Study of 5 Level DWT and Comparative Performance Analysis of Digital Video Watermarking Techniques Using 3-L-DWT and 5-L-DWT

Neha Goel, Vinith Chauhan, Krishna Mohan Rai

***Abstract*— In present day communication systems, personal computers are being applied in most of the fields. Nevertheless, internet has grown exponentially and become very popular and easier to use. So, over the years, owing to internet, downloading data from World Wide Web is now at tips. Most of the information is transmitted through digital format. Eventually, data copying, theft and backup of digital content is not a big deal in the world of internet and multimedia. Therefore, the authentication and copyright and ownership of the content are diminishing. As a result, security of digital data as well as authentication of digital data is the primary requirement of today's digital world [1][2][3]. In recent times, so many forms of media are taking on the digital format, it become very prior to secure valuable intellectual property (IP).**

In this paper, Data Security and Data Authentication are implemented by applying Water Marking Techniques. Watermarking is the process of perceivably inserting information into a piece of digital data with the surety of retaining the digital information recoverability [4]. Watermarking is constantly under research due to its sure-shot ability to secure the digital data. Hereby, we compare the performance of digital video watermarking techniques based on identical frame extraction in 5 levels DWT and 3 levels DWT. Watermarking is divided into Embedding and Extraction. In the DWT technique, firstly, the host video is divided into video shots and then from each video shot one video frame called identical frame is selected for watermark embedding. Each identical frame is decomposed into 5 levels DWT to embed the watermark adaptively, and then select the higher sub-band co-efficient. Thus, the perceptual invisibility of watermark is guaranteed [5]. For watermark detection, the correlation between the watermark signal and watermark video is compared with a threshold value obtained from embedded watermark signal.

***Index Terms*— Wavelet, Digital Video Watermarking, Embedding and Extraction algorithm, RGB and YIQ color space, identical frame, perceptibility, 5-level DWT.**

I. Introduction

Internet growth by leaps and bounds has made the transfer or transmission of digital information very frequent. Communication of digital information and data is very rapid because of the availability and efficiency of worldwide computer networks. In present scenario, any digital content likewise digital images, video, and audio clips and other multimedia can be stored, transmitted, captured and even manipulated because the computer networking facilities are now widely spreaded and available at a very low cost. Easy approach towards storing, accessing, and distributing digital data is providing lots of benefits to the digital multimedia field. Distortion free transmission, compact storage and easy editing are the prominent properties of digital multimedia. Free access to the digital multimedia and easy communication and transfer also provides virtually unprecedented opportunities for pirating or destroying copyrighted digital content. So, intellectual property protection is an extremely important concern for the digital content owners who possess digital representations of books, manuscripts, photographs, videos, audios and other artwork on the internet. Therefore, the idea of using a digital watermark to detect and trace copyright violations has inspired many owners and also stimulated interests among engineers, lawyers, artists, scientists, and publishers as well. Hence, the application of digital watermarking is very popular across electronic publishing, picture galleries, advertising merchandise, ordering and delivery, digital libraries, online newspapers and magazines, digital video and audio, personal communication and more. Digital watermarking is a suitable tool for identifying the original source, owner, creator, and distributor or even authorized user of digital content. Evaluation of water marking techniques can be measured by considering the following prominent factors [6].

- Capacity (Data Load): This property defines the maximum amount of data that can be inserted into the host data or signal. This data can be simultaneously recovered without errors. Eventually, this quality of water marking gives the surety of proper recovery of water mark during extraction process.
- Transparency: This property describes how easily a watermark can be visible to the users. The embedded watermark should be upgraded in the host data. If, anyhow, visible distortion interfere the host image, it creates degradation in the commercial value of the image and an ease to the attacker.
- Robustness: The major quality of any watermark is its resistance to the alterations of the original contents. In the present digital world, unintentional attacks (cropping, filtering, scaling, and compression) and intentional attacks are prone to the host data in order to destroy the watermark. Thus, the watermark should be invariant to such attacks.
- Fidelity: The watermark should not hinder the visual appeal of the host data by its presence. Watermarking is done by the alteration of the original data and addition of a

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message to it; therefore, it can affect the image or video quality.

