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A ROBUST SCENE- BASED VIDEO- WATERMARKING USING DIFFERENT WAVELET

DOLLEY SHUKLA[a1] AND MANISHA SHARMA[b]

[a]ShriShankaracharya Technical Campus, Bhilai, Chhattisgarh, India
[b]Bhilai Institute of Technology, Durg, Chhattisgarh, India

ABSTRACT

This paper presents a robust digital watermarking algorithm for video sequence in the application of copyrightprotection . Proposed scheme divide the video into frames.A scene change detector is used to detect the scene changed frame.The discrete wavelet transform is used for embedding the watermark in scene change frame, using the 1 st level decomposition i.e. LL subband.The embedding and extraction process performed using three different wavelets i.e. haar, Daubechiesand biorthogonal. Peak signal to noise ratio, Mean square error, and structural similarity index are computed for testing the quality of video. The proposed scheme is also tested to verify the robustness performance using normalized correlation.Comparative performance analysis using different wavelet reveals that scene–based-watermarking shows high imperceptibility and robustnessunder different attacks with Daubechies wavelet.

KEYWORDS: Video,Video-watermarking, Scene Change Detector, Wavelet.

With the development of the technology of computer and network, booming increase in multimedia contents and their applications, the copyright protection problem becomes very important, since pirate and illegal useof digitalcontent have significantly harmed the advantages of their owner.With the introduction of digital image processing, digital watermarking has one of the possible solutions to this problem [Hartung and Kutter, 1999]. Digital image watermarking is extended to audio & video also. In watermarking, thewatermark is inserted into a digital media which can be extracted or detected for ownership proof and copyright protection purpose. Imperceptibilityand robustness are the two obviouscharacteristics of theeffective watermarking scheme. For imperceptibility, watermark embedding should not degrade the quality of the protected data significantly. For robustness and security, the watermark should be able to authenticate the copyright of the input data and not easy to be removed [Cox and Miller, 2001]. Since thevideo is the sequence of correlated images, therefore watermarking in thevideo can be done frame by frame (Framewise)basis.In order to achieve the high robustness, this paper presents scene- based approach for video watermarking where watermark embedding process is done in the wavelet coefficients.Before presenting the proposed watermarking scheme,related work has been presented in next section.

REVIEW STAGE

Existing information hiding techniques are mostly based on the spatial rather than the frequency domain. Spatial domain watermarking involves embedding and detection of thewatermark, by directly modifying the pixel intensity values of the host video frame but at a low level of complexity. Although the technique is easy to implement, sometimes adding noise can entirely demolish the watermark [Tokar et. al., 2009].

In the frequency domain watermarking [Cox et. al., 1997 & Sinha et. al., 2011], spatial pixel values of host video are changed on the basis of frequency transform. These techniques are more robust than spatial domain techniques.One common frequency domain technique is the Discrete Cosine Transform (DCT) which divides the imageinto low, middle and high frequency bands. Out of which, the middle band is the best option for imperceptibility measurement also requires greater computational capacity [Yu et. al., 2014].

Another frequency domain technique is the Discrete Wavelet Transform (DWT), which decomposes the image down into four sub-bands, representing a low-resolution approximation (LL) and the horizontal (HL), vertical (LH) and diagonal (HH) detail of components.Watermarks embedding in the detail coefficients of the wavelet transform results in increasing the robustness [Langelaar et. al., 2000].The HL and LH are normally selected for watermarking [Chimanna and Khot, 2013]. Overall, the DWT, like the DCT, is no more efficient than the spatial domain in terms of transparency; and requires even more computational power than the DCT [Sinha et. al., 2011]. Several authors presents imperceptible and robust video watermarking algorithm based on Discrete Wavelet Transform (DWT) [Hu and Wei, 2010].Because of its excellent spatial-frequency localization properties, the DWT is very suitable to identify areas in the host video frame where a watermark can be embedded imperceptibly and is more computationally efficient than other transform methods [Wang et. al., 2009]. Shojanazeri et. al., 2011 presented state of the art in

[1]Corresponding author

video watermarking. Bin, 2011 implemented watermark based on DWT for electronic seal. A watermarking technique for scanned colored PDF Files proposed by A. Mahmoud et. al., 2015. To prove the ownership, thelogo was used for embedding. To further improve the robustness and visual quality of the watermarks, region adaptive watermarking technique wasproposed by Song. For embedding and extraction of thecolour watermark image, watermarkalgorithm based on DWT was proposed by Gupta et. al., 2014. In 2013, Masouumi and Amiri presented a scheme of video watermarking which was based on the scene detection in the video. A wavelet transform is used for watermark insertion operation. In 2013, Ko et. al., presented a novel watermarking scheme in which the watermark is inserted in the frame which has high intensity, texture, and motion. This schemehelp to improve the robustness of the video watermarking.A video watermarking scheme for embedding the different part of the watermark in adifferent scene of the video is presented by the Singh et. al., 2013.

