A Fusion Technique of Video Watermarking in Wavelet Domain and Encryption Method for Video Authentication

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ABSTRACT
In Recent time's security of multimedia content or digital products on the internet is very crucial. Data security is awfully essential. Hence, Watermarking and Encryption are a corresponding outline of security in protecting multimedia content. In this regard this, paper proposed a combine technique of watermarking and encryption method. Digital watermarking is the process of embedding data into digital multimedia content. Encryption is also one technique to give security for information. It involves reshuffling of pixel of the image based on scan pattern. For reconstruction of the original image decryption process is also done. The experimental results show that this combine technique gives double security for the protection of video content and achieves good PSNR.

Keywords
Digital Video Watermarking, DWT (Discrete Wavelet Transform), Inverse DWT, PSNR (peak signal to noise ratio)

1. INTRODUCTION
In recent era of information technology & globalization the security of multimedia products or data over internet becomes vital factor with data authentication. These factors are addressed by two different means that is media encryption and digital watermarking. Encryption is one of the techniques to give security of media information or digital data. And digital watermarking is used for the defense of digital images and digital data.

Video watermarking refers to embedding of a watermark data in a video sequence to defend from illegal copying or sharing and also protection of identity of authorized consumer or creator of the work. There are numerous schemes for image encryption [1] & for digital watermarking that have their own ideas. In few encryption techniques, encryption of image depends on carrier image [2]. For watermarking different types of approaches has been proposed for different application. The watermarking method has been applied either in spatial domain or in frequency domain (DWT, DFT, DCT, FFT etc) transform [3] [4]. Hence, the proposed work is based on the concept of hybridizing Scan pattern and watermarking in DWT domain to get dual protection of video content that makes the technique more secure.

There are numerous methods introduced by different authors on this technique. Maniccam, et al [1], Chao-Shen Chen, et al. [2] proposed a technique, a image encryption (of binary or gray scale) images. Cheng-Han Yang et al. [3] proposed a watermarking embedding technique in DCT domain, to reach good transparency & robustness against some attacks like noise, luminance modification. M.R. Islam et al. [4] compares an advantage of wavelet transform over Fourier transform. Jiansheng et al. [5] introduce a watermarking in both DWT and DCT domain and simulation results shows that this algorithm is invisible and has good robustness for some common image processing application. Salwa A.K. Mostafa et al. proposed a video watermarking in PCA and wavelet transform and shows robustness against attacks of common video processing applications [6]. Hitesh Patel et al. [7] implement a video watermark using 4-level DWT; result shows robustness against all video attacks. Peter Gos et al. [8] introduced video watermarking technique in DWT domain. A result is depending on the dynamic properties of video. Better watermark extraction is obtained when video content is less dynamic. Huang, Hui-Yu et al. [9] introduce a video watermark in DCT and QIM. Experimental results show the robustness & can survive filtering, compressions and noise attacks with a good invisibility. Video watermarking systems use spatial domain or transformed domains such as (DWT) [10, 11], (DFT) and DCT [12] for data embedding. In uncompressed domain these technique are applied which show robustness against compression attacks. Among image and video watermarking methods, several schemes use wavelet transform. Shaabany et al. embed different parts of a watermark into different scenes of a video using wavelet transform [13]. Radu Ovidiu Preda et al. proposed a two blind video watermarking technique in both Spatial and wavelet domain. Due to the use of wavelet techniques better video quality is achieved and robustness to attacks than the spatial domain technique [14]. A. M Kothari, implements video watermark and analyze the performance by using combine technique DWT with SVD approach here, the SVD is applied to approximation coefficients and the maximum singular value is used for data hiding [15]. Nisreen Yassin et al. introduce a video watermarking algorithm, implemented using 2-level DWT with PCA transform. By analyzing the result, it can be concluded that, this scheme is imperceptible and show robustness against several attacks [16]. A novel approach is introduced by Amrita Singh et al. for image encryption algorithm for security enhancement [19]. In [20], watermark technique is implemented in DCT domain, in this value of NC is 1, which shows that 100% recovery of watermark is obtained. Encryption technique based on scan pattern is introduced; result confirms that Scan pattern gives more efficient result for image encryption [21]. Author uses a combine method of DWT & PCA, this method is robust against several attacks and do not affect the original quality of the video content. [22] [24]. Author implement video watermark in PCA & DWT domain to achieve robustness and uses AES algorithm, so that authorized users can extract the watermark [25].

The proposed technique is based on watermarking and encryption algorithm in wavelet domain for enhancing security. Wavelet is more compatible as aspects to (HVS) human visual system and provide better localization both time

domain & frequency domain. Experimental outcome show the efficiency of the proposed fusion method. Double security will be obtained by using combine technique of watermark & Encryption.

