ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

Digital Video Watermarking using cascaded stages of Discrete Wavelet Transforms

Chitrank Jha , Agya Mishra
Dept. of Electronics and Telecommunication, RGPV, India

Abstract*—with the exponential advancement in communication technology, digital multimedia content (audio or video) can be easily copied and stored easily without any loss in their original content. Therefore, it became important to overcome this and the need of a suitable kind of copyright protection system is being sensed within the copyright owners. Copying of digital data without any loss of quality is not what was desired at all by the content providers, in fact it became a major threat, because it may cause them considerable loss to their reputation as well as monetary losses. Therefore Digital watermarking can be one of the solution to the above problem. It is the process of embedding some user data (watermark) within the original data content such as a digital audio, image, or video signal. The watermark must be imperceptible and must be able to withstand distortion from different signal processing operations (basically attacks).In this proposed work, a novel developed and evaluated algorithm based on cascades stages of Discrete Wavelet Transform (DWT) is introduced to eradicate the above problem and is compared with the existing algorithms on the grounds of Peak Signal to Noise Ratio (PSNR) and Normalized Correlation (NC). The proposed algorithm shows quite good results of PSNR and NC.

***Index Terms*—Discrete Wavelet Transform (DWT), Mean Square Error (MSE), Noise Variance (NV), Normalized Correlation (NC), Peak Signal to Noise Ratio (PSNR), Video Watermarking,**

I. INTRODUCTION

There has been a noticeable progress in the past few years in the field of digital multimedia technology. It not only proves to be advantageous as compared to its analog part but very rapidly has grown in the current scenario as almost all multimedia production and distribution is digital. The transmitted data and the capability to copy the digital content without any loss in the facet of the original content have made the digital technology superior to the other competitive technologies if any. More importantly, the advancement of digital multimedia technology has shown itself on Internet and wireless applications. But with the great eruption in this technology has also brought some problems beside its advantages as everything in this world has its pros and cons. The scattering and use of multimedia data is much easier and faster with the upcoming of Internet. The availability of protean multimedia processing software and the end level coverage of the inter-connected networks have eased unblemished copying, modifications and facile distribution of the digital multimedia (digital video, audio, text, and images) that has created a major menace among the copyright holders of the multimedia content. Although cryptography was a tool for multimedia security, but the unappealing characteristic of providing no protection to the media once decrypted has limited the practicability of its global use Digital Watermarking is one of best solution to the current problem. In watermarking, the existence of the embedded information is unknown to unauthorized parties who have access to the data, and can attempt unlawful attacks to break the same Since developing a watermarking scheme or algorithm is a tedious job, many previous attempts have been made to develop a more precise and accurate result producing algorithm but all of them suffer from one or the other problem like some are not robust against rotation, scaling and some suffer to conquer the noise attacks.

II. TRANSFORM BASED EXISTING ALGORITHMS

There are several criteria how watermarks for video sequences can be classified. Watermarking techniques can be classified into- **Spatial** and **Transform** domain by place of application.

A. Video Watermarking

Spatial domain watermarking is performed by modifying values of pixel color samples of a video frame such as Singular Value Decomposition. This scheme is less complex in computation and is less secure and less robust compared to frequency domain techniques.

Transform 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. Discrete Cosine Transform and Discrete Wavelet Transform belong among whole frame frequency transforms. The latter has proved to be more robust than the spatial domain watermarking as per [11]. Different kind approaches for video watermarking were recognized from literature such as Singular Value Decomposition (SVD)[2],[3], 3-D Discrete Cosine Transform (DCT) [4][5], Discrete Cosine Transform (DCT) [6],[7] ,Wavelet Transform (WT) [8], Discrete Wavelet Transform (DWT) [1],[9],[10]. Although the above mentioned algorithms fail at some point or another but the algorithms utilizing the transform domain as approach such as in [1], [9] and [10] are more robust and secure against different kinds of attacks. As in [8] the best achieved PSNR is 41.1830 and an NC up to 0.9835 with the best magnitude factor of 8. Similarly in [1] the best PSNR achieved was 37.192 for Football video sequence with an NC of 0.7286.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