Overall, watermarking with Discrete wavelet transform shows more robustness as compare to Spatial domain techniques.Although they are computationally more resource-intensive than spatial methods but frequency domain techniques better suited for video watermarking than other watermarking domains.

The contribution of the work.The challenge is to develop a video watermarking applications and techniques which must be imperceptible and robustness against differentattacks. Therefore a scene based video watermarking based on DWT is designed and implemented using different wavelets.

PROPOSED METHODOLOGY

Basic building block of the proposed method is shown in Figure 1a and 1b.There are three phases in the algorithm. Detection of scene changed frame is described in the first stage, watermark embedding and watermark extraction process described in the successive stages.

Scene Change Detection

Firstly video is converted into the scenes on the basis of correlation measure between frames in three successive steps, after comparing it with athreshold value, scenes changes are detected.

Watermark embedding Algorithm

In the second stage, watermark image of size 128* 128 is embedded into the cover video frame in the first level decomposition of LL subband using alpha blending Technique. For decomposition Daubechies, haar and biorthogonal wavelets were used.

$$WV(LL) = CW(LL) + \alpha * WI(LL)$$
$$WV(LH) = CV(LH)$$
$$WV(HL) = CV(HL)$$
$$WV(HH) = CV(HH)$$

Where,

WM(LL)-Low frequency approximation of Watermarked videoCV(LL) - Low frequency approximation of Cover Video,

WI -Watermark Image

Watermark Detector and Extraction Process

Detection and extraction process is just the reverse operation of embedding and performed in thethird stage.

It involves (i) Watermarked video preprocessing and detection (ii) Extraction (iii) Watermarked video post processing.

Preprocessing :In preprocessing step watermarked video is converted into frames and checks for the scene changed frame. When scene changed frames are verified, the presence of thewatermark is detected. For detection of thewatermark, thescene changed frames of watermarked video are compared with scene changed frames of cover video using NC. The threshold value is selected AS 1, on hit and trial basis. If NC is not equal to 1, then it shows that "watermark is present".

Extraction: An extraction is the inverse operation of embedding. For extraction, thesubtraction operation is performed between the 1-level LL subband of watermarked video frame and cover video frame using alpha blending technique.

$$WI = (WV(LL) - CV(LL)) / \alpha$$

Where,

WI - Extracted/ Recovered watermark image from Low-frequency approximation of embedded video

WV(LL)- Low-frequency approximation of Embedded watermarked video frame.

CV(LL)- Low-frequency approximation

Post processing: The extracted image isrecovered into the size 128*128 after converting theimage into anunsigned 8 –byte wide integer. It is useful to prove the ownership.

EXPERIMENTAL RESULT AND PERFORMANCE ANALYSIS

The proposed watermarking embedding and extraction scheme is tested on five different Avi videos in the MATLAB platform withthei-5 processor. The video of different frame size & frame rate is considered. After resizing of 256 * 256, thevideo is converted into frames. For the testing, pepper watermark image of size 256 x 256 is considered, which is depicted in Figure3(a).After converting into 128*128 size, the watermark image is hidden into the LL Subband of the selected frames, decomposed by level 1 of DWT. For decomposition three different wavelets i.e. Haar, Daubechies andbiorthogonal are considered.

To measure the perceptual quality, peak signal to noise ratio and mean square error is calculated between watermarked frames and original frame. A PSNR value over 30 dB is acceptable for thehuman visual system. Figure 2 (a),(b),(c),(d) shows the original video frame and watermarked video frame of AD.avi video using different wavelets respectively. Figure 3(a), represents the pepper as a watermark image. The performance analysis of encoder using three different wavelets i.e. haar, Daubechies and biorthogonal for ad.avi video and pepper..jpg, Mandril.jpg and Cameraman.jpg images represented in table 1,2 and table 3. The experimental result shows that AD.avi test video with Mandril.jpg as watermark image perform better i.e. PSNR 71.82 and MSE-0.006311 in all three wavelets.