This paper is organized in six sections. Subsequent section explains the general idea of embedding and extracting algorithm. Section 2 & 3 explain brief about DWT and SCAN based encryption method. Section 4 is methodology. Section 5 is result of the proposed scheme. And finally, section 6 gives conclusion and future scope of propose scheme.

2. DISCRETE WAVELET TRANSFORM

The Discrete Wavelet Transform (DWT) is presently used in a broad variety of signal processing applications, for ex: in audio and video compression, removal of noise in audio, and so on. Wavelets have their energy intense in time and also suitable for the analysis of transient, time-varying signals [3]. The basic concept of discrete wavelet transform in image process is to decompose the image into sub-image of different spatial domain and independent frequencies. This method is also called as multi resolution method [4]. The main feature of this method is that watermark is introduced in imperceptibly significant regions of the information in order to remain robust. Using resolution of wavelets it decomposes the image into frequency bands. It separates an image into a lower resolution approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components [5]. The process can then be continued to compute multiple scale wavelet decomposition. For the reconstruction of image IDWT is applied. It is just inverse of the DWT. This technique is robust to all kinds of distortions such as compression, additive noise, etc [6].

The advantage of the wavelet transform is its compatibility with the model aspects of the human visual system as compared to DFT, DCT & FFT. Wavelet function can be liberally preferred for higher flexibility [7].

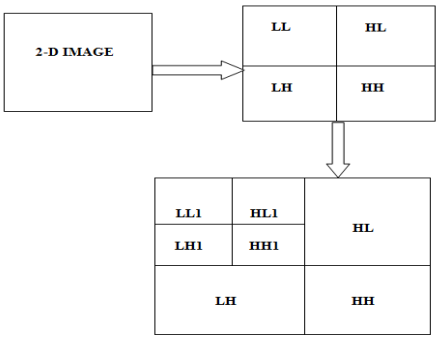


Fig 1- Basic Decomposition steps for image in DWT

3. SCAN BASED ENCRYPTION METHOD

A number of algorithms have been proposed for image encryption. Most image encryption algorithms are based on position permutations with or without disorder functions where the pixel values are scrambled to different positions on the 2D array. SCAN is a class of formal languages, which is applied to encryption, data hiding, compression etc. [1] A scanning of a two dimensional array is an order in which each element of the array is accessed exactly once. The SCAN is a formal language-based two dimensional spatial accessing methodology which can represent and generate a vast number of wide varieties of scanning paths. [2] SCAN language uses four basic scan patterns shown in figure 3. They are continuous raster C, continuous diagonal D, continuous orthogonal O, and spiral S. Each basic pattern has eight transformations numbered from 0 to 7. For each basic scan pattern, the transformations 1, 3, 5, 7 are reverses of transformations 0, 2, 4, 6, respectively. [17] A scanning of a two dimensional array is a collection in which each part of the array is accessed exactly once. The scan method includes image encryption and decryption method, in which image encryption is to reshuffle the pixel i.e. varying the position of the pixel of the image and alter the value of pixel. [19]

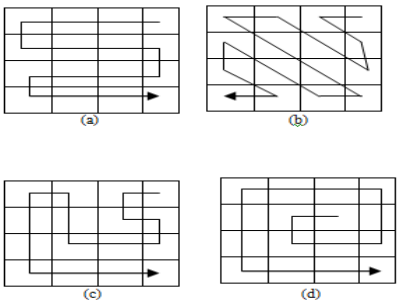


Fig-2 (a) Continous Raster C (b) Continous Diagonal D (c) Orthogonal O (d) Spiral

4. METHODOLOGY

This paper proposes an efficient watermarking based on DWT domain and Encryption method i.e. Scan method. In this a video data input is divided into n-no of frames (image). Details of proposed technique are described in the following subsections.

4.1 Watermarking Embedding Process

The proposed method consists of two procedures: the embedding process and the extraction process. Here first of all, use watermark embedding technique to reach copyright defense mechanism. In addition, to increase the protection of watermark, the watermark is prepermuted by a pseudorandom generator with the secret key (K) to disperse the correlation. In the embedding process, first take a video data as an input and divide this video into frames. After that frame of the video is encrypted using scan method. Then blue channel from this encrypted frame are taken and decomposed it into DWT coefficient. Now select the mid frequency coefficient i.e. LH & HL components of these frames for embedding the watermark using Pseudo-random noise with a key (k) as per the equation below.

