ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijircce.com

Vol. 6, Issue 4, April 2018

A Hybrid Daubechies DWT based Approach for Multiple Image Video Watermarking

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ABSTRACT: Digital watermarking was introduced as a result of rapid advancement of networked multimedia systems. It had been developed to enforce copyright technologies for cover of copyright possession. Due to increase in growth of internet users of networks are increasing rapidly. It has been concluded that to minimize distortions and to increase capacity, techniques in frequency domain must be combined with another techniques which has high capacity and strong robustness against different types of attacks. In this research, an effective, robust and imperceptible video watermarking algorithm is proposed. This algorithm was based on a cascade of powerful mathematical transforms; Discrete Wavelets Transform (DWT), Discrete Cosine Transform (DCT). Three different transform domain techniques showed high level of complementary and different levels of robustness against the same attack will be achieved through their combination.

KEYWORDS: Electric Power, Time series, Electric Load Forecasting, Artificial Intelligence.

I. INTRODUCTION

Nowadays, as the Internet becomes ubiquitous and digitizing devices such as scanners and digital cameras become more available, individuals easily share their own resources on the web [1]. While we enjoy its numerous conveniences, some crucial issues for digital media such as illegal copying, distribution, editing and authentication also arose. This phenomenon has led to an increasing need for developing some standard solutions to prevent these issues. As a powerful method to protect digital copyright, digital watermarking has been developing for many years.

Digital watermarking is the process of permanently embedding data (adding a watermark) into digital multimedia content (host data) without degradation, such that this watermark can resist any extraneous operation. The watermark can be visible or invisible. The basic characteristics of any watermarking scheme are its capacity, robustness, security and imperceptibility [2-6].

Watermarking technique is the process of embedding the watermark into the digital media to protect the intellectual property rights. Watermarking method can be categorized into two groups, namely spatial domain and transform domain. In the spatial domain, the host image pixels are manipulated and the watermark information is directly inserted into them. Although the spatial domain methods have lower computational complexity and higher capacity, they are vulnerable to various attacks and have worse robustness [7,8]. On the other hand, transform domain methods not only tolerate various attacks but have good performances. Although transform domain methods need predefined transformation and inverse transformation, and the watermark information is distributed over the whole range of pixels of the host image instead of local parts, transform domain methods are more robust to various attacks [9].

Maximum occurrences of copyright violation and distribution happen for video media content [10-12].So Video Watermarking is one of the most accepted techniques among the various Watermarking techniques currently in use. Some of the requirements for video water marking are as follows:

- Video data is subject to increased attacks than any other media.
- Video content is sensitive to distortions and Watermarking may degrade the quality.
- Video compression algorithms are computationally rigorous.

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- Video require large bandwidth that is why it is mostly carried in compressed domain. So Watermarking algorithm is also adaptable for compress area processing.

II. Related Work

Ganic et al. [12], proposed a hybrid technique DWT- SVD. The original image is divided into four bands and then all bands are transformed by SVD. This watermarking technique is robust facing to diverse attacks.
Makbol et al [13] presented a medical image watermarking scheme which combines DWT and DCT. The watermark is inserted into DCT of high-frequency sub-band (HH) of the cover medical image. The quality of the proposed scheme is evaluated by the peak signal to noise ratio (PSNR) for different gain.
Zear et al. [14] the authors present a multiple watermarking for healthcare applications using combinations DWT-DCT-SVD. Two watermarks are inserted in the singular value of the original medical image after its decomposition until the third level DWT and transformation by DCT and SVD. The results demonstrate that this method is able to resist against various attacks.
Gunja et al. [15] proposed a comparative analysis of DWT and DWT-FWHT-SVD. The cover image is divided into four sub bands and then transformed by DWT-FWHT and SVD. The proposed algorithm DWT-FWHT-SVD is strongly robust to various attacks compared with DWT.
Emon Dey et al. [16] proposed a semi blind watermarking scheme utilizing both Discrete Wavelength Transform (DWT) and Singular Value Decomposition (SVD). To embed the watermark, we transformed the host image into wavelet domain and generated a secondary host image using directive contrast. By remodeling the SVD coefficients of the watermark with the SVD coefficients of secondary image we inserted the watermark into the secondary image. A genuine extraction scheme has also been developed to recover the watermark from the cover image. The scheme has been employed using horizontal sub band. In addition to, evaluations have been added in terms of vertical and diagonal sub bands to compare the performance of the algorithm on the basis of specific sub bands. Experimental evaluations in terms of Normalized Correlation (NC) and Peak Signal to Noise Ratio (PSNR) give proof that our procedure is durable and imperceptible under variety of attacks [17].
Swagata Mawande et al. [18] proposed digital video watermarking scheme based on Discrete Wavelet Transform and Singular Value Decomposition. Design of this scheme using Matlab is proposed. Embedded watermark is robust against various attacks that can be carried out on the watermarked video.
Jayprakash Upadhyay et al. [19] proposed an algorithm based on DWT transforms. The LSB method is used to hide the data in the least significant bit of the “Original video” pixels. Imperceptibility, embedding capacity and robustness are the parameters for this technique. Simulation results show that the proposed algorithm achieves these parameters in their acceptable range i.e. imperceptibility is high, embedding capacity is also high in noisy environment and highly robust to a wide range of attacks, e.g. salt & pepper noise, rotation, cropping & median filtering as compared to existing watermarking methods.