Assessment of Invisibility

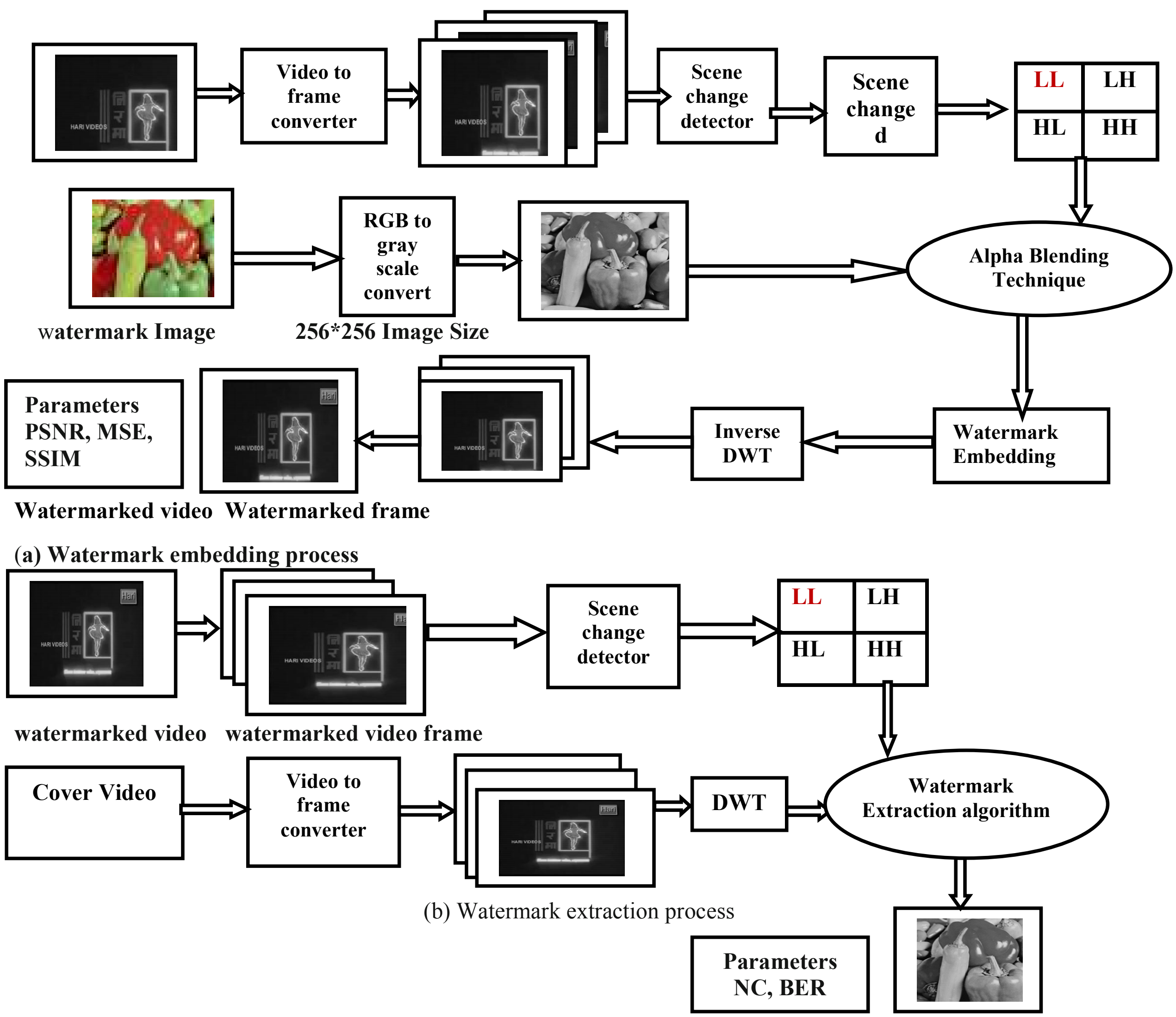


Figure 1: Watermark Embedding & Extraction Process

One more visual quality assessment structural similarity or SSIM is used for measuring the similarity between two images. SSIM considers theimage as perceived change in structural information. SSIM values of nearly one signify that the watermarked frames are similar to original frames.

Assessment of Robustness

Extracted watermark is attained by resizing the original watermark. Normalized correlation is used to evaluate therobustness of proposed scheme. Performance analysis of decoder for test video and three different watermark images are depicted in table 4, table 5 and table 6.