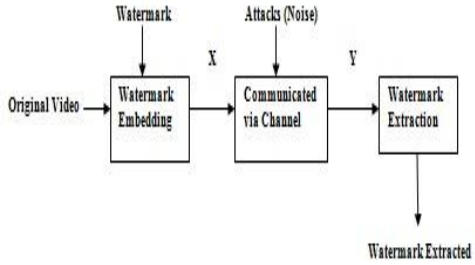


Fig. 1 A general Video Watermarking process
X = Watermarked Video
Y = Noisy Watermarked Video

A general video watermarking process has been shown in Fig.1. The input or the original video sequence is been embedded with a watermark i.e. image, text, data etc. (in our case- image). When the watermark video has been embedded with the watermark image, the video has been transferred via the communication channel where it gets attacked (noise) by different intentional and unintentional users. At the receiving end, the receiver receives he watermarked video sequence after it has faced various attacks during the communication process and thus gets modified. The watermark extraction is done via an optimum algorithm and is checked for authenticity by different measuring parameters via the algorithm in use. In present work, a cascaded stage of Discrete Wavelet Transform has been employed to get the desired output. At the beginning, the original video sequence has been partitioned into frames and converted into a black and white video by applying RGB to gray process. After this, Discrete Wavelet Transform is applied. The DWT breaks the sequence into different sub bands out of which LL sub band is selected for watermarking and video watermarking is performed. The watermark image is also been converted to a gray scale image and is embedded into the LL sub band of the video sequence. The watermark image has been embedded into each and every frame of the original video sequence as per the watermark embedding process. Further the extraction of the watermark image has been done by the watermark extraction process. Experimental results shows that the applies watermark algorithm provides desired results of better visual quality. The overall paper has been organized as follows: In Section-3,the proposed algorithm using cascaded stages of Discrete Wavelet Transform has been discussed in detail. Section-4 deals with the experimental results and the desired output parameters and finally in Section-5 conclusion has been summarized.

III. PROPOSED ALGORITHM

A. Watermark Embedding Process

Before embedding watermark into the original video , the following process should carried out to improve the efficiency of our proposed approach and the overall security since the video sequence faces different kinds of attack during the process of communication. Fig. 2 shows the basic block diagram of how the approach goes towards the embedding of the watermark image in our work. The process includes-

Step1: Partition the original input video sequence into a number of frames.
Step2: Convert the original video sequence into Black & white video by RGB to Gray process.
Step3: Convert the original watermark image to gray scale image.
Step4: After converting the original video sequence into black and white video, DWT is applied.
Step5: The watermark is also applied to the DWT block.
Step6: DWT decomposes the video sequence into sub-bands and after that video watermarking process has been carried out i.e. watermark embedding process.
Step7: Inverse DWT is being performed and the embedded video containing the watermark is being displayed.