Hannes Mareen et al. [20] proposed a watermarking approach in order to protect videos from copyright infringement, based on implicit distortions generated by a video encoder, rather than artificial distortions used in the state-of-the-art. These distortions are imperceptible and robust against video manipulations.

III. Proposed Methodology

In this research, an effective, robust and imperceptible video watermarking algorithm is proposed. This algorithm was based on a cascade of powerful mathematical transforms; Discrete Wavelets Transform (DWT), Discrete Cosine Transform (DCT). Three different transform domain techniques showed high level of complementary and different levels of robustness against the same attack will be achieved through their combination. Selection of the Middle band Co-efficient as in Zig Zag order. Multiple images are used for water marking.

A. Embedding Algorithm

The Watermark embedding process consists of the following steps (as in figure 1):

a. Video is divided into frames RGB frames are converted to YUV frames.

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b. DCT and 2 level Daubechies DWT is applied on it.
c. RGB watermark image is converted into a YUV image.

The watermark pixels are embedded with strength x into the middle band of the wavelet transform. The embedding equation is:

$$I_i = I_i + x * W_{image}$$

Where, x is the watermark embedding strength.

d. Inverse DWT is applied to obtain the watermarked component of the frame. Finally watermarked frame is reconstructed and watermarked video is obtained.

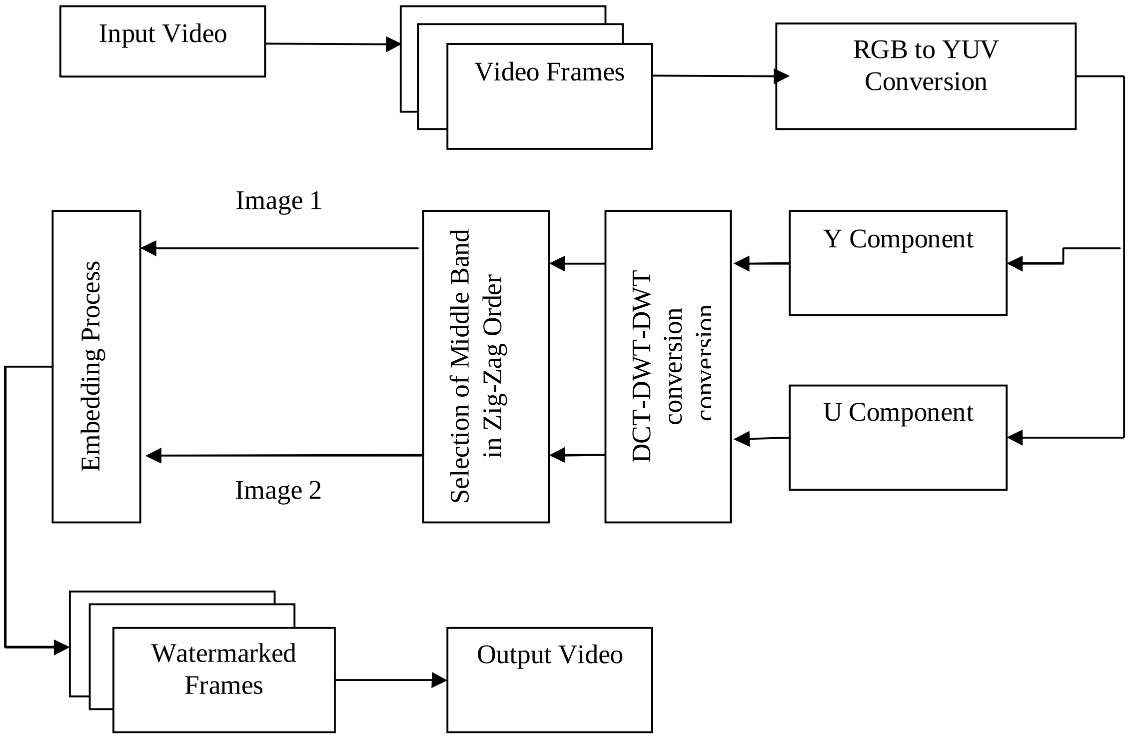

Figure 1: Watermark Embedding Process

B. Watermark Extraction Algorithm

The steps used for watermark extraction is the same as the steps in the embedding but in the reverse direction as follows (as shown in figure 2):