In our proposed video watermarking technique, Original video can be of any size, it needs not to be squared anymore like 3-L-DWT, i.e., any video can be used as original video. The watermark used also can be of any size. No host video is required for watermark detection as 3-L-DWT needs the host data to detect the watermark. Eventually, invisible robust watermarking can be achieved. In 5-L-DWT for the designing and implementation of robust image or invisible video watermarking technique, many researchers all over the world have considered digital watermarking.

R. Lippmann [9] and M. Shensa[7] in 1987 & 1992 contributed majorly in the field of video and neural network technology. For the advancement of the stated technology, the authors applied the neural technology to digital watermarking. The procedure includes the conversion of the host video. The host video is converted into the video shots for watermark embedding. For the extraction of the watermark, the watermark is extracted from the trained neural network.

S. Islam, R. Debnath, and S. Hossain in 2007presented the Blind watermarking scheme[10] very sincerely. Blind watermarking scheme is a very notable work in the video watermarking technology. In this scheme, a watermark is embedded into the 1 level DCT. This scheme applies both the neural network and HVS Model. The Neural network is implemented for the watermark embedding and extraction. The HVS Model is implemented to determine the watermark insertion strength. The watermark inserted into the host data is a random sequence. Here, a secret key is used to determine the initial position of the image where the watermark is to be inserted.

S. Gandhe, U. Potdar, and K. Talele in December 2009 notably presented an important work based on Discrete Wavelet Transform (DWT). In their work [6], they resize the host video to 256*256 size blocks and further Discrete Wavelet Transform is being applied on the watermarked video. The authors named it the embedding process. For the extraction of the watermark, the authors just followed the reverse of the embedding process. This method somewhere lacks in technology because the limitation here is that the host video must be square in size. As well as, the image used as a watermark must also be in square size. After watermarking, the quality of the watermarked video is degraded as compared to the original host video.

Tian Hu et al in 2010 proposed a Discrete Wavelet Transform (DWT) technique [11] for digital watermarking. The watermarking technique was based on 1D-DWT. In this technique, 1D-DWT is applicable to the luminance of two consecutive frames to attain low frequency image. Afterwards, this low frequency image is divided into equal sized sub-images. Average pixel in each block is calculated. The watermark is embedded in these blocks according to the interval where the pixel value lies. For watermark detection, the author used 1D-DWT to the luminance of two consecutive frames to obtain low frequency image. Average pixel value for each block is determined. Then, the interval where the average pixel value lies is computed. This method has a major drawback that only the binary image can be used as the watermark.

Y. Zhang and H. Bi. In 2012 presented a very prominent Blind video watermarking scheme. This method [8] is based on pseudo-3D DCT. In this method, the authors converted several scenes of a video into video segment. The frames in each scene are transformed into 2D- DCT. Then, the resulting Direct Current (DC) components are transformed along the temporal dimensions. Further, the normally distributed watermark is embedded into the pseudo-3D DCT Alternating Current (AC) coefficients.

II. PROPOSED WATERMARKING TECHNIQUE

This section is dedicated to the fundamentals and approach used in proposed digital video watermarking technique. The proposed technique is based on 5-level-DWT. The whole procedure can be explained under following stages which are described as Introduction to the wavelets followed by the RGB and YIQ color model representation and selection of sub-band for 5-level video watermarking. Besides, presentation of the formation of 5-Level-DWT (Discrete Fourier Transform) Proposed watermark embedding including identical frame extraction technique and Final stage of the detection of the digital watermark is also mentioned here in our proposed watermarking technique.

A. Introduction to Wavelets

The concept of “wavelets” or “ondelettes” started in the literature in the early 1980’s. The concept of wavelets can be treated as a synthesis of various ideas from different disciplines including Mathematics, Physics and Engineering. “A Wavelet is a small wave having its energy or spectral characteristics that vary with time.” Wavelet is oscillating in nature like sinusoid waves and has been used for simultaneous time and frequency analysis. A wavelet has a wave like oscillation with an amplitude beginning at zero (0), increases and then decreases back to zero (0). It can be referred to as “Brief Oscillation”. Wavelets are irregular, asymmetric and of limited duration. Wavelets serve as a tool to analyze and generate the most natural signals. Wavelets can be deterministic as well as non-deterministic. Wavelets provide time-frequency representation which is not provided while using Fourier analysis. Wavelets are suitable tool for transient and non-stationery or time varying signals. Wavelet analysis is based on a short duration wavelet of a specific center frequency. In Fourier transform sinusoids are used as basis functions. Sinusoids only provide the frequency information. Temporal (time) information is not given by Fourier transform. There are some applications where there is a need of both the frequency and time components at the same time. Impulse function provides the best time resolution. Sinusoids (Fourier) provide the best frequency resolution. Best time and frequency resolution is provided by the wavelet transform. Wavelet transform is an efficient and effective time frequency representation algorithm. The wavelet transform has an exact spatial resolution as the frequency gets higher and higher. Wavelets can be considered as a family of functions constructed from translation and dilation of a single function ψ. The single function “ψ” is known as mother function. There are numerous basis functions which are used as mother function for the wavelet transform. The mother function determines the characteristics of the resulting wavelet

