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Highly Robust and Imperceptible Digital Watermark Technique by Exploiting Various Noise Attacks

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Abstract:- Due to expeditious use of multimedia entities in the network, there is issue to protect images from piracy. So this is required for implementation of copyright on high priority that can preserve ownership for copyright protection and protected images can be claimed by actual owner only. Digital image watermarking is the technology invented for securing images from illicit utilize. There are many watermarking techniques in spatial as well as in frequency domain like Discrete Wavelet Transform and Discrete Cosine Transform. These techniques are widely known to be more usual, robust and imperceptible. In the paper, literature review work give out about analysis of different attacks like Gaussian Blur, Salt & Pepper, Gaussian Noise, Geometric and Joint attacks on images. Also these are implemented on DWT and DCT watermarked image using Python code and after attack the performances are measured by Peak Signal to Noise Ratio(PSNR) and Normalized Correlation(NC) for surveying about robustness of images before and after attack.

Keywords:- *Peak Signal to Noise Ratio, Discrete Wavelet Transform, Discrete Cosine Transform.*

I. INTRODUCTION

Copyright for multimedia objects has become important aspect to protect them from illegal access. The watermarking is good approach to protect digital media. There is need to protect data and watermarking is the best solution for this to maintain integrity of information. Also watermarking methods are more robust, perceptible against any type of attack like geometric, compression, collision and ambiguity attack[1-2]. There are two type of watermarking method: spatial and frequency-domain[3-5]. The technique in frequency domain is better than in spatial domain to achieve robustness. Frequency-domain watermarking technique is more effectual than spatial domain techniques [5] in order to get robustness and perceptibility of images [6]. Some common watermarking methods are as DWT, DCT, SVD and DFT. In the research work, the algorithm for image watermarking after combining two approached are considered. Watermark is embedded in the image and the effects of watermarking at various stages are determined by PSNR NC and SC. These values are examined for checking robustness of images after some attacks like combined attack, Gaussian Blur, Gaussian Noise Attack Salt & Pepper Attack [7-10].

II. PROPOSED METHOD - DCT AND DWT WATERMARKING TECHNIQUES WITH PYTHON

Discrete Cosine Transform and Discrete Wavelet Transform techniques are commonly taken for various approaches. Two transforms techniques are presented for implementation of watermarking [11-13] in next paragraph. Discrete Cosine Transforms is a method to convert actions into frequency sections[14]. Magnitudes and frequencies are shown for input image x. DCT is output image transformed coefficients. As per equation 1, y is calculated and x is taken as input image with N x M pixels. The pixel is given as x(m,n) where m is row and n is column for image. On the other hand y(u,v) is denoted by coefficient for DCT where u is row and v is considered as column in matrix form.

$$y(u,v) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\ \alpha u\ \alpha v \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} x(m,n) \quad \ldots..(1)$$

$$\cos\frac{(2m+1)u\prod}{2M}\ \cos\frac{(2n+1)v\prod}{2N}$$

$$\text{Where } \alpha u \begin{cases} \frac{1}{\sqrt{2}} & u = 0,\ u = 1,2 \ldots\ldots..N-1 \\ 1 & \end{cases}$$

$$\alpha v \begin{cases} \frac{1}{\sqrt{2}} & v = 0,\ v = 1,2 \ldots\ldots..N-1 \\ 1 & \end{cases}$$

By pertaining DCT method, image is rebuilt as in equation 2:

$$x(m,n) = \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\ \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} \alpha u\ \alpha v\ y(u,v) \quad \ldots (2)$$

$$\cos\frac{(2m+1)u\prod}{2M}\ \cos\frac{(2n+1)v\prod}{2N}$$

DCT transform components are applied to every block. The resultant shows low, mid and high frequency sub-bands. So watermarking with Discrete Cosine Transform is founded as signal energy which gives low-frequencies sub-band and it is main area of image. The compression and noise attack can damage frequency of image. So the watermark should be placed in middle frequency to avoid this. This maintains the visual impact of image[15-17].

A. The DWT transform

DWT is frequency domain technique to examine signal at various resolution. In DWT technique, images in 2D form are placed into four parts. In these four parts are taken in which one is for low frequency, left part for vertical details and top right part for horizontal image. There is high frequency for bottom right part of image. The transformation continues gradually and it is known as DWT decomposition as described in Figure. 2[18-20].