a. Watermarked video is converted into frames. Each RGB frame is converted to YUV representation.
b. DCT and 2-level Daubechies DWT is applied on middle sub-bands.
c. Following equation is used to extract watermark:

$$W = \frac{I_i^1 - I_i}{x}$$

d. The extracted watermark is compared with the original watermark as follows:

$$NC = \frac{\sum_i \sum_j (w(i,j) * w'(i,j))}{\sum_i \sum_j w(i,j)^2}$$

Where, NC is the normalized correlation. NC value is 1 when the watermark and the extracted watermark are identical and other than one if the two are different from each other.

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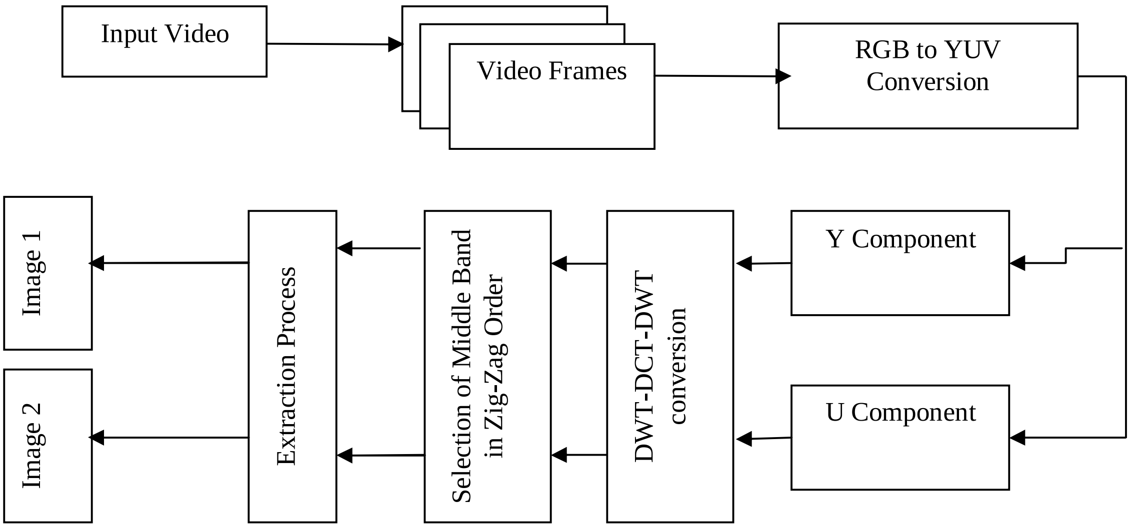

Figure 2: Watermark Extraction Process

IV. Result Analysis

Robustness of watermark means that the after intentional or unintentional attacks thewatermark is not destroyed and it can be still used to provide certification and it is measured using correlationcoefficient. It is measured "after attack". For the robust capability, mean absolute error (MSE) measures the mean ofthe square of the original watermark and the extracted watermark from the attacked image. The lower the value ofthe MSE lower will be the error. It is represented as:

$$MSE = \frac{1}{XY[\sum_{i=1}^{X} \sum_{j=1}^{Y} (c(i,j) - e(i,j))}$$

X and Y are height and width respectively of the image. The c (i, j) is the pixel value of the cover image and e (i, j)is the pixel value of the embed image.
PSNR represents the degradation of the image or reconstruction of an image. It is expressed as a decibel scale.Higher the value of PSNR higher the quality of image. PSNR is represented as:

$$PSNR = 10log10(\frac{(L * L)}{MSE}$$

In this research work following analysis are performed:

- To analyse the performance of Haar based proposed algorithm as well as Daubechies based proposed algorithm.
- To analyze on Different Attacks such as Gaussian noise, Poisson Noise, Salt and pepper Noise, etc.
- To compare with some existing work.

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Table I: Comparative Analysis of Haar and Daubechies based Proposed Algorithm

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
DWT(Haar)					
Image 1 (256*198)	VIDEO 1 (1.5 MB)	0.003	170.3	21.05	21.05
Image 2					
Image 1	VIDEO 1	0.004	166.5	21.72	16.37
Image 3					
DWT (Daubechies)					
Image 1	VIDEO 1	2E-05	221.4	4.35	24.29
Image 2					
Image 1	VIDEO 1	6E-05	207.6	25.11	18.23
Image 3					

The table I shows the comparison of Haar based proposed algorithm as well as Daubechies based proposed algorithm. From result analysis it has been noticed that Daubechies based proposed algorithm achieves high PSNR value as well as low MSE value as compared to Haar based proposed algorithm.