transform because only mother function generates all the wavelet functions used for transformation. Thus, appropriate mother function should be selected for the effective and efficient use of transform.
The mother function can be defined as follows

$$\varphi_{j,k}(t) = \frac{1}{\sqrt{a_o^j}}\varphi(\frac{t}{a_o^j} - kb_o) \quad (1)$$

where, a, b Є R (a>0), a is the scaling parameter which measures the degree of compression and b is the translation parameter which determines the time location of the wavelet .For the condition of Normalization,

$$\left|\varphi_{a,b}(t)\right| = \left|\varphi(t)\right| \quad (2)$$

The "Continuous wavelet transform" of a function f (t) Є R is defined as

$$\varphi_{a,b}(t) = \frac{1}{\sqrt{|a|}}\varphi(\frac{t-b}{a}) \quad (3)$$

Case1: if $|a| < 1$, then, the wavelet is the compressed version (smaller support in time domain) of mother wavelet and corresponds to higher frequencies.Case2: if $|a| > 1$, then, wavelet has a good support in time domain and corresponds to lower frequencies. At large scale, the solution is coarse in the time domain and fine in frequency domain. Conversely, as the scale decreases, the resolution in the time domain becomes finer while that in frequency domain the resolution is coarser.

B. *RGB and YIQ Color Space:*

RGB color model can be changed into YIQ color space where Y corresponds to perceived luminance, I correspond to color information and Q corresponds to luminance information. Since, RGB color model deals in pixel values (bits) YIQ color space is also preferred for watermarking. There are some steps for the conversion of RGB color space into YIQ color space. Firstly, color image is read and R, G, B components of the host data are separated. After separation, the components are converted into YIQ color space using following equations:

$$Y=0.299R+0.587G+0.114B \quad (4)$$
$$I=0.596R-0.274G0.322B \quad (5)$$
$$Q=0.211R0.522G+0.311B \quad (6)$$

After conversion, watermark is embedded into YIQ color space using DWT. After embedding the watermark into YIQ color space, it is changed back into RGB color space using following equations:

$$R= Y+ 0.956I+0.621Q \quad (7)$$
$$G= Y-0.272I-0.647Q \quad (8)$$
$$B= Y-1.106I+1.702Q \quad (9)$$

C. *Selection of Subband in Dwt:*

DWT technique of frequency domain offers multi resolution representation of an image. Besides, decomposed image can be reconstructed perfectly by applying DWT. In DWT a wavelet is used to transform. Wavelet is a small wave full of energy. The energy of wavelet is concentrated in time. Wavelet is a family of functions constructed from translations and summation of a single function called the "mother wavelet" ψ (t). It is represented in equation (1). For dyadic wavelets, a_o=2, b_o=1, thus, equation of wavelet can be represented as

$$\varphi_{j,k}(t) = \frac{1}{\sqrt{2^j}}\varphi(\frac{t}{2^j} - k) \quad (10)$$

DWT easily decomposes the image into sub-bands of different resolution whenever the image passes through a series of low and high pass filters.