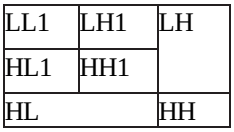


Fig. 1: Decomposition of DWT Technique

LL: This element comprise of low frequency details of host image.
LH: This element comprise of vertical details of host image.
HL: This element comprise of horizontal details of host image.
HH: This element comprise of high frequency details of host image.

DWT technique identifies the area in original image to put watermark effectively. In low frequency of sub-bands LLx, the quality of image may degrade. On the other sub bands of high frequency contains texture and edges of image and it alters in sub-bands[18-20]. Therefore DWT based watermarking algorithm is applied in LHx and HLx bands to insert watermark. The watermark can be embedded without recognizing through this [21].

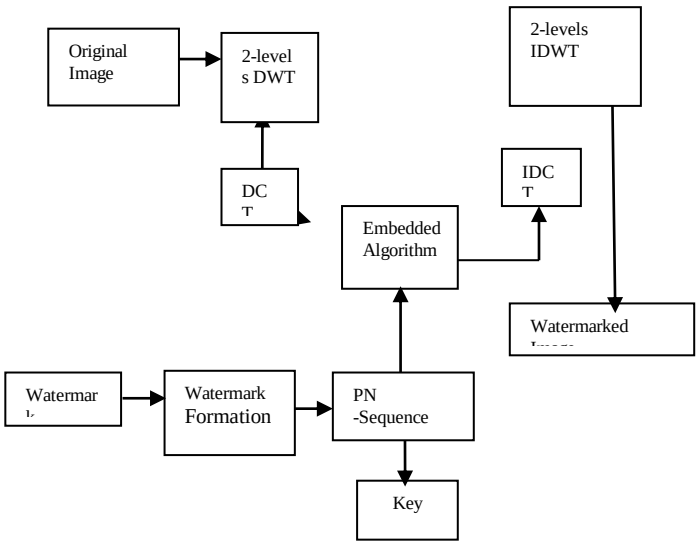
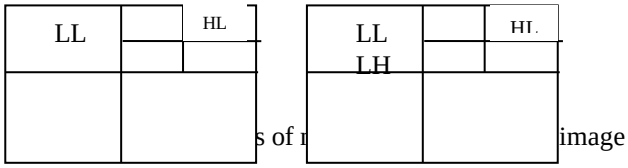


Fig. 2: Embedding of DWT-DCT watermarking Technique



s of r image

B. DCT-DWT Merged Algorithm

The embedding of watermark method is described in Figure 1[22].

- **Step 1:** DWT technique is used to break up the host image into four sub-bands and these sub bands and it consists of multiresolution of image such as LL1, LH1, HL1 and HH1.
- **Step 2:** DWT technique is implemented again in sub-bands HL1 to receive smaller sub-bands band as shown in Figure 2 a. This process is repeated continuously. Now again DWT technique is used to put sub-bands HH1 to find smaller sub-bands HH2.In Figure 2b, this technique is given shown.
- **Step 3 :** The sub-bands of image are divided into 4x4 parts such as HL2 or HH2.
- **Step 4 :** In each block, DCT technique is applied for more sub-bands such as HH2 or in HL2.
- **Step 5:** The watermark image is converted into zero and one vectors.
- **Step 6:** There is regeneration of pseudorandom sequence. For embedding watermark, a sequence of bit 0 and bit 1 are used. The number of components elements must be equal in pseudorandom series
- **Step 7:** Two pseudorandom sequences for bot 0 and 1 are embedded in 4x4 segments of DCT transform for original image.

Only in mid-band DCT coefficients, bits are embedded. This method is not applicable for all coefficients of DCT technique block[23-25]. If X is denoted as the matrix of coefficients mid-bands for transformed block then embedding is done as described below:

Watermark bit = 0, X '= X + a * PN_0 .... (3)

Otherwise,

Watermark bit = 1, X '= X + a * PN_1....(4)

- **Step 8:** After modifying mid band coefficient in every block, DCT and inverse DCT is applied to every segment for embedding watermark as given in earlier step.
- **Step 9:** To get watermarked image, inverse DWT technique is applied.