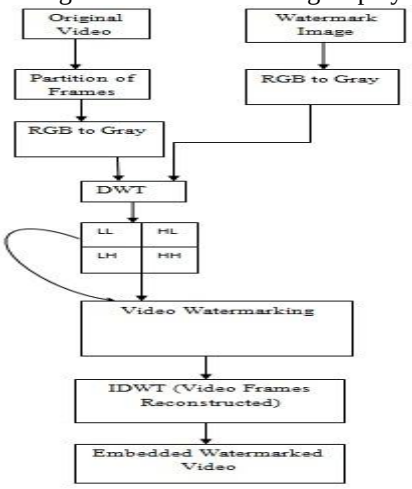


Fig.2. Watermark embedding process

B. Watermark Extraction Process

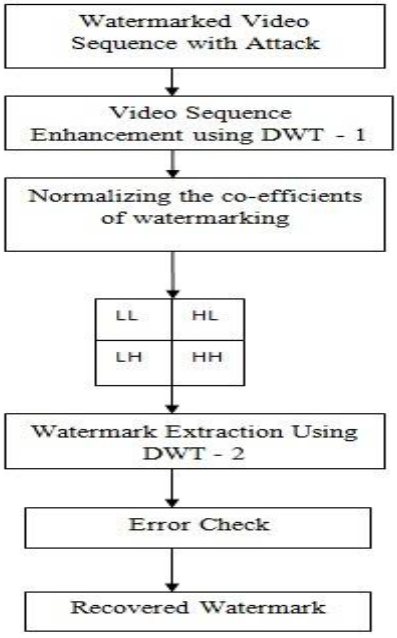


Fig.3. Watermark Extraction process

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

Step1: The watermarked video sequence (with attack) is being enhanced using Discrete Wavelet Transform-1 i.e. the "db4" wavelet.
Step2: After the enhancement, the output coefficient has been normalized so as to get a better visual output.
Step3: The DWT-2 i.e."Haar" wavelet has been applied for watermark extraction so as to get the watermark image from the low frequency sub band i.e. LL sub band.
Step4: The recovered watermark image in then displayed and is further applied for error check.
Step5: The error check block is basically the measuring parameter for the extracted watermark i.e. via the Normalized Correlation (NC)

C. *Measuring parameters*

In present work, Peak Signal to Noise Ratio and Normalized Correlation has been chosen as the measuring parameters for the performance evaluation of our proposed work. The PSNR and MSE is calculated as -

$$PSNR = 10 \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad (1)$$

$$MSE = \frac{1}{mn}\sum_{i=o}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (2)$$

A measure of the normalized correlation named NC calculates the difference between the extracted watermark $\hat{W}(i,j)$ and the original watermark W(i,j) is used to evaluate the performance defined as [4] -

$$NC = \frac{\sum_{i=o}^{x}\sum_{j=0}^{y} W(i,j)\,\hat{W}(i,j)}{\sum_{i=o}^{x}\sum_{j=0}^{y}[W(i,j)]^2} \quad (3)$$

Where
MAX_I = is the maximum possible pixel value of the image
I (i,j) = noise free *m* x *n* monochrome image
K(i,j) = noisy approximation of I
W(i,j) = original watermark
$\hat{W}(i,j)$ = extracted watermark

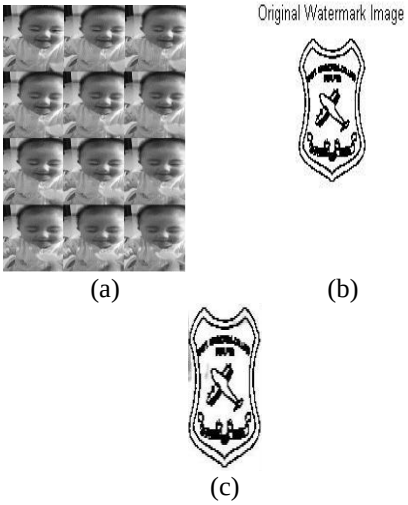
IV. EXPERIMENTAL RESULTS

In this section, evaluation of the proposed algorithm by is done considering two different video sequences, one indoor (Case Study 1) and another outdoor (Case Study 2) for assuming noise as an attack using the noise variance property. The experimental results are being discussed further based on the values of PSNR and NC. The general desired values of the measuring parameters PSNR and NC is expected to be above 50db and 0.8 respectively for Case Study 1 (Indoor) and for Case Study 2 (Outdoor) , PSNR and NC should be above 45db and 0.9 respectively as per literature survey.

A. *Case Study 1 (INDOOR*

Video Type – INDOOR, Video duration – 26 seconds, Total number of Frames – 644, Format – MPEG-4 and Overall Bit Rate – 291 kbps

(i). Performance Of the proposed algorithm without attack:
The experimental results of the proposed digital video watermarking scheme using cascaded stages of Discrete Wavelet Transform are presented. The watermarked video sequences possess superior Peak Signal to Noise Ratio (PSNR) and visual quality for grayscale watermark images. In Fig. 4(a), the first 12 frames of the original video sequence has been shown along with the original watermark image in Fig.4 (b) that is to be embedded in the video. The extracted watermark has also been shown in Fig.4(c).