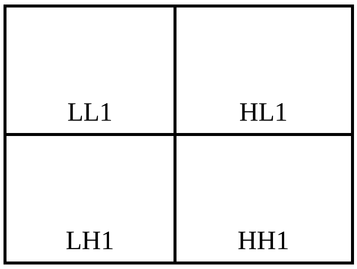

Fig. 1 : One level image decomposition

Here, DWT is decomposing the image for LL into four non-overlapping multi-resolution sub-bands:
LL1: Approximate Sub-band
HL1: Horizontal sub-band
LH1: Vertical sub-band
HH1: Diagonal sub-band
HH1, LH1 and HL1 are high frequency components while LL1 is the lowest frequency component. Maximum energy of images is always concentrated in approximate subband (LL1). So, any manipulation or modification in the lowest frequency component can degrade the image/video severely. Thus, watermark embedding is not meant for LL1 sub-band. Human eyes are not sensitive to high frequencies. So, watermark embedding can be achieved in the remaining three directorial sub-bands (HL1, LH1 and HH1). But, the diagonal sub-band (HH1) is full of edges and textures of the image. Hence, HH1 will not serve for watermark embedding. Now, two options of horizontal and vertical sub-bands (HL1 and LH1) are left. Human eyes are less sensitive for horizontal sub-band (HL1) as compared to vertical sub-band (LH1). As a result, horizontal sub-band (HL1) is the most suitable for watermarking.

D. F*ive (5)-level DWT formation:*

While going through this proposed technique, a general question might arise in mind that what is discrete wavelet transform? What is the use of Discrete Wavelet Transform? Here, the answer lies within this stage. Basically, DWT is a mathematical tool used to decompose an image in hierarchical order [12]. DWT is the multi-resolution description of an image. The decoding of the watermark is done sequentially i.e. from low resolution to high resolution [13]. The DWT has the feature to split the signal into low and high frequency parts. The high frequency part stores the information about the edge and surface components. Whereas, the low frequency part is splitted again and again into high and low frequency parts. Watermarking is usually done by using high frequency components because human eye is less sensitive to the change or transformation in the edges or surfaces [14]. After level 1 decomposition, total four numbers of sub-bands are generated LL1, LH1, HL1, and HH1. The LL sub-band of the previous level is widely used as the input for the decomposition of the successive levels. For example:

- For second level decomposition, the DWT is applied to the previous level LL band i.e. LL1 band. This LL1 band is further decomposed into four sub-bands LL2, LH2, HL2, and HH2.
- For third level decomposition, the DWT is applied to the second level LL band i.e. LL2 band. This LL2 band is further decomposed into four sub-bands LL3, LH3, HL3, and HH3.
- For fourth level decomposition, the DWT is applied to the third level LL band i.e. LL3 band. This LL3 band is further decomposed into four sub-bands LL4, LH4, HL4, and HH4.
- For fifth level decomposition, the DWT is applied to the fourth level LL band i.e. LL4 band. This LL4 band is further decomposed into four sub-bands LL5, LH5, HL5, and HH5.

E. *Watermark Embedding*:

This stage includes the foundation of 5-level-DWT i.e., identical frame extraction technique for digital watermark embedding. There are numerous of different video frames present in a video. Sometimes, the various video frames become identical. These identical video frames are called video shots. Video shot has one or more continuous identical video frames. Now, the proposed system (5-Level-DWT) divides the host video into video shots just to increase the performance of watermark embedding process. The two image pixels are compared in order to determine whether the two video frames are identical. The intensity for a RGB frame can be computed according to video standard as

$$I=0.299R+0.587G+0.114B \qquad (11)$$

Here, R, G, and B are the red, green and blue pixels respectively.At higher frequencies, human visual system is least sensitive [15] and so among the three channels of RGB image, blue channel has the highest frequency range. As a result, the blue channel is transformed into DWT for the high performance of watermark embedding. Now, the watermark is embedded from HL5 sub-band of the blue channel of the host video frame. The LH5 sub-band is used for remaining watermark signal embedding if HL5 sub-band is completely occupied. Again, HH5 sub-band is further used for watermark signal embedding if LH5 sub-band is completely filled up. Now, if the level 5 is completely occupied, the next upper level is considered for watermark embedding that is HH4, HL4, and LH4 is used. This process of watermark embedding continues likewise till the higher levels and, thus, the watermark is embedded into the video frame.