C. Extraction of Watermark

The watermark extraction technique shows that original image is not essential to recover watermark[26-28]. The steps are as follows:

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- Step 1: DWT technique is applied to decay watermarked image into four sub- bands such as LL1, LH1,HL1 and HH1.
- Step 2: The Discrete Cosine Transform technique is applied into HL1 cell and four sub-bands are found. Now HL2 cell and then DWT method is applied to HH1 sub-band and it gives the sub-band of HH2. This is indicated in Figure 2b.
- Step 3: The sub-band of HH2 or HL2 are parted into 4x4 parts.
- Step 4: Method of Discrete Cosine Transform is applied for sub-bands of every block such as HH2 or HL2. Sub-bands (HL2 or HH2), mid-band coefficients are recovered from each DCT mutated block and then apply DCT technique.
- Step 5: Two bits 0 and 1 of pseudorandom progression are revived in embedding of watermark.
- Step 6: In the sub-band HL2 (or HH2), each block is calculated for correlation between coefficients of middle band and other two are created for pseudorandom sequences. If correlation value for bit 0 was higher than correlation value with bit 1 then recovered watermark bit is zero otherwise it is examined as 1.

Fig. 4: Original image, Figure 5. Watermark Image

- **Step 7:** By extraction algorithm, watermark is recovered and similarity is checked between original and watermarked image.

Fig. 6: Original Image, Watermark Image, Watermarked Image Extracted watermark

III. PERFORMANCE ANALYSIS

The effect of merged DWT-DCT watermarking technique is deliberated as 512x512 original image and a 256x256 grey-scale of watermark image[29-32] as shown in Figures 5 and 6. The robustness of watermarked images are examined by MSE and PSNR values between host and watermarked image.

PSNR: Robustness of watermarked image is known by calculating PSNR values as shown in equation 5. The quality of original image should not be disfigured then it is known as imperceptibility.

$$PSNR=10.\log 10^{\left(\frac{MAX^2 1}{MSE}\right)} \quad ...(5)$$

The perceptibility of joint DWT and DCT technique is measured by calculating PSNR for HL2 and LL1 sub-bands. The value of PSNR for LH2 is 27.9156 while it is 27.8027 for HH2. There is not major difference in PSNR values. On the other hand table 1 shows difference in PSNR values between combined DWT-DCT and DWT only. It concludes that there is not more requirement of improvement in imperceptibility [28-30].

A. Normalized Correlation (NC)

Normalized cross correlation (NCC) formula is used for calculating degree of similarity or dissimilarity of two images. Normalized cross is less sensitive in the amplitude of illumination in the two compared images. Hence Normalized Cross Correlation lies in the range between –1 and 1.

B. Standard Correlation (SC)

The Standard Correlation is examined for resistance of images. The values of Standard Correlation range between -1.0 and 1.0. The value greater than 1.0 or less than -1.0 indicated error in the correlation measurement.

IV. RESULTS

Five images are used named lena, baboon, pepper, boat and barb of size 2048x2048 and watermark image of size 128x128 as in Figure 9 for testing the technique[31-33]. The watermark image of size 128x128 is embedded into original image as in Figure 4. In Figure 6, the results for before and after watermarking of host images are shown.

Test Images:

Fig. 7: Original and Extracted Watermark Images

Fig. 8: Original Extracted Watermark Image Watermark Image

V. REVIEW OF TECHNIQUE USED

Robustness of proposed method is examined by PSNR values between original and watermarked image as in table 1. The scatter chart for different PSNR values is also shown in Figure 8. NC and SC are also calculated to know the visibility of host and recovered watermark images in table 2.

We have taken five test images lena, baboon, pepper, boat and airplane for this testing in table 1[34-37].