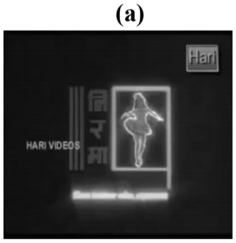
From the above tables of respectivewavelets for PSNR and NC Values, It is clearly shown that there is an inverse relation between PSNR and NC value in Video watermarking. AD &Mandril has highest PSNR (71.82931) and minimum NC (0.7867045). It requires a compromise between the two. In order to prove the robustness and imperceptibility, PSNR and NC values of approximately 40db and 1 respectively can be considered. Therefore for attack analysis AD.avi as cover video and Pepepr.jpeg as watermark image is considered.

Comparative Assessment Using Different Wavelets

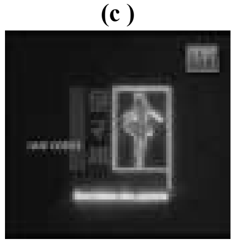
Comparative analysis of the designed system using three different wavelets i.e. Haar, Daubechies and Biorthogonal Waveletfor AD Video and three images i.e. pepper, Mandril andCameraman is shown in Figure4 (a) and (b)for Imperceptibility measurement and for robustness assessment in Figure 5. Comparative analysis shows that proposed system performs better with Daubechies wavelet.

(a)

(c)



(c)



(d)

Figure 2: (a) Original video frame (b,c,d) Watermarked video frame

Assessment of robustness under attack

A set of fifteen attacks of four different categoriesisperformed on the watermarked video to evaluate the robustness. Embedded watermark is retrieved using NC value of recovered watermark in table 7. Graphical representation, depicted in Figure 6 proves that the proposed system sustain all fifteen attacks. Maximum NC value 0.92113 (salt n pepper noise) andminimum0.67457(Blur)except gaussian noise.

Assessment of Robustness in Terms of Bit Error Rate and Imperceptibility in Terms of Similarity Index

FigureVII and FigureVIIIrepresent the robustness andimperceptibility of the proposed system under different fifteen attacks in terms of bit error rate and SSIM. The values

Table 1: Encoder Performance usingdaubechies wavelet

Wavelet Used – Daubechies wavelet				
Video	**Watermark Image**	**MSE**	**PSNR**	**SSIM**
AD.avi	pepper.jpeg	0.016689	66.90628	1
AD.avi	Mandril.jpeg	0.006311	71.829313	1
Ad.avi	Cameraman	0.001338	55.86926	1

Table 2: Encoder Performance usingHaar wavelet

Wavelet Used – Haar wavelet				
Video	**Watermark Image**	**MSE**	**PSNR**	**SSIM**
AD.avi	pepper.jpeg	0.016689	65.10629	1
AD.avi	Mandril.jpeg	0.0063117	70.12931	1
Ad.avi	Cameraman	0.0580400	50.4940	1

Table 3:Encoder Performance using Biorthogonal wavelet

Wavelet Used - Biorthogonal wavelet				
Video	**Watermark Image**	**MSE**	**PSNR**	**SSIM**
AD.avi	Pepper.jpeg	0.015532	64.118542	1
AD.avi	Mandril.jpeg	0.006259	70.166347	1
AD.avi	Cameraman	0.05771	50.5198	1

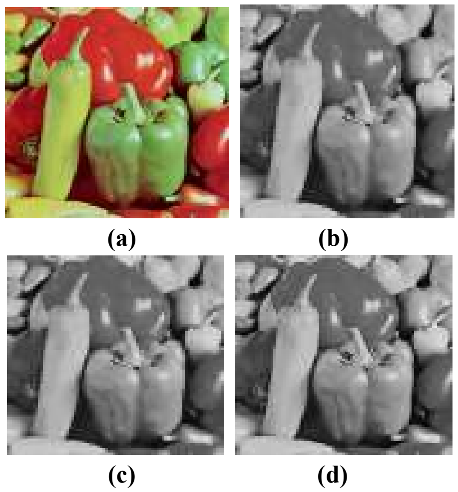


Figure 3: (a) original watermark Image (b,c,d) Extracted Image using Haar, daubechies and Biorthogonal wavelet are depicted in table 8 and table 9 respectively

Comparison With Other Previously Reported Technique

The performance of proposed system is compared with Chandrakar and Qureshi, 2015 Proposed scheme gives high 66.90628 dB PSNR and 0.016689 MSE value. The system also sustains fifteen attacks of four different categories.Comparative analysis of table 10 proves the preference of the proposed scheme in comparison with thealready existent scheme.