Table II: Analysis of Proposed Algorithm under Mean Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1	VIDEO 1	0.883	112.1	25.47	18.27
Image 2					
Image 1	VIDEO 1	0.883	112.1	24.63	18.54
Image 3					

Table II show the result analysis of proposed algorithm under mean attack.

Table III: Analysis of Proposed Algorithm under Median Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1	VIDEO 1	0.273	123.9	31.6	23.48
Image 2					
Image 1	VIDEO 1	0.273	123.9	33.65	22.13
Image 3					

Table III show the result analysis of proposed algorithm under median attack.

Table IV: Analysis of Proposed Algorithm under Rotation Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1	VIDEO 1	17.83	82.04	29.19	27.98
Image 2					
Image 1	VIDEO 1	17.83	82.04	28.42	23.17
Image 3					

Table IV show the result analysis of proposed algorithm under rotation attack.

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Vol. 6, Issue 4, April 2018

Table V: Analysis of Proposed Algorithm under Salt & Pepper Noise Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1 Image 2	VIDEO 1	101	64.68	33.37	21.75
Image 1 Image 3	VIDEO 1	100.9	64.68	37.77	28.01

Table V show the result analysis of proposed algorithm under salt and pepper noise attack.

Table VI: Comparative Analysis of Proposed Algorithm under Gaussian Noise Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1 Image 2	VIDEO 1	99.66	64.81	31.56	24.41
Image 1 Image 3	VIDEO 1	99.68	64.81	29.71	22.76

Table VI show the result analysis of proposed algorithm under gaussian noise attack.

Table VII: Analysis of Proposed Algorithm under Poisson Noise Attack

IMAGES	VIDEOS	MSE	PSNR	Embedding Time (in sec)	Extraction Time (in sec)
Image 1 Image 2	VIDEO 1	98.87	64.89	45.49	25.61
Image 1 Image 3	VIDEO 1	98.87	64.89	47.43	23.14

Table VII show the result analysis of proposed algorithm under poisson noise attack.
After analyzing different attacks it has been concluded that the proposed algorithm is robust in nature. Now the comparative analysis is performed with some of the existing work which are shown below in Table 4.8 and 4.9 as well as in figure 4.6-4.8.

Table VIII: Comparative Analysis of Proposed Algorithm with 2-level DWT

GAIN FACTOR	TECHNIQUES	MSE	PSNR
0.01	Proposed Technique	0.0000157	221.4414
	2-LEVEL DWT	0.0029	169.0934
0.05	Proposed Technique	0.0000785	205.347
	2-LEVEL DWT	0.0147	152.9991
0.1	Proposed Technique	0.000157	198.4156
	2-LEVEL DWT	0.0295	146.0676
0.2	Proposed Technique	0.000314	191.4841
	2-LEVEL DWT	0.0589	139.1361
0.3	Proposed Technique	0.000471	187.4294
	2-LEVEL DWT	0.0884	135.0815

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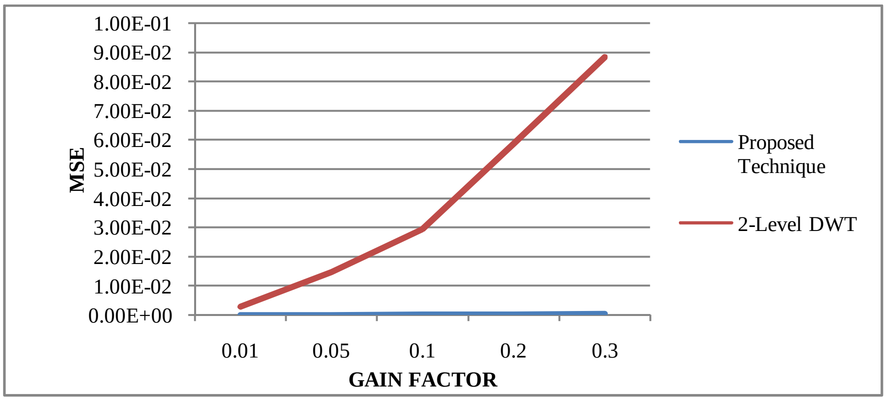