Name of Images	Original Image	PSNR
lena.png		31.2951

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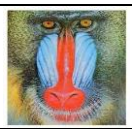
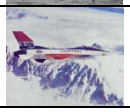
baboon.jpg		31.6195
pepper.png		31.2750
boat.png		31.3337
airplane.png		31.3019

Table 1: PSNR Values for Host and Watermarked Images

Graph is plotted in Figure 10 for multiple test images of compared PSNR Values of host and watermarked images before attack:

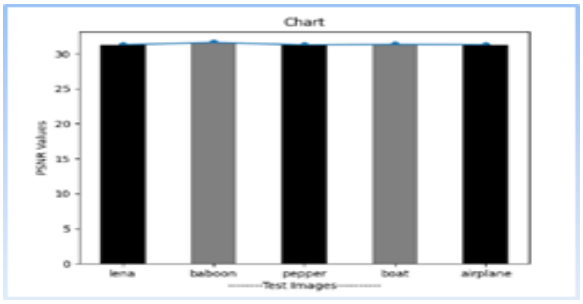


Fig. 9: Chart of PSNR Values before attack

Name of Images	NC	SC
lena.png	0.9999	116
baboon.jpg	0.9999	116
pepper.png	0.9999	116
boat.png	0.9999	116
airplane.png	0.9999	116

Table 2: Values of NC and SC for host and extracted watermark images

A. Attacks

The noise density of 0.009 is added into the watermarked images in Salt & Pepper noise[38-42], radius 1 is added in Gaussian blur Noise, Gaussian Noise of length=2 and theta=4, Sharpening with parameter 0.5 and Combined attacks[37-40]. PSNR values are described in table 3 after applying attack on host and watermarked images.

Name of Attack	PSNR(dB)				
	lena	baboon	pepper	boat	airplane
Salt & Pepper	31.2493	31.2420	31.2557	31.2847	31.2476
Gaussian Blur	31.3259	30.9739	31.3016	31.3646	31.3295
Gaussian Noise	30.9201	30.6228	30.5728	30.6499	30.3053
Sharpening	29.0249	28.4328	30.5728	20.0457	28.9401
Combined Attack(Gaussian Noise, Poisson Noise, Salt & Pepper and Speckle Noise)	27.9049	27.9075	27.9166	27.8722	27.6580

Table 3: PSNR values of original and watermarked images after attacks

The graph for multiple images is plotted for PSNR Values of host and watermarked images after applying Salt & Pepper Attack as shown in chart 9.

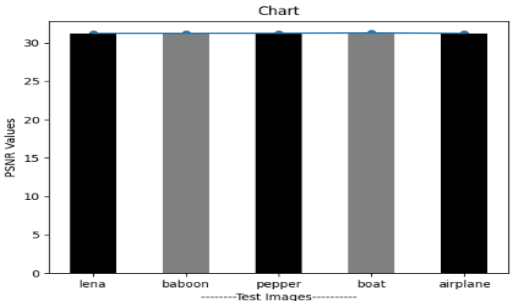


Fig. 10: Chart showing PSNR Values after attack

Different values of PSNR for host and watermarked images after Gaussian Blur Attack are shown in Figure 10.

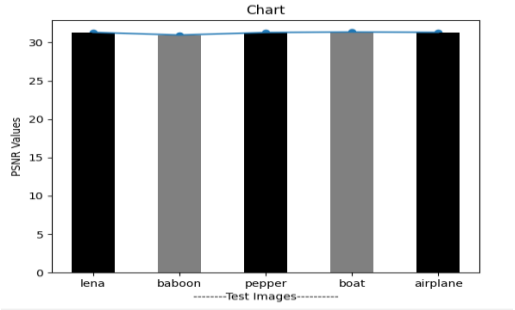


Fig. 11: Chart showing PSNR Values after attack

The values of PSNR for host and watermarked image after Gaussian Noise Attack are shown in Figure 11.

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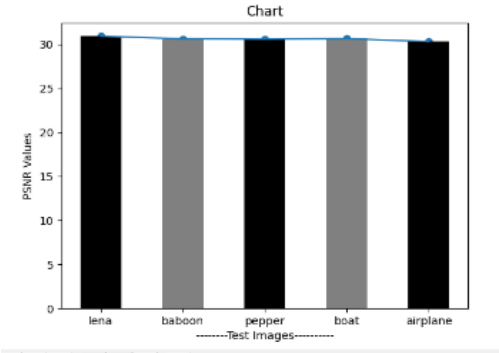

Fig. 12: PSNR Values after Gaussian Noise Attack

PSNR values of host and watermarked image after Sharpening Attack are shown in Figure 12.