This proposed technique of 5-level-DWT has some advantages which can be beneficial to the work such as larger watermark can be embedded into the original video and by using high frequency

<table>
<tr><td>LL5</td><td>HL5</td><td rowspan="2">HL4</td><td rowspan="2">HL3</td><td rowspan="2">HL2</td><td rowspan="2">HL1</td></tr>
<tr><td>LH5</td><td>HH5</td></tr>
<tr><td colspan="2">LH4</td><td>HH4</td><td rowspan="2">HH3</td><td rowspan="3">HH2</td><td rowspan="4">HH1</td></tr>
<tr><td colspan="3">LH3</td></tr>
<tr><td colspan="4">LH2</td></tr>
<tr><td colspan="5">LH1</td></tr>
</table>

Fig. 2 : Five level image decomposition

blue channel; the invisibility of the digital watermark can be achieved in the watermarked video frame.

A major global characteristic known as Intensity Histogram of the video frames is also considered. The intensity histogram difference (IHD) can be expressed as-

$$|SD_i| = \sum_{a=1}^{N} |H_a(b) - H_{a+1}(b)| \qquad (12)$$

where, N denotes the total number of levels for the histogram and $H_a(b)$ denotes the histogram value for the a^{th} frame at level b. The Intensity Histogram Difference varies with the video frame sequence. It can be illustrated as-i) Small histogram difference for a continuous video frame sequence. ii) Spiky Intensity Histogram difference for sudden transition detection.iii)Relatively small (as compared with the peaks in sudden change) for a notable movement or change between the neighboring frames. As a result, a proper Threshold is effective in measuring the difference of Intensity Histogram for sudden transition in video frames. The Threshold Value to determine a sudden transition in the Intensity Histogram can be expressed as

$$Th = \mu + k\sigma \qquad (13)$$

where μ and σ are the mean value and standard deviation of Intensity Histogram Difference respectively. The value of k varies from 2 to 6.

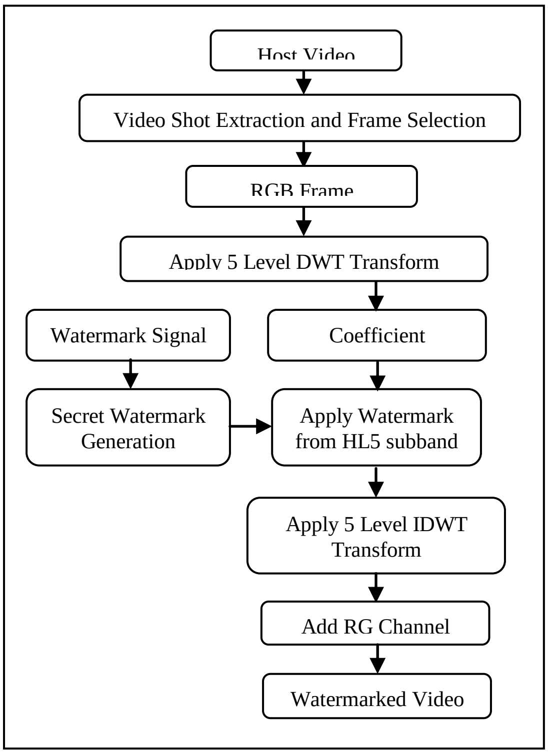

Fig. 3: Steps of proposed watermark embedding process

The proposed watermark embedding process is shown in the above figure. From the flowchart it is clear that the proposed system will apply 5-Level–DWT on the blue channel after separating the video into video shots. In the 5-level-DWT coefficients, the preprocessed watermark image is embedded from HL5 to HL1 sub-band consecutively and further it is transformed into 5-level inverse DWT. Afterwards, the watermarked blue channel is combined to the other two channels (Red and Green) to obtain the watermarked video frame. The watermark used for embedding should be preprocessed necessarily. The process involved the conversion of digital watermark into the binary image form as ω' (a, b) Є {0, 1} for a, b=0 to M. Here, 0 denotes the black value and 1 denotes the white value. M is the number of binary pixel of the host image. Now, binary image form is transformed into vector Ω (i, j) Є {1, -1}. Here, 0 is replaced by 1 and 1 is replaced by -1.Finally, 2D watermark ω (a, b) is changed into 1D watermark ω (l) (l=1, 2, 3…L).Here, L is the length of the watermark. The relation of embedding can be given as

$$\lambda'_{a,b} = \lambda_{a,b} + \beta\left|\lambda_{a,b}\right|\omega_{a,b} \quad (14)$$