Table 4: Decoder Performance using Daubechies wavelet

Video	Watermark Image	NC
AD.avi	pepper.jpeg	0.939116
AD.avi	Mandril.jpeg	0.7867045
Ad.avi	Cameraman	0.95401044

Table 5: Decoder Performance using Haar wavelet

Video	Watermark Image	NC
AD.avi	pepper.jpeg	0.900005
AD.avi	Mandril.jpeg	0.7500457
Ad.avi	Cameraman	0.900442

Table 6: Decoder performance using Biorthogonal wavelet

Video	Watermark Image	NC
AD.avi	pepper.jpeg	0.8292213
AD.avi	Mandril.jpeg	0.6105773
Ad.avi	Cameraman	0.8441

Table 7: Performance Analysis under different Group of Attacks

Cover Video- AD.avi Watermark image - pepper.jpeg Wavelet - daubechies		
	Attack	**NC**
None	none	0.90912
Image processing Attack	Salt & pepper(noise density -0.05)	0.92113
	Gaussian (0.5)	0.52113
	Speckle(variance- 0.05)	0.86185
	Gaussian LPF	0.98632
	Bllurring(size 5 & sigma 10)	0.67457
	Sharpening	0.85788
	Normal Blurr	0.72113
	Motion blurr(size20, sigma 45)	0.88374
JPEG Compression	JPEG Compression (quality – 40)	0.91211
Geometrical Attacks	Resizing(By 1.05)	0.84787
	Rotation (1 degree)	0.73558
	Strecingh(1.05*width)	0.89673
Video Attacks	Frame Averaging	0.89676
	Frame Dropping [20 frames]	0.90370
	Frame Swapping	0.85211

Table 8: Performance Analysis using Bit Error Rate

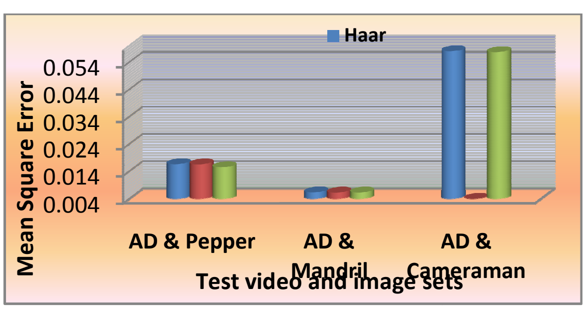
S. No.	Attack	Bit Error Rate	S. No.	Attack	Bit Error Rate
1.	none	0.0000	9	Resizing	0.0000
2.	Salt & pepper	0.34167	10	JPEG Compression	0.44774
3.	Gaussian	0.39499	11	Normal Blur	0.32238
4	Speckle	0.32525	12	Motion blur	0.30532
5	Gaussian LPF	0.06597	13	stretching	0.00000
6	Rotation	0.24392	14	Frame Averaging	0.42055
7	Bllurring	0.22718	15	Frame Dropping	0.00000
8	Sharpening	0.17017	16	Frame Swapping	0.30141

Table 9: Performance Analysis in terms of SSIM

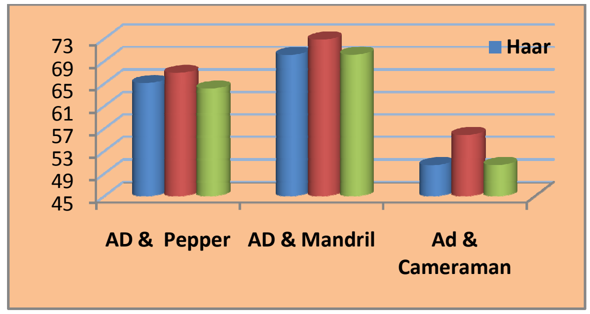
S. No.	Attack	SSIM	S. No.	Attack	SSIM
1.	none	1.00000	9.	Motion blurr	0.72636
2.	Salt & pepper	0.91068	10.	JPEG Compre ssion	0.92913
3.	Gaussia n	0.35145	11.	Resizing	1.00000
4.	Speckle	0.69411	12.	Rotation	0.85382
5.	Gaussia n LPF	0.99701	13.	Stretchi ng	1.00000
6.	Blurring	0.89462	14.	Frame Averagi ng	0.64745
7.	Sharpenin g	0.97710	15.	Frame Droppin g	1.00000
8.	Normal Blurr	0.69215	16.	Frame Swappi ng	0.73649