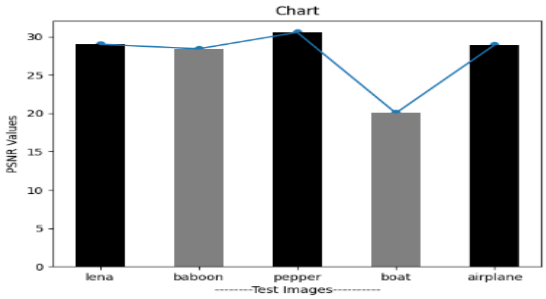

Fig. 13: PSNR Values after Sharpening Attack

The graph for PSNR values of multiple images after **Combined Attack** is plotted for original and watermarked images.

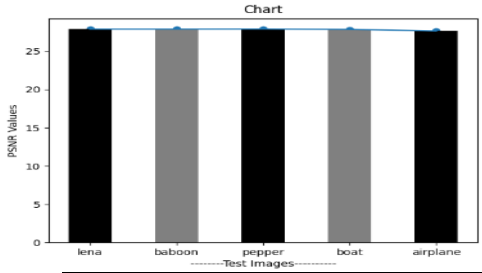

Fig. 13: PSNR Values after Combined Attack

The values of Standard and Normalized Correlation are also calculated to know the visibility of host and extracted watermark images as in table 4 and 5.

Name of Attack	SC				
	lena	baboon	pepper	boat	airplane
Salt & Pepper	46.6459	35.4754	52.4291	45.8058	44.3613
Gaussian Blur	47.0348	35.7924	52.8919	46.1911	44.7682
Gaussian Noise	44.1068	33.2103	49.1692	42.3234	41.7884
Sharpening	38.3862	29.1680	43.4523	38.1133	38.1225
Combined Attack(Gaussian Noise, Salt & Pepper, Poisson Noise and Speckle Noise Attack)	35.0815	26.2749	41.0744	37.1481	26.6959

Table 4: Normalized Correlation between host and extracted watermark images after various attacks

Name of Attack	NC				
	lena	baboon	pepper	boat	airplane
Salt & Pepper	0.0279	-0.0106	0.0331	0.0351	0.0240
Gaussian Blur	0.0281	-0.0105	0.0333	0.0349	0.0240
Gaussian Noise	0.0280	-0.0104	0.0332	0.0349	0.0240
Sharpening	0.0471	-0.0195	0.0637	0.0200	-0.2300
Combined Attack(Gaussian	0.0237	-0.0241	0.0287	0.0331	0.0258

Noise, Salt & Pepper, Poisson Noise and Speckle Noise Attack)					

Table 5: SC between original and extracted watermark images after attacks

VI. CONCLUSION

It is concluded that after applying attacks such as Gaussian Blur, Salt & Pepper, Gaussian Noise, Sharpening and Combined on 8 bit test images, the values of PSNR values between host and watermarked image on 8 bit test images comes between 30 to 50 Decibels (dB). The resistance of watermark is examined through robustness against attacks. So after attack the resultant deals with robustness. So these values indicate the characteristics of watermarked image and it is not much devalued by any of above attacks. Considering above results, it is concluded that proposed algorithm is almost robust for various tested multiple attacks. On the other hand, Normalized Correlation (NC) and Standard Coefficient (SC) from table values are degraded after the above attacks on images. It shows that the degree of similarities differs between the images after attack. Hence there is mild loss of information in images after attacks and the visual quality of images will be decreased.

VII. FUTURE SCOPE

The suggested algorithm of watermarking can be enhanced for luminosity of extracted watermark after applying attack. Also the proposed scheme can also be carrying through for videos.

REFERENCES

[1.] Aditya Awaghate, Rajesh Thakare and Sandeep Kakde, "A Brief Review on: Implementation of Digital Watermarking for Color Image using DWT Method" in International Conference on Communication and Signal Processing, 2019

[2.] Rita Choudhary and Girish Parmar, "A robust image watermarking technique using 2-level discrete wavelet transform (DWT)" in IEEE 2nd International Conference on Communication, Control and Intelligent Systems, 2016.

