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Enhance Gray Image Performance using 3-DWT-SVD and DCT Approach Based Image Watermarking with Different Attacks

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Abstract: This research presents a robust Descrete cosine Transform (DCT)-discrete wavelet transform (DWT)-singular value decomposition (SVD) method based image watermarking (IW) with dissimilar attacks. In the intial stage, split the original (cover) image into four sub-bands using DCT-3DWT, after that apply SVD on every band using modifying their singular values. After obtaining the watermarked image (WI) to different attacks namely blurring, adding noise, contrast adjustment, histogram equalization, swirl, median filter and negative. We extract the original embedded WI from all bands and evaluate them on the foundation of their mean square error (MSE) and Peak Signal Noise Ratio (PSNR) parameters. In this approach, try to recover original watermark image from attacked watermarked image.
Keywords: DWT;SVD;DCT;PSNR;Attacks;Image Watermarking.

I. INTRODUCTION

Digital contents are transmitted through internet; there is a need to protect it from the pirating, unauthorized access. To provide solution to the mentioned requirements Digital technology is emerged as a solution. The main aim of this technology is to provide protection to data. Among the different techniques of protecting the data Digital watermarking (DW) is proved to be the best solution to protect multimedia data [1].

Digital image watermarking (DIW) is a technology that has been made to protect digital data like pitures, audio & video from prohibited manipulations. The common traits of DW are: insensitivity, secrecy, and robustness. In DIW the inserted watermark need to no longer degrade the visual perception of an authentic picture and have to be robust.

In this paper using techniques

A. Discrete Wavelet Transform (DWT)

DWT is a method for analyzing multi-level signal it can analyze the signal at different frequency bands with different resolutions by decomposing it into approximation and detailed infonnation. The principle of the algorithm is to divide the image into four at each iteration, three blocks on the details of the image (LH, HL, HH), and the fourth (LL) corresponds to the most important information for the eye (low frequencies), which serves basis for the next iteration. To decompose this image into sub image we use: high and low pass filters (LPF). The DWT can be expressed as follows:

$$X_f(a_2 b) = \int_{-\infty}^{+\infty} f(t).\frac{1}{\sqrt{a}}\Psi^*\left(\frac{t-b}{a}\right).dt$$

B. SVD based Watermarking

It is a numerical analysis device used to diagonalize matrices. It is advanced for a selection of packages algorithm. The most important properties of the SVD in tenns of image processing (IP) applications are: Singular values (SVs) of the picture have very good balance to understand while a small perturbation is made inside the picture of the SV does now not alternate extensively; SV is an algebraic intrinsic belongings. SVD processing in a matrix A can be decomposed into three matrices of the equal size because the preliminary matrix; two orthogonal matrices U and V and a diagonal matrix S.

A = U * S * VT

The columns of U and V are called respectively left and right singular vectors of A. They essentially detennine the details geometry of the original image. The diagonal values of the matrix S are ranked in descending order. [3]

$$\sigma 1 \geq \sigma 2 \geq \sigma 3 \geq \cdots \ldots \ldots \ldots OR \geq OR + 1 \geq= \cdots \ldots ON = 0$$

C. Discrete cosine transforms (DCT)

First of all image is segmented into non overlapping blocks of 8x8. Then every of those blocks ahead DCT is implemented. After that some block selection criteria is applied and then coefficient selection criteria is applied. Then watermark is embedded by using modifying the chosen coefficients and ultimately on every 8x8 block inverse DCT remodel is applied.

$$y(j,k) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_j\alpha_k\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n) * \cos\frac{(2m+1)j\pi}{2M}\cos\frac{(2n+1)k\pi}{2N}\}$$

$$\alpha_j = \begin{cases}\frac{1}{\sqrt{2}} & j = 0 \; or \; j = 1,2,\ldots\ldots, N-1 \\ 1 & \end{cases}$$

$$\alpha_k = \begin{cases}\frac{1}{\sqrt{2}} & k = 0 \; or \; k = 1,2,\ldots\ldots, N-1 \\ 1 & \end{cases}$$

II. LITERATURE SURVEY

AsnaFurqan (2015) et al present that decompose the original (cover) image into 4 sub-bands using 2-D DWT, and then we apply the SVD on each band by enhancing their SV. After subjecting the WI to various attacks like blurring, including noise, pixelation, rotation, rescaling, contrast adjustment, gamma correction, histogram equalization (HE), cropping, sharpening, lossy compressionetc[4].