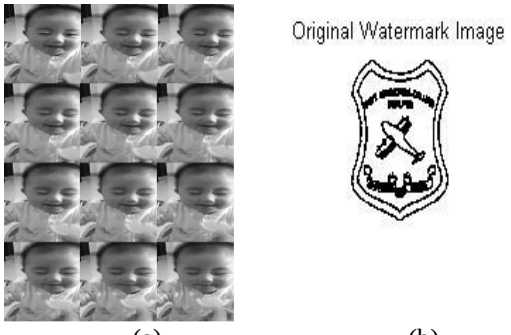
(a) (b)

(c)

Fig. 4. (a) Input Indoor Video Sequence (b) Watermark image (c) Extracted image

The output acquired from the proposed video watermarking scheme has been evaluated by PSNR and NC (Normalized Correlation). the PSNR measured from equation (1) comes out to be 52.7459db which is as per desired and fairly good. the value of NC has been computed from equation (3) and it comes out to be 0.8321. the video sequence that has been considered in Case Study-1 is basically an INDOOR video sequence with a total frames of 644 in number.

(ii). Performance Of the proposed algorithm with attack:
The shown Indoor video sequence in Fig. 5 (a) is being attacked artificially by Gaussian noise and using the Noise Variance property, for different values of noise variance the corresponding PSNR and NC has been calculated as shown in Fig.6 and Fig.7 The Noise Variance has been varied from zero value to 10^(-10) in steps of 10 and for each and every value of Noise Variance , corresponding PSNR and NC has been calculated.



(a) (b)

Fig. 5. (a) Input Indoor Video Sequence (b) Watermark image

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

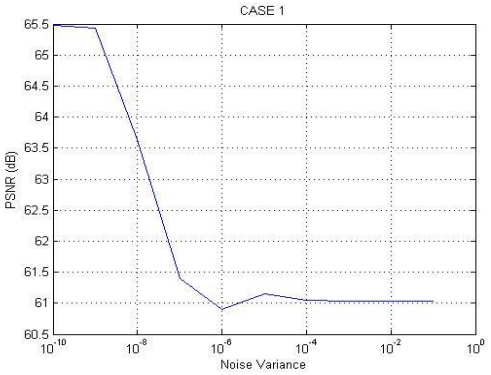


Fig. 6. PSNR vs Noise variance Plot (Case study 1)

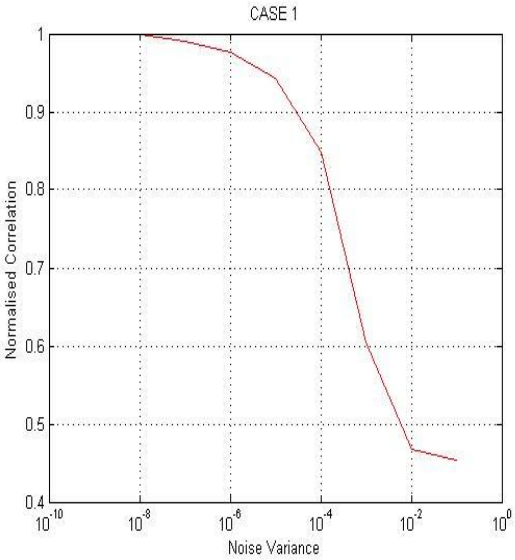


Fig.7. NC vs Noise variance Plot (Case study 1)

Table-1 Different Values of Noise Variance and the corresponding PSNR and NC (Case Study 1) - INDOOR

Noise Variance (NV)	PSNR	NC
0	61.0277	0.9998
10^(-10)	61.0277	0.9997
10^(-9)	61.0285	0.9997
10^(-8)	61.0290	0.9988
10^(-7)	61.0428	0.9910
10^(-6)	61.1496	0.9757
10^(-5)	60.9088	0.9429
10^(-4)	61.4060	0.8483
10^(-3)	63.6403	0.6042
10^(-2)	65.5292	0.4683
10^(-1)	65.4754	0.4538

Fig 8 shows the effect of noise variance on the extracted watermark and their respective PSNR and NC values. An appreciable value of PSNR is obtained when NV equals 10^(-5) which is 60.9088 dB with the corresponding NC value of 0.9429 directs that it is a better result of Case Study 1.