[3.] K. Chaitanya, E. Sreenivasa Reddy and K. Gangadhara Rao, "Digital Color Image Watermarking using DWTDCT Coefficients in RGB Planes" in Global Journals Inc. (USA), Volume 13, 2013

[4.] Nikita Kashyap, G. R. Sinha, "Image Watermarking Using 3-Level Discrete Wavelet Transform (DWT)",I.J.Modern Education and Computer Science, 2012.

[5.] Nirupma Tiwari, Manoj Kumar Ramaiya and Monika Sharma, "Digital Watermarking using DWT and DES" in IEEE International Advance Computing Conference (IACC), 2012

[6.] Umaamaheshvari and K.Thanushkodi, "High Performance and Effective Watermarking Scheme for Medical Images", European Journal of Scientific Research, Vol.67, 2012.

[7.] Yogesh Kumar, Pramod Vishwakarma and Rajiv Kumar Nath, "Semi-Blind Color Image Watermarking on High Frequency Band Using DWT-SVD" in International Journal of Engineering Research and Development (IJERD), Volume 4, 2012.

[8.] Prof. Manoj Ramaiya and Richa Mishra, "Digital Security using Watermarking Techniques via Discrete Wavelet Transform" in National Conference on Security Issues in Network Technologies (NCSI-2012), 2012.

[9.] Yashovardhan Kelkar, Heena Shaikh and Mohd.Imran Khan, "Analysis of Robustness of Digital Watermarking Techniques under Various Attacks" in International Journal of Engineering Research and Development (IJERD) Volume 2, 2012.

[10.] P Singh, Satish Kumar, G R Mishra, Charu Pande and Vartika Singh and "Study of Watermarking Techniques Used in Digital Image" in International Journal of Scientific and Research Publications (IJSRP), Volume 2, 2012.

[11.] Navnidhi Chaturvedi and S.J.Basha,"Analysis of Image Watermarking by DWT and Performance Under Attacks" International Journal of Computer Technology and Electronics Engineering (IJCTEE) , ISSN 2249-6343, Volume 2, 2012.

[12.] Manik Mondal and Debalina Barik, "Spatial domain robust watermarking scheme for color image," International Journal of Advanced Computer Science.2012

[13.] Abhimanyu Singh Garhwal, "Non blind Discreet Wavelet Transformation based Digital Watermark Embedding and Extraction Algorithm", Master Thesis, Dept. of Comp. Science and Information Technology, Rajasthan Technical University, Kota,Rajasthan, India, 2012.

[14.] Baisa L. Gunjal and Suresh N. Mali, "Strongly robust and highly secured DWT- SVD based color Image Watermarking: Embedding data in all Y, U, V color spaces" in I.J. Information Technology and Computer Science, 2012

[15.] Cheng-qun Yin, Li Li, An-qiangLv and Li Qu, "Color image Watermarking algorithm based on DWT-SVD," Proceedings of the IEEE International Conference on Automation and Logistics, 2012.

[16.] Dharwadkar N.V, Amberker and B. B, Gorai "Non-blind watermarking scheme for Color images in RGB Space using DWT- SVD," International Conference on Communications and Signal Processing, 2012

[17.] R. Eswaraiah and E. Sreenivasa Reddy, "Robust Watermarking Method for Color Images Using DCT Coefficients of Watermark", Global Journals Inc, 2012.

[18.] YjunGuouping Hu, Zhijian Wang, Hui Liu, Guang "A geometric distortion resilient image watermark algorithm based on DWT-DFT", Journal of Software, vol. 6, 2011.