Table 10: Comparative Analysis with all existing technique

Method	[20]	Proposed method
Methodology	Random frame selection	Scene change detection
Technique used	[DWT] Embedding in LL & LH subband	[DWT] Embedding in LL Subband
PSNR	39.7596	66.90628
MSE	1.2114	0.016689
NC	0.9888	0.90912
Analysis on no. of attacks	NIL	Fifteen attacks in four groups



(a) Mean Square Error



(b) Peak Signal to Noise ratio

Figure 4: Comparative performance evaluation using Haar,Daubechies and Biorthogonal [imperceptibility]

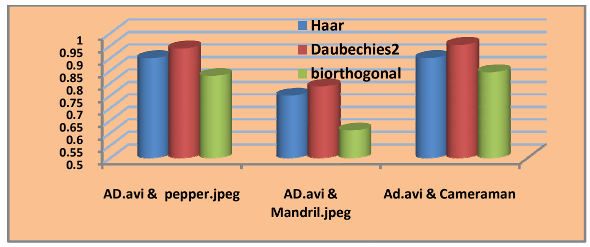


Figure 5: Comparative performance evaluation using Haar,Daubechies and Biorthogonal [Robustness]

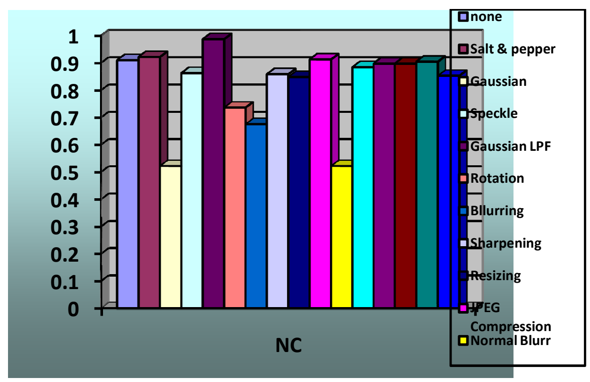


Figure 6: Robustness in terms of Normalized correlation

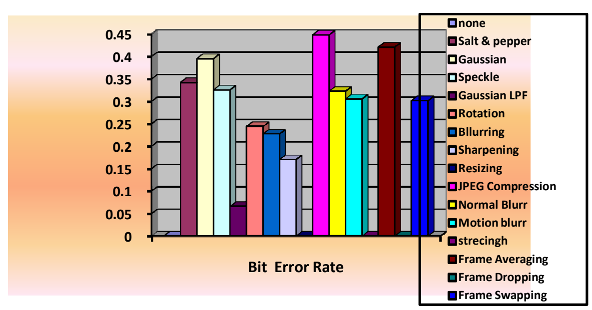


Figure 7: Robustness in terms of Bit error Rate

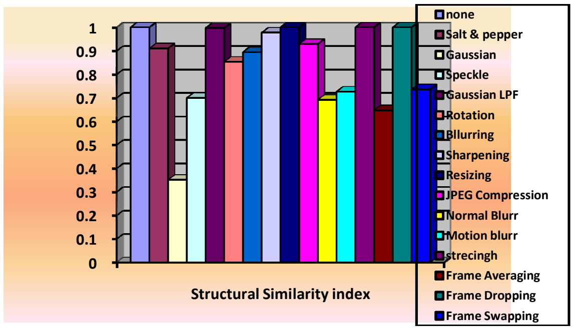


Figure 8: Imperceptibility in terms of SSIM

CONCLUSION

In this paper, a Robust video watermarking scheme based on detection of ascene change from thevideo for embedding identical watermark to scene change frame was introduced. The watermarking process has utilized the LL frequency coefficient of wavelet using 2D- DWT for embedding the watermark. Due to the embedding of watermark only in the scene change frame, watermark embedding and extraction is found to be fast with reduced computational time. Proposed algorithm performance is compared using three wavelets i.e.haar, Daubechies and biorthogonal.The experimental result shows the high performance of proposed method against four different groups of attacks contains total fifteen attacks. Because of the non-blind retrieval of the watermark,the proposed watermarking scheme can be used for a watermarking application like copyright protection and copy protection. The proposed scheme is proven to be most remarkable in terms of Imperceptibility and robustness forDaubechies wavelet. Future work will focus on improvement in the performance.using two and three level decomposition of LL subband for embedding.

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