$FW_{u,v}=\{Fi+K * pn,\ \text{if } W=0,\ u,v \in HL,LH \ldots\ldots\ldots(1)$

Where, $FW_{u,v}$ = watermark frame component,

Fi= original encrypted frame without watermark,

K= gain factor,

Pn= pseudo random number.

Once the watermarking embedding is accomplished then inverse discrete wavelet transform is applied to reconstruct the frame or image. Constitute these frame to rebuild the video i.e. watermark video.

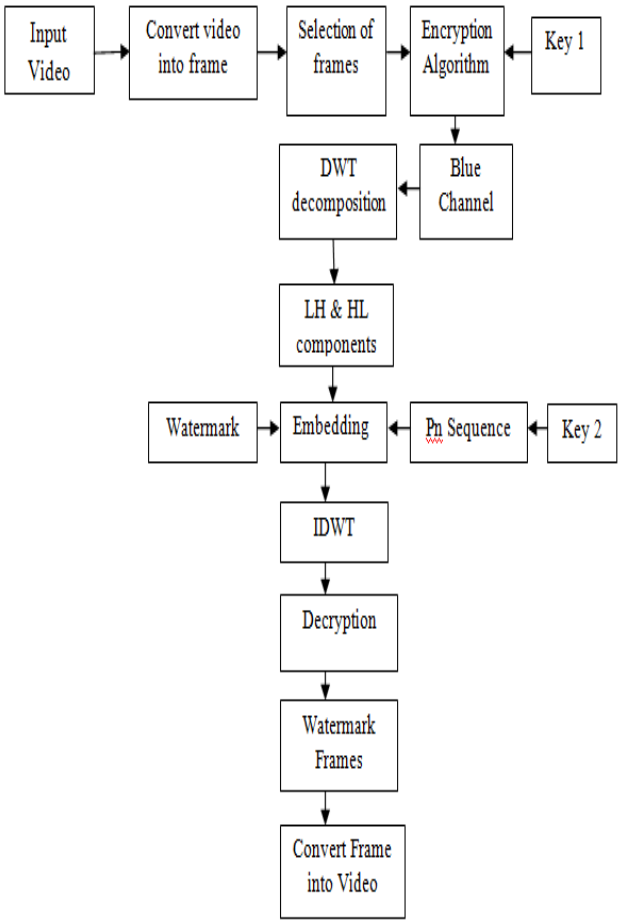


Fig-3 Block diagram of Embedding Process

The embedded watermark is a black & white image. This watermark is shown in the Fig. 4. The size of watermark depends on the resolution of original video and also depends on the level of wavelet decomposition. In our experiments size of the embedded watermark is 50x20.

Fig 4: Embedded Watermark

4.2 Extraction Process

In the extraction, the embedded watermark will be extracted. Extraction process is just reverse of embedding process. Here, in extraction process a watermark video is taken as an input and divide the video into frames. Encrypt each frame using encryption method. Select the blue channel of each frame and decompose this channel using DWT & get the mid-frequency coefficients. After, getting the mid-frequency coefficient perform the correlation test between pn sequence & mid-frequency coefficient as per the below equation, and get the extracted watermark or recovered image.

$$EWu,v = \begin{cases} 0 & if\ corr(FWu,v,pn) > threshold \\ 1 & else \end{cases} \quad u,v \in HL,LH \qquad \ldots\ldots\ldots\ldots (2)$$

Here, EWu,v represents the extracted watermark bit.

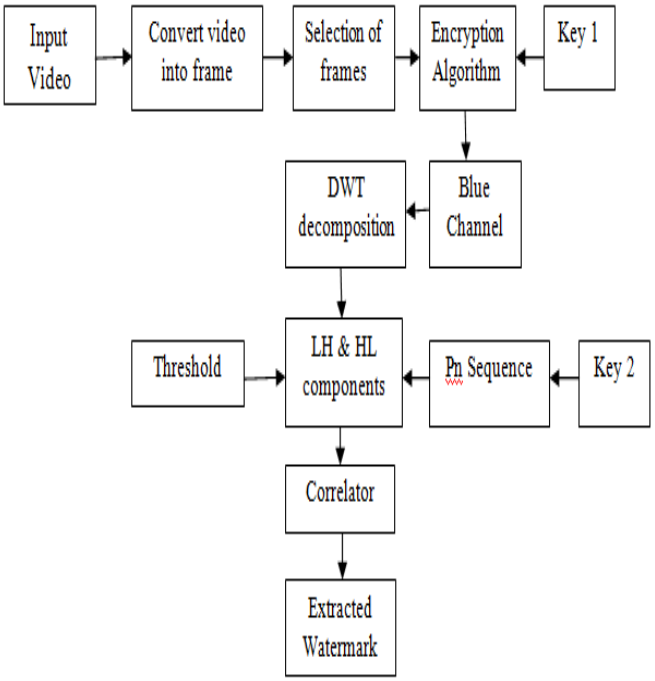
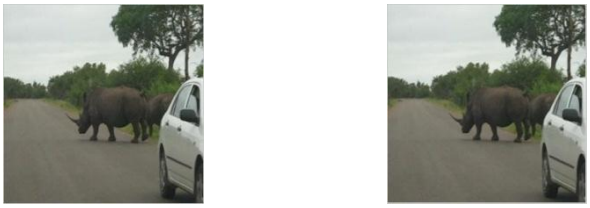