GirijaNagar (2015) et al present that a singular optimization approach for DI watermarking within the DWT domain. DIW has proved its performance in shielding unlawful authentication of information [5].

Nadhir Ben Halima (2015) et al present that applied 3- degree Haar-DWT and thereafter, DCT transformation on each selected HH3 subband is computed. In extraction the same process is used to retrieve watermark brand image from the DCT aspect of middle frequency subband of selected HH3 subband[6].

Ms.Mahejabi Khan (2015) et al present that a secure and robust watermarking algorithm based on the combination of image interlacing, DWT &DCT techniques. To minimize the bandwidth requirement during transmission of watermarked image EBCOT algorithm to compress the image and error correcting codes are applied to receive error free content at receiver end [7].

Ranjan Kumar Arya (2015) et al present that provide higher safety of host image (HI). Proposed approach is applied the usage of DWT and DCT. Watermark picture is inserted in LL sub-band of host photograph by means of dividing it the use of DWT. 8x8 block DCT is implemented on LL sub-band and watermark is embedded into remaining pixel of every block. On the idea of watermark pixel fee, pixel price of HI is affected [8].

Anu Bajaj (2014) et al present that Hybrid IW technique is proposed inthis paper which takes the advantages of different transformslike RDWT, DCT, SVD and trigonometric functions. So, all thefunctions are combined at one place to create a non-blind, robustand reversible watermarking scheme [9].

Nasrin M. Makbol (2014) et al present that The IW schemes which can be beneficial to serve these packages have to carry out properly in some of tough applications including print- scan and print-cam (PSPC) applications. This task presents an impetus for studies within the DW discipline. In this paper, the overall performance and the performance of numerous proposed hybrid SVD-based totally DIW schemes are evaluated and studied for PSPC as well as for CP and authentication [10].

III. PROPOSED WORK

In this work, firstly take two images: one is cover image and other is watermark image. Then apply DCT on cover image for modifying the values of image. Then apply 3 level DWT on DCT produced image and split into four bands: Low-pass filter and high-pass filter. After that, take all sub-bands and modify the singular values using SVD. Finally, reconstruct the matrix for obtaininig the watermarked image. Apply attack on watermarked image for robustness and security. In the extraction process, apply DWT-SVD on attack watermarked image and recover all sub-bands of watermark image.

A. Embedding Algorithm

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1) *Input:* Carrier Image and Watermark Image
2) *Output:* Watermarked Image
a) Read carrier image'I' with NXN size and watermark image 'WI' with MXM size.
   $1 = \{1(i,j)|1 \geq i \geq N, 1 \geq J \geq N\}$ (1) (i, j) is the pixel value of the position (i, j) in carrier image, N=512, M=256
b) 2-DCT is implemented for compression, quantization and conversion of the Grayscale facial image to a binary picture. In the equation, x, is the facial picture ingesting N x M pixels, x (m, n) is the intensity of the pixel in column n and row m of the image, and y (j, okay) is the DCT coefficient in column k and row j of the two-DCT matrix.

$$y(j,k) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_j\alpha_k\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n) * \cos\frac{(2m+1)j\pi}{2M}\cos\frac{(2n+1)k\pi}{2N}\} \dots\dots\dots (2)$$

Where

$$\alpha_j = \begin{cases}\frac{1}{\sqrt{2}} & j = 0 \text{ or } j = 1,2,\dots\dots,N-1\\ 1\end{cases}$$

$$\alpha_k = \begin{cases}\frac{1}{\sqrt{2}} & k = 0 \text{ or } k = 1,2,\dots\dots,N-1\\ 1\end{cases}$$