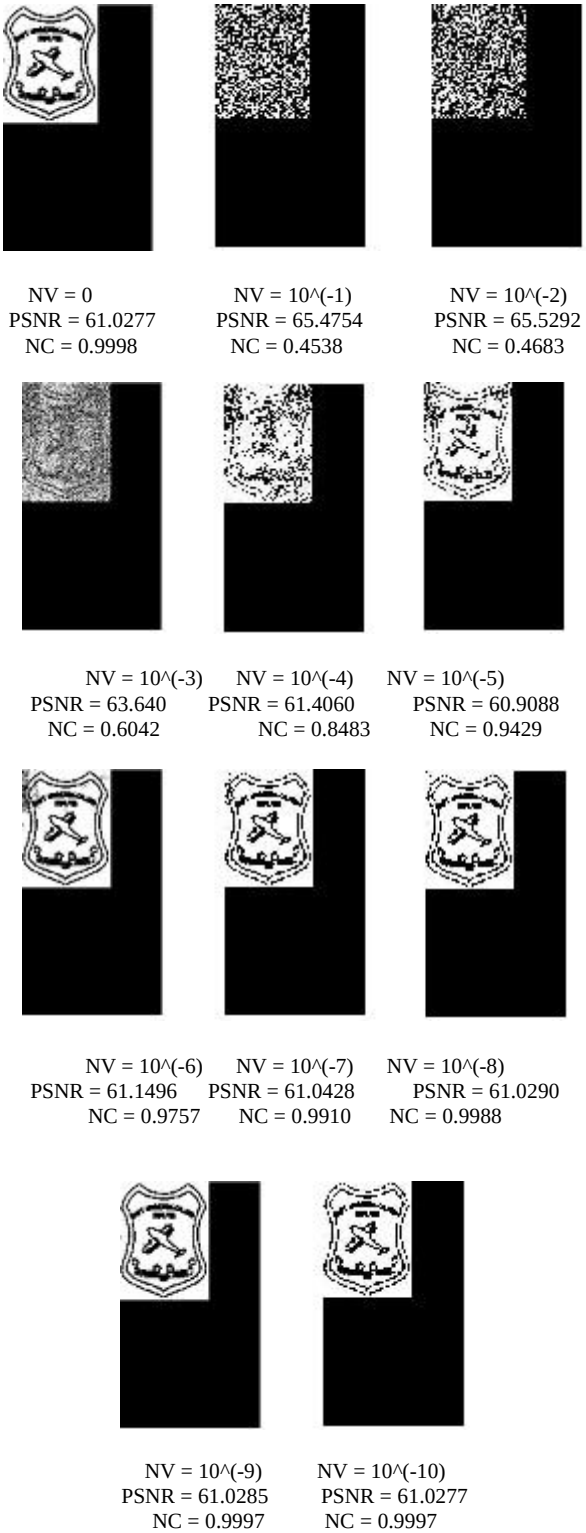


Fig. 8. Effect of Noise Variance on Extracted Watermark Image

The Fig. 8 shows the different outputs for different values of the Noise Variance and the corresponding PSNR and NC has been calculated. It can be evaluated from Fig. 7 as the value of NV decrease, the value of NC gets increased and as NV falls Below 10^(-4) , the value of NC gets more ameliorated.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