Fig 5: Watermark Extraction Process

5. SIMULATION RESULT

In this section, some experimental results of watermarking and scan based encryption method in DWT domain are shown. The algorithm is implemented in Matlab version 7.9.0.529 (R2009b) with the standard rhinos.avi video. The original video sample consists of about 114 frames of size 262x262. Fig. 6(a) and 6(b) show the original and the watermarked video frames respectively. Fig. 7 is the recovered watermark.



(a) (b)

Fig 6: (a) Original video frame (b) Watermark Frame

(1) Orthogonal output PSNR= 38.3568 dB

(2) Diagonal Output PSNR=38.3569dB

(3) Raster Output PSNR= 38.3549 dB

(4) Spiral Output PSNR=38.3539 dB

Fig 7: Different Extracted watermark for different scan pattern with different PSNR values

There is no noticeable difference between original video frame and watermark video frame. For watermarking transparency and the robustness are most significant factors. Hence, to evaluate the transparency, we used the peak signal-to-noise ratio (PSNR) as a criterion to estimate the invisibility.

PSNR*:* The Peak-Signal-To-Noise Ratio can be defined via the mean square (MSE) which gives the idea of different between the original and the altered or distorted signal. PSNR is measured in the logarithm scale and MSE is measured in the general scale.

$$PSNR = 10log_{10}\frac{Max^2}{MSE} \ldots\ldots\ldots\ldots\ldots (3)$$

Where MSE (mean squared error) between the original and distorted frames (size m x n) is defined as:

$$\text{MSE} = \frac{1}{mn}\sum_{x=1}^{m}\sum_{y=1}^{n}[x(m,n) - y(m,n)]^2 \ldots (4)$$

In this proposed technique the original frame is colored which contain RGB value so in the case of color image, find the MSE of each layer and the final value will be the average value of average of MSE of red layer, Green layer and Blue layer. [18]

$$MSE = \frac{MSER+MSEG+MSEB}{3} \ldots\ldots\ldots\ldots\ldots (5)$$

Where x and y are the pixel values at location (m, n) of the original and the distorted frame respectively. Higher values of PSNR specify more imperceptibility of watermarking. It is expressed in decibels (dB). After several experiments, the PSNR values of all the watermarked frames of rhinos video are calculated then it gives an average PSNR value for all watermarked frames which is 38.3568 dB for continuous orthogonal pattern, for diagonal pattern PSNR is 38.3569 dB, for Continuous Raster PSNR is 38.3549 dB, for spiral pattern PSNR value is 38.3539 dB.

Table 1: Watermarking Algorithm with PSNR values

References	Algorithm	PSNR
Salwa A. K. Mostafa [6]	PCA & Wavelet	39.06 dB
Radu-Ovidui Preda [14]	Wavelet Domain	40 dB
A.M Kothari [15]	DWT & SVD	36.35 dB
Ms. Snehlal Shah [20]	DWT	33- 41.5 dB
Ankita A Hood [24]	DWT & PCA	37.46 dB
Saurabh Phadtare [25]	DWT & PCA	37.26 dB
Proposed Work	DWT & Encryption	38.3569 dB

The table shows that the proposed work gets higher value of PSNR in comparison to existing algorithm.

6. CONCLUSION

In this paper, a fusion technique of video watermarking with encryption method based on DWT has been presented, where the embedding of the watermark in mid frequency coefficient LH & HL has been performed, so proper extraction of watermark is achieved. And there is no noticeable difference between watermark video and original video. This watermarking scheme is suitable for video signals in the .avi format. Higher value of PSNR indicates that the algorithm keeps the quality of the image and invisibility of embedded watermark without any attacks. Experimental results shows, that the proposed watermarking method based on DWT and SCAN based encryption technique is robust and gives double protection of video content

Further the algorithm can be carried out by, embedding the watermark in higher levels of the wavelet transform will be investigated; implementation of this scheme in different compressed video codec standard likes (MPEG2, MPEG4). It can also be studied for audio layer in video codec standard and also attacking on frames will be studied.

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