ISSN No:-2456-2165

[19.] Santhi. V and Arunkumar Thangavel "DC coefficients based watermarking technique for Color Images Using Singular Value Decomposition" in International Journal of Computer and Electrical Engineering, 2011
[20.] Rohith. S and Dr. K. N. Haribhat, "A Simple Robust Digital Image Watermarking against Salt and Pepper Noise using Repeition Codes", ACEEE 2011.
[21.] Baise L. Gunjal and Suresh N. Mali, "Secured Color Image Watermarking Technique In DWT-DCT Domain" in International Journal of Computer Science, Engineering and Information Technology, 2011.
[22.] Maha sweta J. Joshi, Prof. Zankhana, H. Shah and KeyurN. Brahmbhatt, "Watermarking in DCT-DWT Domain" in International Journal of Computer Science and Information Technology, 2011.
[23.] Nagaraj V. Dharwadkar and B. B. Amberker, "Watermarking Scheme for Color Images using Wavelet Transform based Texture Properties and Secret Sharing", International Journal of Information and Communication Engineering 2010.
[24.] Mehemed Bashir Aliwa, Tarek El-Ahmady El-Tobely and Mahmood M. Fahmy, "Fidelity and Robust Digital Watermarking Adaptively Pixel based on Medial Pyramid of Embedding Error Gray Scale Images" in International Journal of Computer Science and Network Security, VOL.10, 2010.
[25.] Darshana Mistry, "Comparison of Digital Water Marking methods" in International Journal on Computer Science and Engineering(IJCSE),Vol. 02, 2010.
[26.] Jiang Xuehua, "Digital Watermarking and Its Application in Image Copyright Protection", in IEEE International Conference on Intelligent Computation Technology and Automation, 2010
[27.] M. Devapriya and Dr. K. Ramar, "Statistical Image Watermarking in DWT with Capacity Improvement" in Global Journal of Computer Science and Technology, Vol. 10, 2010.
[28.] Dilip Kumar Sharma, Vinay Kumar Pathak and G.P. Sahu, "Digital Watermarking for Secure E-Government Framework", Towards Next Generation E-Government, 2010
[29.] Yanqun Zhang, "Digital Watermarking Technology: A Review," in ETP International Conference on Future Computer and Communication, 2009.
[30.] Mitra Abbasfard "Digital Image Watermarking Robustness: A Comparative Study," Dept. of Electrical Engineering, Delft University of Technology, Delft, Netherland, 2009.
[31.] Sarvesh Kumar Yadav ,Mrs. Shital Gupta and Vineet Richariya, "Digital Image Watermarking Using DWT and SLR Technique Against Geometric Attacks", International Journal of Computer Technology and Electronics Engineering (IJCTEE), Volume 2, 2009
[32.] Xiao Jun Kang and Li Jun Dong, "Study of the Robustness of Watermarking based on Image Segmentation and DFT" in IEEE International Conference on Information Engineering and Computer Science, 2009.
[33.] Lama Rajab, Tahani, AI-Khatib and, Ali AL-Haj, "Video Watermarking Algorithms Using the SVD Transform", European Journal of Scientific Research, 2009.
[34.] Bo Chen and Hong Shen, "A New Robust-Fragile Double Image Watermarking Algorithm", Third IEEE International. Conference on Multimedia and Ubiquitous Engineering, 2009.
[35.] Mei Jiansheng, Li Sukang and Tan Xiaomei, "A Digital Watermarking Algorithm Based On DCT and DWT", 2009.
[36.] Yhya. R. Kuraz, Modar A.H., "Improve Watermark Security Via Wavelet Transfrom And Cdma Techniques" Al-Rafidain Engineering Vol.16, 2008.
[37.] Chien Chang Chen and De-Sheng Kao, "DCT Based Reversible Image Watermarking Approach" Third IEEE International Conference on Intelligent Information Hiding and Multimedia Signal Processing, 2007.
[38.] Yusnita Yusof and Othman O. Khalifa, "Digital Watermarking For Digital Images Using Wavelet Transform" IEEE Explore, International Conference on Communications, 2007
[39.] Tsai M and H. Hung, "DCT and DWT based Image Watermarking Using Sub sampling" in IEEE Fourth International Conference on Machine Learning and Cybernetics, 2005.
[40.] Potdar V, S. Han and E. Chang, "A survey of Digital Image Watermarking Techniques" in Proc. of the IEEE International Conference on Industrial Informatics, Australia, 2005.
[41.] Kunder and D. Hatzinakos, "Digital watermarking using Multi Resolution Wavelet Decomposition", in Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing'98, volume 5, 2005.
[42.] Chu W, "DCT-Based Image Watermarking Using Sub-sampling", IEEE Transaction on Multimedia, 2003.