of MPEG Video Watermarking Technology", BeiJing University of Posts and Telecommunications, Proceedings of ICCT2003, pp1845-1847.
[18] Ke-Bin Jia, Zhi-Pin Deng, Xin-Yue Zhuang, "The Research of Video Matching Algorithm Based on Spatio-Temporal Feature", College of Electronic Information & Control Engineering, Beijing University of Technology,Beijing, pp1-4.
[19] Xumeing Qian, Guizhong Liu, Huan Wang , "GM/LM Based Error Concealment for MPEG-4 Video Transmission Over High Lossy and Noisy Networks", International Conference on Intelligent Information Hiding and Multimedia Signal Processing, 978-0-7695-3278-3/08 $25.00 © 2008 IEEE, pp670-674.
[20] Peng Zheng,Bo Zhao, Min-zhong Liu , "An Efficient Method to Hide Information in MPEG Video Sequences", International Conference on Multimedia Information Networking and Security 978-0-7695-3843-3/09 $26.00 © 2009.
[21] Hao-Xian Wang, Zhuo-Zhi Diao , "A Novel Real-Time Information Hiding Technique In Vlc Domain"**,** Fourth International Conference on Innovative Computing, Information and Control, 978-0-7695-3873-0/09 $29.00 © 2009 IEEE.
[22] Peng Zheng1, 2, Bo Zhao1, 2, Minzhong Liu1, Yueyun Shang , "A Novel Approach To Hide Information Based On Mpeg B-Frames", International Symposium On Intelligence Information Processing And Trusted Computing,2010, 978-0-7695-4196-9/10 $26.00 © 2010,pp129-132.
[23] Tamer Shanableh , "Data Hiding In Mpeg Video Files Using Multivariate Regression And Flexible Macroblock Ordering", IEEE Transactions On Information Forensics And Security, Vol. 7, No. 2, April 2012,pp455-464.
[24] A. Aggoun and I. Jalloh ,"Two Dimensional DCT/IDCT Architecture", Faculty of Computing Sciences and Engineering, De Montfort University, The Gateway Leicester LE1 9BH.
[25] Dmitry Furman and Moshe Porat, "Three-dimensional DCT-based video compression using activity maps", Proc. SPIE 4667, Image Processing: Algorithms and Systems, 493 (May 23, 2002); doi:10.1117/12.468012; http://dx.doi.org/10.1117/12.468012
[26] Andrew B. Watson," Image Compression Using the Discrete Cosine Transform", NASA Ames Research Center in Mountain View, California.
[27] S.M. Rafizul Haque, " Singular Value Decomposition and Discrete Cosine Transform Based Image Watermarking ", Department of Interaction and System Design School of Engineering, Sweden.

BIOGRAPHY

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