c) Replace the original pixel values in the carrier image with those of the calculated N × N embedding coordinate positions (xn, yn); namely, (xn, yn) → $I'(xn, yn)|i$=1,2,...,N×N. Then, the original carrier image can be obtained, whose size is still $N×N$, and only the pixel values of a minority of points change slightly.
d) Apply 3-DWT on the I split into four groups:LLa1,LHa1,HLa1,HHa1.
e) Apply SVD on one level preceded by DWT on carrier images..
   $I_i = [U_i, S_i, V_i]$(3)
   Where U_i,V_i are orthogonal matrices of an image and S_i is singular matrix and i indicate a level of LLa1,LHa1,HLa1,HHa1
f) Perform SVD on the WI coefficient of the watermark image.
   $[U, S, V] = svd(WI)$(4)
g) Modify the SV of S_i by using embedding the singular value of watermark picture such that
   S_m=S_i+ alpha*S(5)
h) Where Sm is modified singular matrix of Siand alpha denotes the scaling thing, is used to have electricity over the power of watermark signal Embed singular matrices with orthogonal matrices for very last watermark photograph as W with beneath method:
   $Wm = U_i * S_m * V_i'$(6)
i) Perform the one level inverse DWT (IDWT) on the DWT transformed image, to obtain the watermarked image on four coefficients:wimg_LL,wimg_LH,wimg_HL,wimg_HH.

3) *Input:* Watermarked Image
4) *Output:* Attacked Image
a) Apply Gaussian blur (GB), Salt and Pepper Noise attack (SNP), Gaussian Noise (GA),histogram equalization (HE), Contrast Adjustment (CA), Median Filter (MF), Swirl Attack (SA) and Negative attack (NGA) on watermarked image for security and robustness.

B. Extraction Algorithm
1) *Input:* Attack Watermarked Image
2) *Output:* Extracted Watermark Image
a) The image is reconstructed by relating inverse of 2-DCT operation, according to Equation. 13:

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$$x(m,n) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\alpha_j\alpha_k\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{y(j,k) * \cos\frac{(2m+1)j\pi}{2M}\cos\frac{(2n+1)k\pi}{2N}\} \ldots\ldots\ldots\ldots (7)$$

b) Apply one 3 DWT transform to decompose the attack watermarked image W into four overlapping sub-bands (LLwm,LHwm,HLwm,HHwm).

c) Apply SVD on one level preceded by DWT on attack watermarked imag

$W_m = [U_m, S_m, V_m]$(8)

Where U_m,V_m are orthogonal matrices of an image and S_m is singular matrix and m indicate a level of LLwm,LHwm,HLwm,HHwm

d) Modify the singular value of S_i by extracting the singular value of watermarked image such that

$$S_j = \frac{(S_m - S_i)}{alpha} (9)$$

e) Extract singular matrices with orthogonal matrices for final extracted watermark picture as W with underneath formula:

$$W = U_m * S_j * V_m{}'(10)$$

f) Perform the one level inverse DWT (IDWT) on the DWT transformed image, to obtain the extracted watermark image on four coefficientsnewwatermark_LL, newwatermark_LH, newwatermark_HL, newwatermark_HH.

g) Calculate PSNR and MSE value of extracted watermark and cover image.

$$MSE(x) = \frac{1}{N}||x - x\hat{}||^2 = \frac{1}{N}\sum_{i=1}^{N}(x - x\hat{})^2 \qquad (11)$$

Where x is cover image, x^ is extracted watermark image, N is the size of thecover image

$$PSNR(x) = \frac{10\ Xlog((double(m).\hat{}2))}{MSE(x)}$$ (12)Where m is the maximum value of the cover image