Where, a and b are selected coefficients in the DWT. $\lambda'_{a,b}$ is the DWT coefficient of the blue channel of the original video frame. $\lambda_{a,b}$ is the DWT coefficient of the blue channel of the watermarked video frame. $\omega_{a,b.}$ is the watermark signal. β (beta) is the scaling parameter ranges from 0.2 to 0.6.For multiple watermark embedding the equation can be repeated up to n times

$$\lambda^{n}_{a,b} = \lambda^{n-1}_{a,b} + \beta\left|\lambda^{n-1}_{a,b}\right|\omega^{n-1}_{a,b} \quad (15)$$

F. *Watermark Detection*

Authorized detection of the hidden content can be achieved by using the watermarked video and watermark signal. Here, no original video is required for detection. The purpose of the detector is to detect whether the watermark is present or absent in the watermarked video. The following steps occur during watermark detection. The system extracts the video shots and then appropriate identical frame is selected from each video shot. Nevertheless, the detection process is similar to the embedding process. Now, the 5-level DWT is applied on the blue channel of the selected video frame. The average value of the selected coefficients in the sub-bands A is calculated finally. A correlation Co is compared with the average value A. If Co is larger than Av (Co>A), then the system detect a watermark.

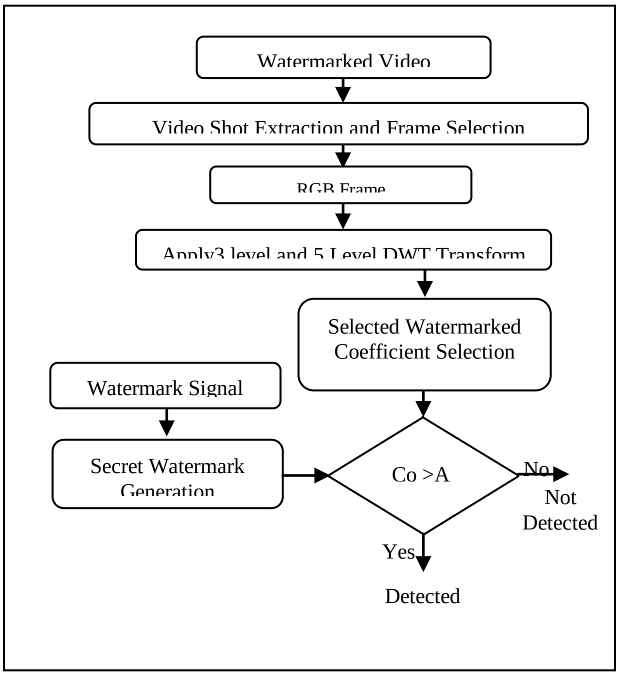

Fig. 4: Steps of detection process for 3-L-DWT and 5-L-DWT comparison.

Now, considering the size of the selected coefficient blocks C*D and total length of the watermark L (in 1D), A can be calculated as- If CD ≤ L

$$A = \left\{ \frac{1}{CD} \sum_{a=0}^{C-1} \sum_{b=0}^{D-1} F'(a,b) \right\} \quad (16)$$

If CD>L

$$A = \left\{ \frac{1}{CD} \sum_{a=0}^{C-1} \sum_{b=0}^{D=\frac{L}{C}-1} F'(a,b) \right\} \quad (17)$$

Now, the correlation Co between the selected DWT co-efficients F'(a, b) and provided vector ω is determined and compared with the average value of the selected co-efficients A. Correlation Co can be calculated as follows:

If CD ≤ L

$$Co = \left\{ \frac{1}{CD} \sum_{a=0}^{C-1} \sum_{b=0,c=a*C}^{D-1} F'(a,b)\omega_c \right\} \quad (18)$$

If CD > L

$$Co = \left\{ \frac{1}{CD} \sum_{a=0}^{C-1} \sum_{b=0,c=a*C}^{D=\frac{L}{C}-1} F'(a,b)\omega_c \right\} \quad (19)$$

If the embedded watermark signal and the provided watermark are similar then, the value of correlation Co is greater than the threshold value A otherwise Co is smaller than A i.e. provided watermark will be detected only if Co is greater than A. As the 1D vector watermark ω has value -1 or 1 and F' (a, b) may also be negative, then, A will always be greater than Co. Therefore a scaling parameter S is required. Hence, the adjusted threshold is now:

If CD ≤ L

$$A = \left\{ \frac{S}{CD} \sum_{a=0}^{C-1} \sum_{b=0}^{D-1} F'(a,b) \right\} \quad (20)$$

If CD > L

$$A = \left\{ \frac{S}{CD} \sum_{a=0}^{C-1} \sum_{b=0}^{D=\frac{L}{C}-1} F'(a,b) \right\} \quad (21)$$

The value of S can be estimated empirically through experiments.