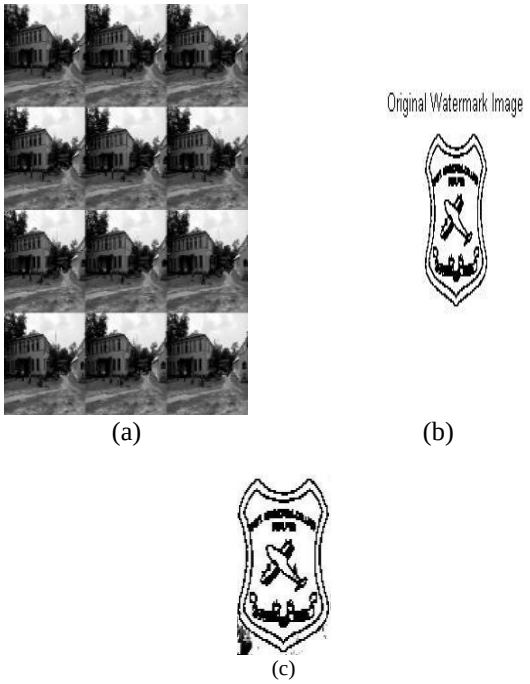
B. Case Study 2 (OUTDOOR)

Video Type – OUTDOOR, Video duration – 11 seconds, Total number of Frames – 260, Format – MPEG-4 , Overall Bit Rate – 1772 kbps

(i) Performance Of the proposed algorithm without attack:

The experimental results of the proposed digital video watermarking scheme using cascaded stages of Discrete Wavelet Transform are presented. The watermarked video sequences possess superior Peak Signal to Noise Ratio (PSNR) and visual quality for grayscale watermark images.

In Fig.9 (a), the first 12 frames of the original video sequence has been shown along with the original watermark image in Fig.9 (b) that is to be embedded in the video. The extracted watermark has also been shown in Fig.9 (c). The video sequence that has been considered in Case Study-2 is basically an OUTDOOR video sequence of our Institute i.e. JABALPUR ENGINEERING COLLEGE,JABALPUR (MP) with a total frames of 260 in number with a total duration of 11 seconds.



(a) (b)

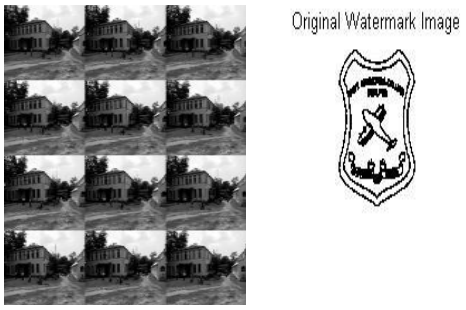
(c)

Fig. 9. (a) Input outdoor Video Sequence and (b) Watermark image (c) Extracted image

The measured output for the proposed video watermarking scheme has been evaluated by PSNR and NC (Normalized Correlation). The PSNR measured comes out to be 49.6629 db which is as per desired and the value of NC comes out to be 0.9311.

(ii) Performance of the proposed algorithm with attack:

The shown Outdoor video sequence in Fig. 10 (a) is being attacked by Gaussian noise and using the noise variance property, for different values of noise variance the corresponding PSNR and NC has been calculated as shown in Fig.11 and Fig.12 The Noise Variance has been varied from zero value to 10^(-10) in steps of 10 and for each and every value of Noise Variance , corresponding PSNR and NC has been calculated.



(a) (b)

Fig. 10. (a) Input Outdoor Video Sequence (b) Watermark image

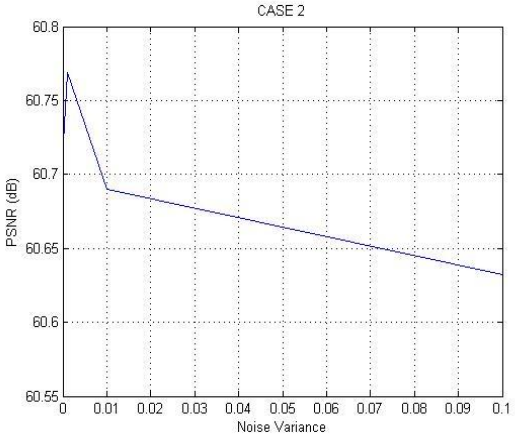


Fig. 11. PSNR vs Noise variance Plot (Case study 2)