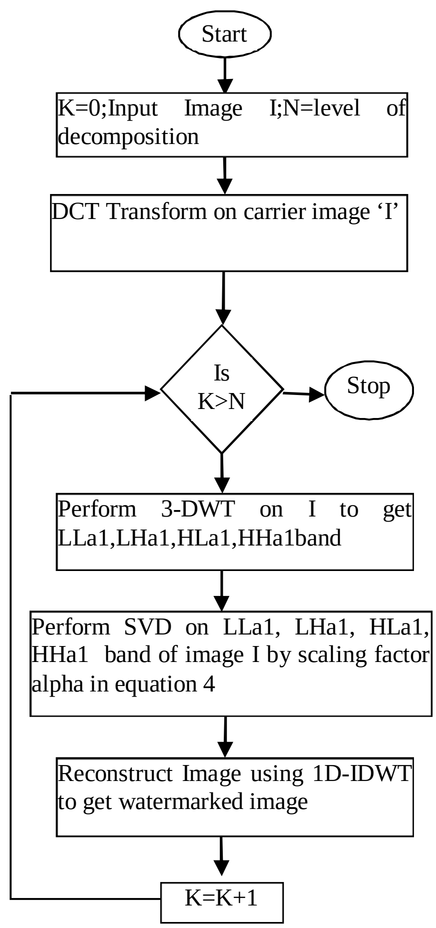

Fig1. Flow Chart of Embedding Algorithm

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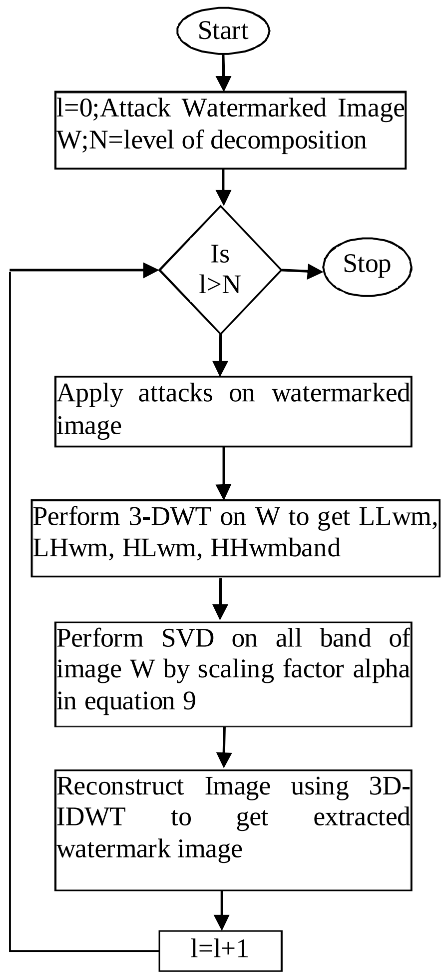

Fig2. Flow Chart of Extraction Algorithm

IV. RESULT SIMULATION

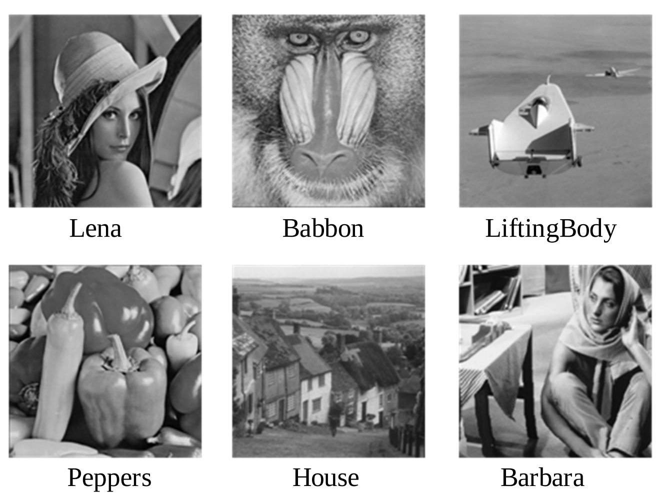

Fig.3. image dataset

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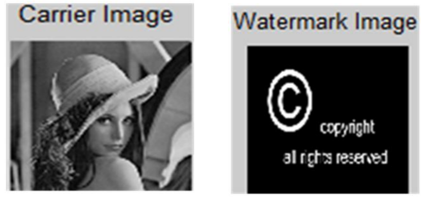
A. Read Cover Image and Watermark Image



(a) (b)

Fig4. (a) Show Carrier Image (b) Show Watermark Image

B. Embedded Image

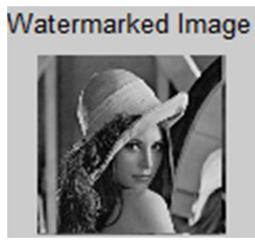
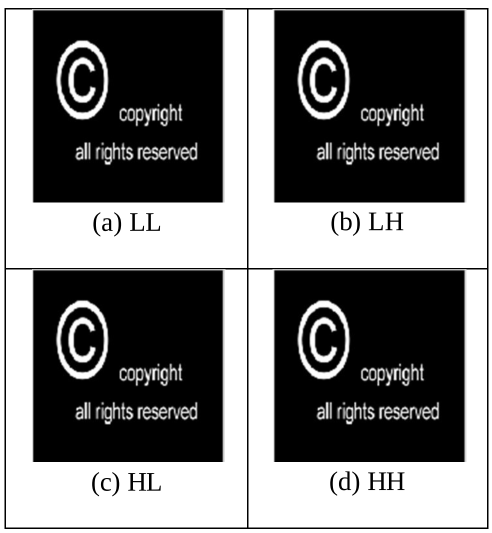