III. EVALUATION AND RESULTS

Several experiments are conducted on various uncompressed video clips listed in the following table…. These experiments are performed to verify the effectiveness i.e., robustness, imperceptibility, fidelity, transparency, data load etc. of the proposed video watermarking technique. The videos used for the experiments are mostly downloaded from the YouTube (www.youtube.com). The description of the videos used in the experiments is given below:

- Burj Khalifa (Burj Dubai) Construction, U.A.E. (BK) represents a video which is constructed by several still images.

	Resolution	Length (Min)	No. of Frames	No. of Identical Frames	PSNR (dB) 5L DWT	PSNR (dB) 3L DWT
BK	640*360	06:06	3745	52	53.74	39.12
SS	256*192	02:29	4075	125	55.07	40.22
BB	256*144	10:00	13485	87	59.86	40.56
DD	216*144	05:56	5456	45	63.06	39.89
HA	256*144	07:54	7456	53	64.26	41.11
FB	256*148	03:25	3526	74	56.58	41.25

Table 1: Comparison of PSNR value of the Videos used in the experiment for 3 and 5 levels DWT

- STS-111 landing (SS) is a low resolution video which has 4075 video frames.
- Life BBC – Plantas (BB) brings natural real images having minimum camera movement.
- Donald Duck Cartoon (DD) – is a popular animated cartoon series.
- Home Alone 6 (HA) – is a famous live action comedy short film.
- For the Birds (FB) – is a short animated film which is produced by Pixar Animation Studios.[19]

A. *Perceptibility*

“Perceptible**”** implies “Visible**”** i.e., how

visible the watermark is. Alternatively, perceptibility is the measure of distortion in the host data caused mainly by watermark embedding. Perceptibility is measurable by a well known ratio referred to as Peak Signal- To-Noise Ratio (PSNR). Perceptibility is inversely proportional to PSNR i.e., the watermark is more perceptible for lesser value of PSNR. Table 1 denotes the PSNR value (in db) of each video used in the experiment for 3-L-DWT as well as 5-L-DWT. Here, PSNR value is the average value of total identical frames of all the video shots used in the host video for both the levels. PSNR value is taken from the frames because the watermark is embedded only in the identical frame of each video shot. The quality of watermarked video will remain almost same as that of the original video if the PSNR value is greater than 41db i.e., PSNR Value ≥ 41db. It is clear from Table 1 that the PSNR value is always greater for 5-L-DWT as compared to 3-L-DWT. Therefore, the quality of the video will not be degraded in 5-L-DWT.

A. *Noise attack*

A. *Firstly, the embedding of the watermark is done in the video. For Noise attack, MATLAB function is used. Two types of noises are added to the video separately, they are:*

- Gaussian Noise
- Salt and Pepper Noise.

The watermark detection is based on

- Variance: The system we proposed can support up to 0.21 for proper detection of watermark.
- Noise Density: The system proposed the density range between 0 to 0.638 or watermark detection is possible up to this value of Noise Density.

	Noise Attack	Threshold η	Correlation C	Water Mark Detected (Using 3DWT) ?	Water Mark Detected (Using 5DWT) ?
BK	Salt & Pepper	2.5642	4.212	YES	YES
	Gaussian	3.227	7.5457	NO	YES
SS	Salt & Pepper	4.5561	10.2224	YES	YES
	Gaussian	3.1683	7.3215	NO	YES
BB	Salt & Pepper	2.5642	4.0356	NO	YES
	Gaussian	3.1217	6.7981	NO	YES
DD	Salt & Pepper	4.5363	10.1152	YES	YES
	Gaussian	2.8921	6.2783	NO	YES
HA	Salt & Pepper	2.6975	4.3129	NO	YES
	Gaussian	3.1863	7.5464	NO	YES
FB	Salt & Pepper	2.5542	10.2142	YES	YES
	Gaussian	3.0665	6.7582	NO	YES

Table 2: Detection Result for 3-DWT and 5-DWT

Table 2 shows the watermark detection result. In our experiment, we have attacked the host video by Salt & Pepper noise as well as Gaussian noise. A comparative study is done between 3-level and 5-level DWT. It is crystal clear from the table that the watermark is detected only when the correlation Co is greater than the threshold value A for 5-level DWT. Sometimes, the watermark is not detected even if Co>A. Hence, we can conclude that 5-level DWT is more effective than 3-level DWT for watermark detection.