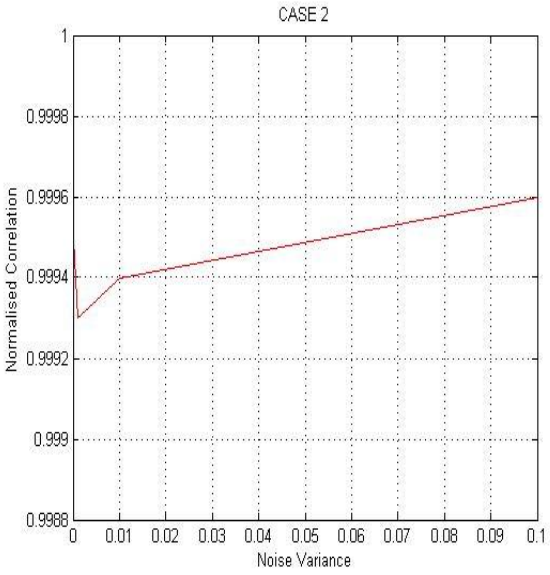


Fig. 12. NC vs Noise variance Plot (Case study 2)

Table-2 Different Values of Noise Variance and the corresponding PSNR and NC (Case Study 2)

Noise Variance	PSNR	NC
0	60.5914	0.9996
10^(-10)	60.7558	0.9989
10^(-9)	60.6440	0.9997

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

10^(-8)	60.5816	0.9998
10^(-7)	60.7229	0.9994
10^(-6)	60.5985	0.9997
10^(-5)	60.5804	0.9997
10^(-4)	60.7205	0.9995
10^(-3)	60.7686	0.9993
10^(-2)	60.6897	0.9994
10^(-1)	60.6325	0.9996

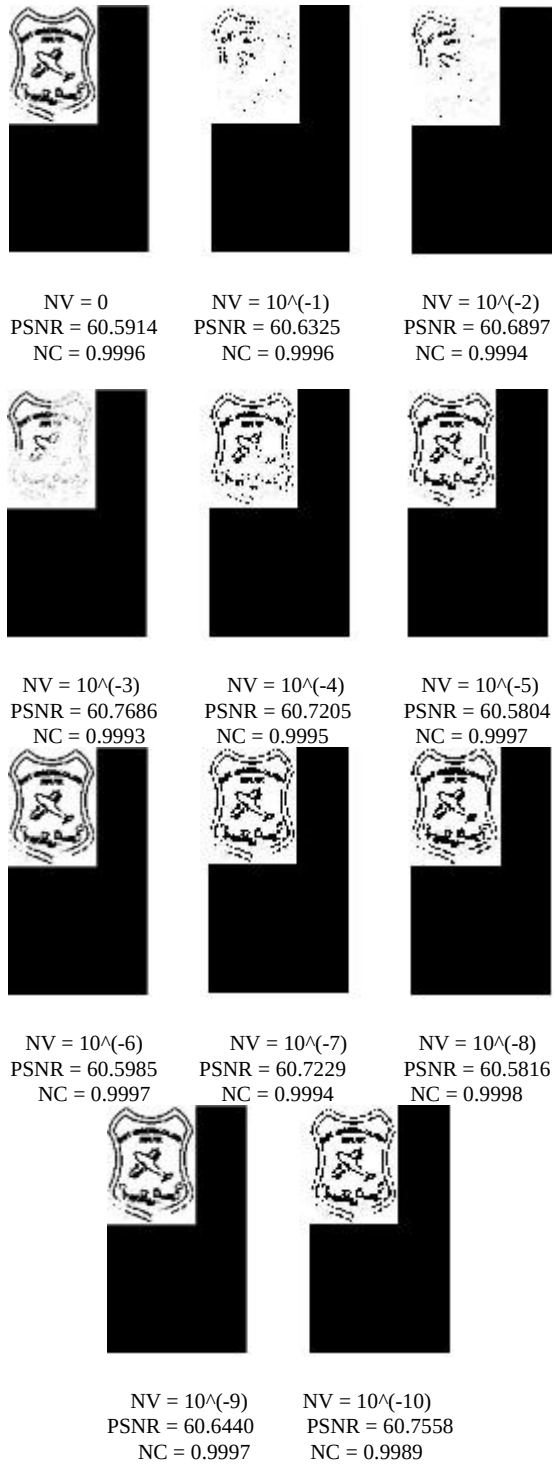


Fig. 13. Effect of Noise Variance on Extracted Watermark Image

The Fig. 13 shows the different outputs for different values of the Noise Variance and the corresponding PSNR and NC has been calculated.