Fig5. Show Watermarked Image



(a) LL (b) LH (c) HL (d) HH

Fig6. (a-d)Extracted watermark images from 4 sub-bands

TABLE I. COMPARISION BASE PSNR VALUE FOR ALL ATTACKS ON FOUR BAND USING GRAY IMAGES

Attack Watermarked Image	Base System result on PSNR Values All Bands			
	LL	LH	HL	HH
Gaussian Blur	12.2746	12.0908	12.1032	12.0755
SNP Noise	12.3034	12.0933	12.1163	12.0773
Gaussian Noise	12.2989	12.1084	12.1297	12.0880
Equalization(HE)	12.1734	12.1265	12.1676	12.1209
Contrast	12.1736	12.1253	12.1690	12.1196
Median Filter	12.3136	12.1817	12.1338	12.1188
Swirl	12.3116	12.1167	12.1218	12.0918
Negative	12.2720	12.1056	12.1185	12.0864

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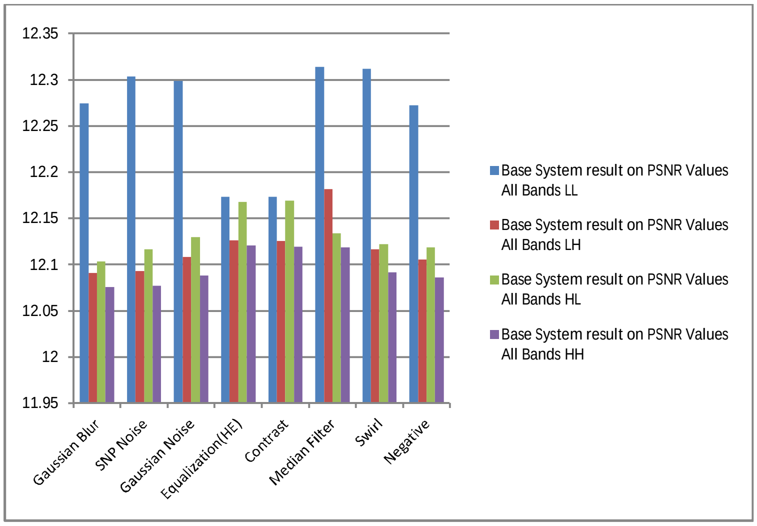

Fig. 7.graph.1. showing Comparision base psnr value for all attacks on four band using Gray images

TABLE II. COMPARISION PROPOSE PSNR VALUE FOR ALL ATTACKS ON FOUR BAND USING GRAY IMAGES

Attack Watermarked Image	Propose System result on PSNR Values All Bands			
	LL	LH	HL	HH
Gaussian Blur	14.5813	14.0766	14.1472	13.9159
SNP Noise	14.5940	13.8185	14.1912	13.9076
Gaussian Noise	14.59.38	13.8631	14.0636	13.9411
Equalization(HE)	14.5788	14.0958	14.1584	13.9246
Contrast	14.5765	14.0939	14.1577	13.9240
Median Filter	14.5954	13.8964	14.0375	13.8362
Swirl	14.5918	13.8690	14.0546	13.9446
Negative	14.5910	13.9411	14.0805	14.0661

Fig.8. graph.2. showing Comparision propose psnr value for all attacks on four band using Gray images