Figure 3: MSE Analysis of Proposed Algorithm with 2-level DWT

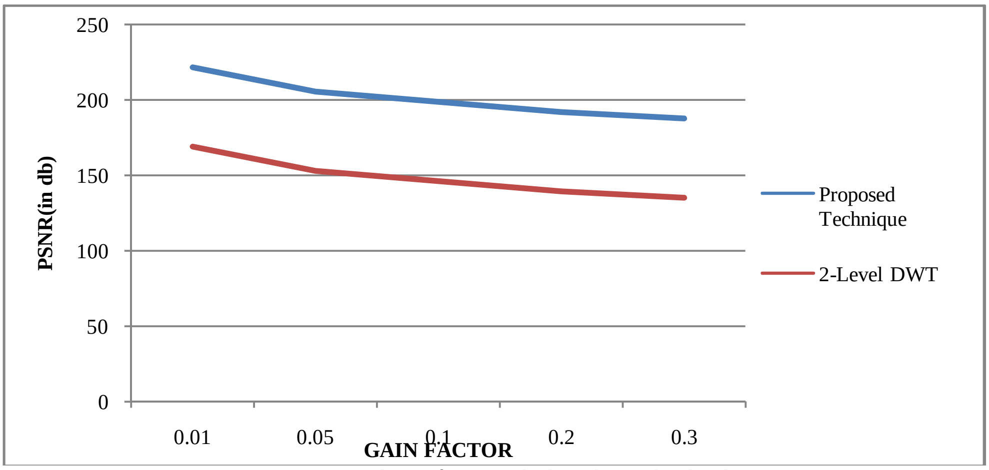

Figure 4: PSNR Analysis of Proposed Algorithm with 2-level DWT

Table IX: Comparative Analysis of Proposed Algorithm with Existing Work

Gain Factor	Proposed Work	Existing Work [1]
0.01	205.3973	69.32
0.05	189.3029	54.02
0.1	182.3714	48.15
0.2	175.44	42.28
0.3	171.3853	38.83

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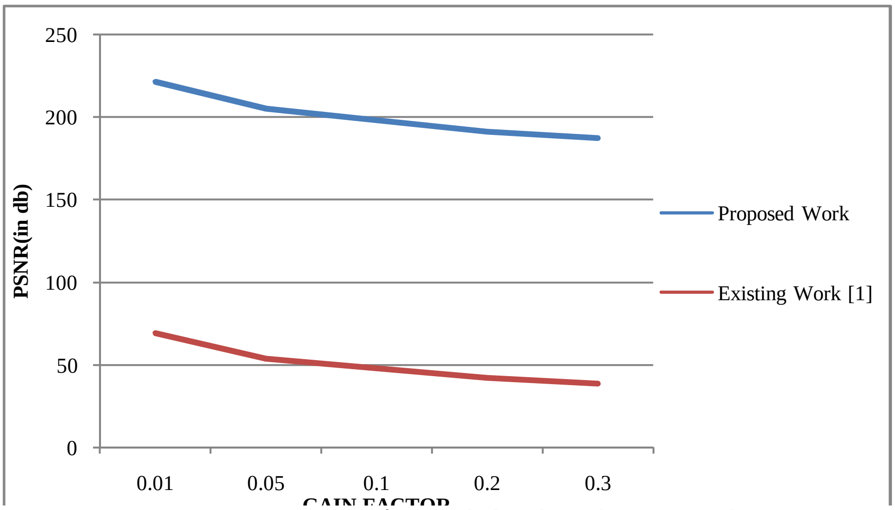

Figure 5: PSNR Analysis of Proposed Algorithm with Existing Work

V. CONCLUSION

Watermark embedding and extraction algorithms are required for providing copyright protection and ownership identification. This research work provides comprehensive survey on various digital image watermarking techniques in different domains and their requirements. It has been concluded that to minimize distortions and to increase capacity, techniques in frequency domain must be combined with another techniques which has high capacity and strong robustness against different types of attacks.

In this research watermarking is done by the combining the features of DWT (Discrete wavelet transformation) and Discrete Cosine Transformation (DCT). RGB color image is converted into YUV color model. Y and U color component of the image is used for reducing computational complexity for embedding the multiple watermarks. Further DCT-DWT-DWT embedding and extraction technique is performed on middle band of the video frames. The result analysis is performed on different types of attacks and concluded that proposed technique is quite efficient as compared to 2-level DWT video watermarking technique as well as some of the existing work. The robust video watermarking algorithm is proposed by embedding watermark on each frame of the video. This algorithm realizes blind watermarking with watermark detection and extraction and is found to be robust to most common attacks. The future works will be focused on improving the performance of our technique against geometric attacks and furthering research on techniques of watermarking for medical applications and biometrics applications.

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