C. Comparison with Existing Algorithm:

In this section, the proposed algorithm is compared with the existing discussed in [1] and the proposed algorithm in this work for the two cases studied as in the case of [1]. Table 4 shows that the result obtained from the proposed algorithm are better as compared to the existing algorithms on the evaluated parameter of PSNR and NC.

Table-4 PSNR and NC comparison with the algorithm in [1]

	Parameters	DWT based Reference paper[1]	Proposed Method
Case Study 1	PSNR(dB)	37.192	60.9088
	NC	0.7286	0.9429
Case Study 2	PSNR(dB)	34.81	60.5804
	NC	0.7082	0.9997

V. CONCLUSIONS

The sole motive of the work considered so far is to provide accurate and precise watermarking of multimedia content. In this paper, the proposed transformed based video watermarking algorithm is vital for achieving better security. In this paper, the experimental results show that this algorithm performs quite efficiently with good PSNR and NC. Comparison with the existing [1] also shows that the proposed algorithm is quite good in NC.

REFERENCES

[1] M. Sundararajan, G.Yamuna "DWT based scheme for video watermarking" in International conference on communication and signal processing, April 3-5, 2013, India

[2] W.-M. Chen,C.-J. Lai, H.-C.Wang,H.-C.Chao,C.-H.Lo, "H.264 video watermarking with secret image sharing" IET Image Process., 2011, Vol. 5, Iss. 4, pp. 349–354.

[3] Prashanth Swamy, M. Girish Chandra and B.S.Adiga, "On Incorporating Biometric Based Watermark for HD Video Using SVD and Error Correction Codes "International Conference on Microelectronics, Communication and Renewable Energy (ICMiCR-2013)

[4] Hui-Yu Huang, Cheng-Han Yang and Wen-Hsing Hsu," A Video Watermarking Technique Based on Pseudo-3-D DCT and Quantization Index Modulation" IEEE Transactions On Information Forensics And Security, Vol. 5, No. 4, December 2010, pp 625-637.

[5] Iwan Setyawan and Ivanna K. Timotius, "Content-Dependent Spatio-Temporal Video Watermarking using 3 -Dimensional Discrete Cosine Transform" 2013 IEEE.

[6] Azadeh Mansouri, Ahmad Mahmoudi Aznaveh, Farah Torkamani-Azar and Fatih Kurugollu," A Low Complexity Video Watermarking in H.264.Compressed Domain" IEEE Transactions On Information Forensics And Security, Vol. 5, No. 4, December 2010, pp 649-657.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 4, Issue 3, September 2014

[7] Ta Minh Thanh, Pham Thanh Hiep, Ta Minh Tam, Kohno Ryuji, "Frame-patch matching based robust video watermarking using Kaze Feature".

[8] Jantana Panyavaraporn, "Multiple Video Watermarking Algorithm based on Wavelet Transform"2013 13th International Symposium on Communications and Information Technologies (ISCIT), pp. 397-401.

[9] Satyendra N.Biswas, Touhidul Hasan, Shuvashis DasGupta, Sunil R. Das, Voicu Groza, Emil M. Petriu, and Mansour H. Assaf, "Compressed Video Watermarking Technique".

[10] Yueh-Hong Chen and Hsiang-Cheh Huang, "A Robust Watermarking Scheme for Stereoscopic Video Frames"2013 IEEE 17th International Symposium on Consumer Electronics (ISCE), pp. 295-296.

[11] Prabhishek Singh, R S Chadha ISSN: 2277-3754 ISO 9001:2008 Certified International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 9, March 2013.