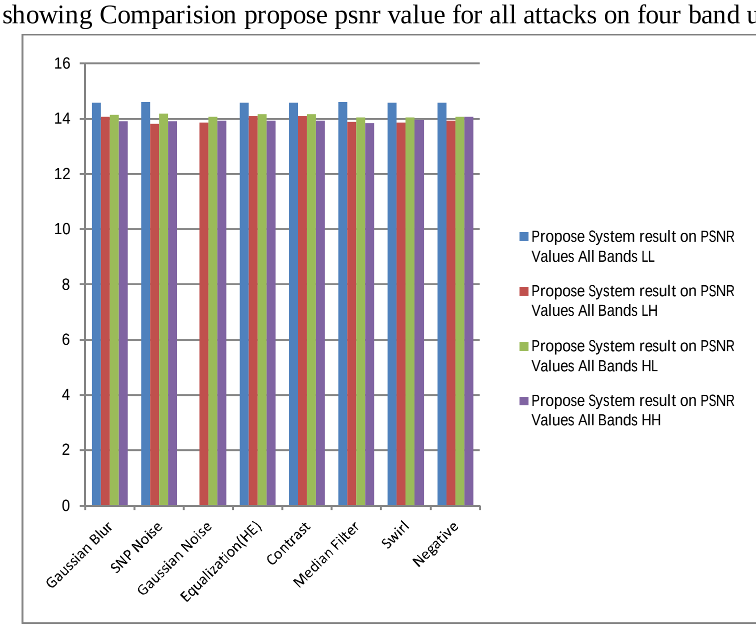

TABLE III. COMPARISION BASE MSE VALUE FOR ALL ATTACKS ON FOUR BAND USING GRAY IMAGE

Attack Watermarked Image	Base System result on MSE Values All Bands			
	LL	LH	HL	HH
Gaussian Blur	17.2326	17.6377	17.6080	17.6612
SNP Noise	17.1629	17.6274	17.5888	17.6612
Gaussian Noise	17.1696	17.6085	17.6014	17.6475
Equalization(HE)	17.4847	17.6310	17.5609	17.6361
Contrast	17.4825	17.6263	17.5603	17.6362
Median Filter	17.1388	17.5548	17.6240	17.6223
Swirl	17.1499	17.5863	17.5762	17.6290
Negative	17.2269	17.6234	17.5896	17.6488

Fig.9. graph.3. showing Comparision base mse value for all attacks on four band using Gray images

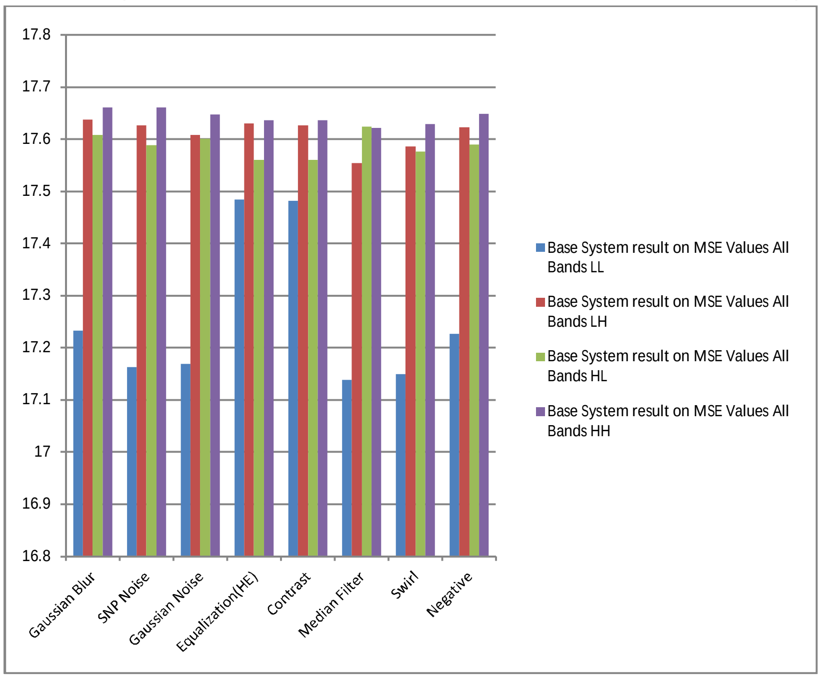

TABLE IV. COMPARISION PROPOSE MSE VALUE FOR ALL ATTACKS ON FOUR BAND USING GRAY IMAGE

Attack Watermarked Image	Propose System result on MSE Values All Bands			
	LL	LH	HL	HH
Gaussian Blur	15.6323	0.0910	0.0134	0.0249
SNP Noise	14.9050	0.0231	0.0143	0.0258
Gaussian Noise	14.9111	0.2934	0.2917	0.3739
Equalization(HE)	15.8821	0.0555	0.0108	0.0230
Contrast	15.8515	0.1040	0.0141	0.0246
Median Filter	15.0064	1.1138	1.1510	1.2039
Swirl	15.1335	0.2770	0.1651	0.3225
Negative	15.0470	0.3747	0.1615	0.3642