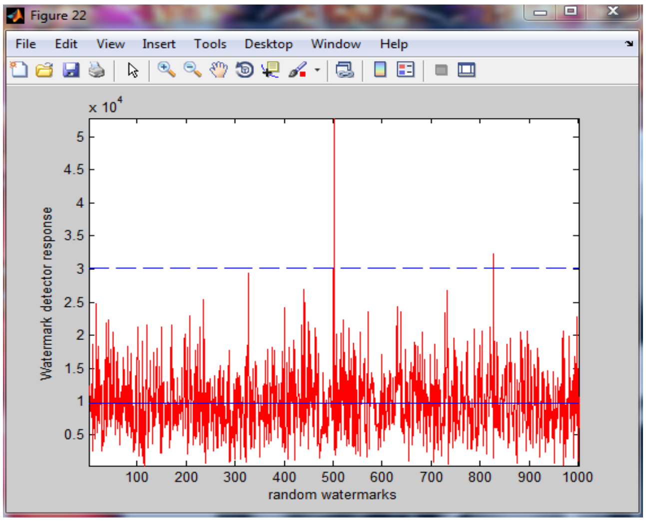

Fig. 5:Detection response for noise attacking on watermark.

B. *Time consumption:*

B. *Embedding and extraction process of watermark are both time consuming. Therefore, this section measures the time consumption of both the embedding and extraction process. There are two MATLAB functions known as 'tic' and 'toc' which are used to measure the time consumption. Table 3 shows the result of time measurement after three iterations.*

The time test has been conducted on a computer having the configuration: Intel core i-3 processor, 2.50 GHz, 2 GB memory and Windows 7 operating system. Resolution and number of frames of the video are the two important factors for the time consumption. Actually, the time is proportional to these two factors. The embedding and detection time increases if the resolution and number of frames increases. One more fact is also solved from the table that detection process takes less time as compared to the embedding process. The table shows the comparative study of time consumption for embedding and detection of 3 and 5 level DWT. It is very prominent from the comparison that only 5 level DWT is taking a lesser time for the embedding and extraction of the watermark.

	Resolutio n	Embeddin g Time (s) 5DWT	Detectio n Time (s) 5DWT	Embeddin g Time (s) 3DWT	Detectio n Time (s) 3DWT
BK	640*360	358	201	399	266
SS	256*192	320	203	350	278
BB	256*144	470	171	495	220
DD	216*144	396	166	430	194
HA	256*144	549	225	588	281
FB	256*148	179	50	246	115

Table 3: Embedding and Detection Time Consumption of 3 and 5 level DWT.

IV. CONCLUSION

In this paper, a thorough study is done on 5-L-DWT and a proper comparison is made between 3-L-DWT and 5-L-DWT video watermarking techniques based on identical frame extraction which is very remarkable as shown in the tables 1, 2, and 3. The watermark embedded is perceptually invisible for 5-L-DWT as compared to 3-L-DWT.This proposed method shows little bit time complexity in watermark embedding process for 3-L-DWT. Though the system of 5-L-DWT has some limitations but it shows better results in various attacks such as salt and pepper noise and Gaussian noise as the watermark is being detected each and every time for 5-L-DWT. According to the time consumption result our proposed method has a limitation of greater embedding time as compared to the detection time. But, the Detection time is always lesser for 5-L-DWT as compared to 3-L-DWT. Hence, we can summarize that on performance basis 5-L-DWT has given better performance as compared to 3-L-DWT. In future our plan is to minimize the watermark embedding time to improve the performance in 5-l-DWT as the watermark is visible in 3-l-DWT which is a major drawback. Hence, according to the results and evaluations we can conclude that the performance of 5-l-DWT is far better than 3-l-DWT.

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