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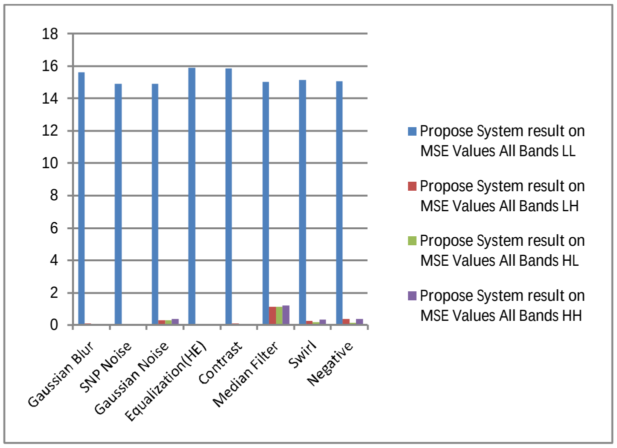
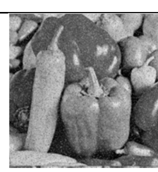
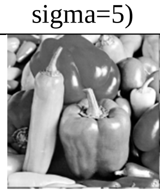
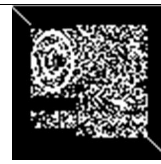
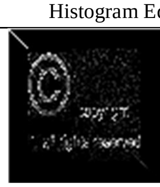
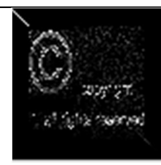
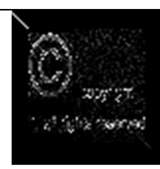
Fig.10. graph.4. showing Comparision propose mse psnr value for all attacks on four band using Gray images



Lena Attacked Watermarked Images on Various Attack			
 Gaussian Blur (hsize=3 & sigma=5)	 Salt & Pepper Noise (d=0.02)	 Gaussian Noise	 Histogram Equalization
 Contrast Adjustment	 Median Filter	 Swirl	 Negative

Pepper Attacked Watermarked Images on Various Attack			
 Gaussian Blur (hsize=3 & sigma=5)	 Salt & Pepper Noise (d=0.02)	 Gaussian Noise	 Histogram Equalization
 Contrast Adjustment	 Median Filter	 Swirl	 Negative

Extracted Watermark Images After Degradation of Proposed System			
Gaussian Blur			
 LL PSNR=14.5415	 LH PSNR=14.5418	 HL PSNR=14.5415	 HH PSNR=14.5414
Salt and Pepper Noise			
 LL PSNR=14.6505	 LH PSNR=14.6213	 HL PSNR=14.6146	 HH PSNR=14.5790
Gaussian Noise			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Histogram Equalization			
 LL PSNR=14.5413	 LH PSNR=14.5419	 HL PSNR=14.5419	 HH PSNR=14.5418
Contrast Adjustment			
 LL PSNR=14.5413	 LH PSNR=14.5419	 HL PSNR=14.5419	 HH PSNR=14.5418
Median Filter			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Swirl			

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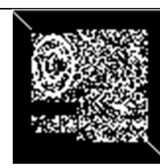
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Negative			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412

Extracted Watermark Images After Degradation of Base System			
Gaussian Blur			
 LL PSNR=14.5415	 LH PSNR=14.5418	 HL PSNR=14.5415	 HH PSNR=14.5414
Salt and Pepper Noise			
 LL PSNR=14.6505	 LH PSNR=14.6213	 HL PSNR=14.6146	 HH PSNR=14.5790
Gaussian Noise			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Histogram Equalization			
 LL PSNR=14.5413	 LH PSNR=14.5419	 HL PSNR=14.5419	 HH PSNR=14.5418
Contrast Adjustment			

 LL PSNR=14.5413	 LH PSNR=14.5419	 HL PSNR=14.5419	 HH PSNR=14.5418
Median Filter			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Swirl			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412
Negative			
 LL PSNR=14.5415	 LH PSNR=14.5414	 HL PSNR=14.5416	 HH PSNR=14.5412

V. CONCLUSION

This paper implemented DCT 3DWT-SVD scheme has proved a high degree of robustness against majority of attacks including noise, blurring, other kinds of image processing attacks which can be validated by recovering the watermark from any of the sub-band, which clearly indicates that transform domain is more robust than spatial domain. Generally, LL band is not modified as any kind of changes in it can be easily perceived by human eyes. But, in DCT-3DWT-SVD approach, we experienced no such problem.If we embed watermark in any of the sub-band, then it makes our image resistive to only few kinds of attacks. But, if we insert watermark into all sub-bands, then it would be very difficult to
remove it from all frequencies. Since we have inserted watermark in LH and HL sub-bands, so inserting watermark in these bands would make our image impervious to attacks like
histogram equalization, swirl effect, negative, and median filtering.

As a future work, the implemented algorithm can be improved using full band DCT-SVD and further can be extended to color images and video processing.

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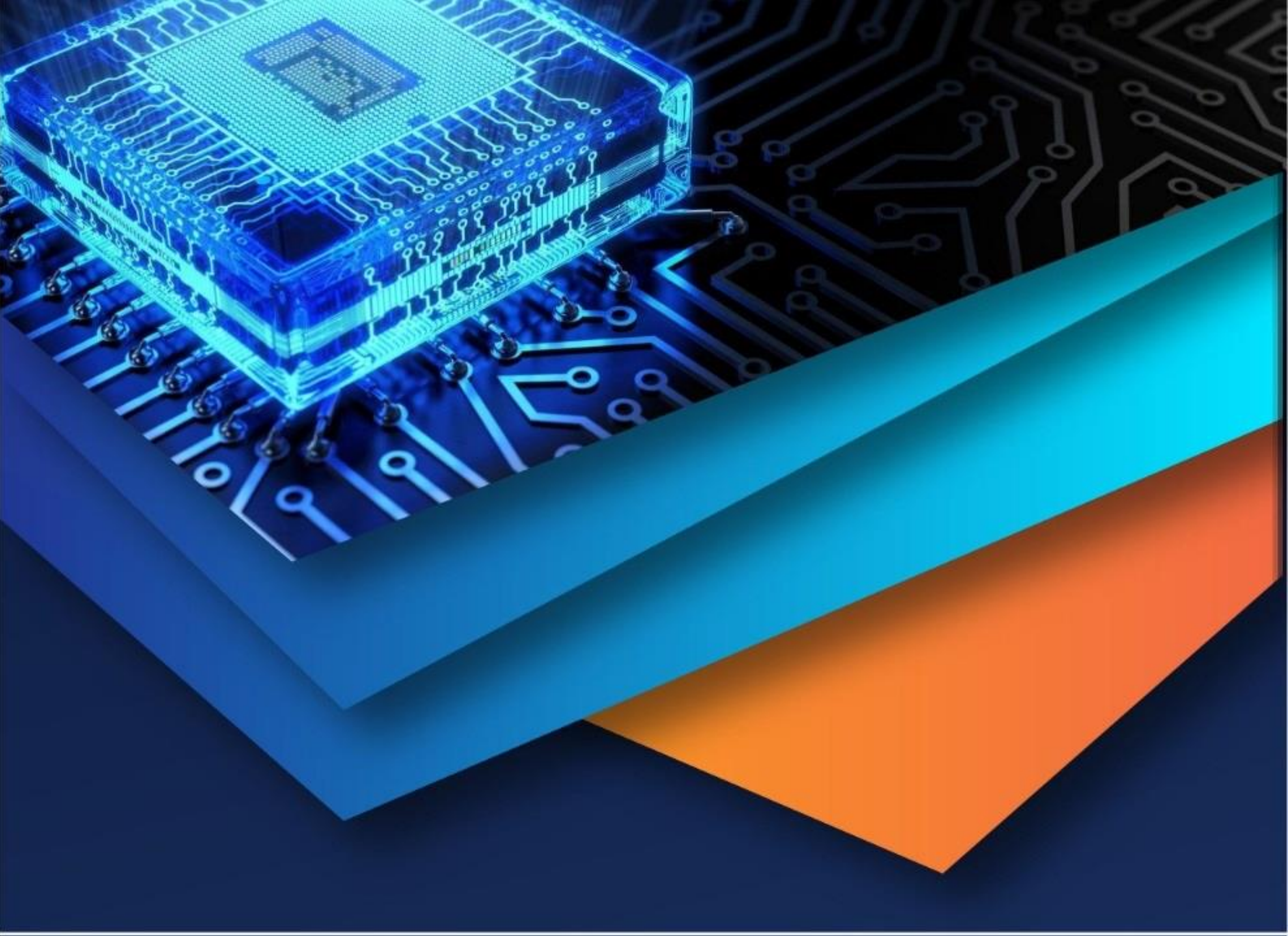

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