Hybrid Method For Image Watermarking Using 2 Level LWT-Walsh Transform-SVD in YCbCr Color Space

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Abstract: Due to tremendous development in technology in recent time and availability of abundant tool, it is very easy for an unauthorized person to imitate crucial information which is present on internet. Therefore to shield valuable information present on internet there are various advanced techniques for example watermarking technique, cryptography technique, steganography and many more. With pace of time analog techniques replaced by digital techniques due to various advantages and in current scenario every country moving towards digitalization. Digital watermarking is a technique through which digital information is embedded into an image and secret digital data can be extracted at receiver side with authentication otherwise impossible to fetch. Spatial domain and frequency are the two techniques through which secret digital information can be embedded. In this paper two level lifting wavelet transform (LWT), Walsh Hadamard transform and singular value decomposition (SVD) technique has been proposed in YCbCr color space. First of all cover image and watermark image converted into YCbCr color space from RGB color space after that one of channel is selected for embedded purpose. Now perform first level LWT on the Y channel of cover and watermark image so that image split into four groups. Now apply second level LWT on any one of four bands. Further Walsh hadamard transform technique applied with singular value decomposition (SVD) technique to get enhanced output. In base paper DWT-DFT-SVD used but in this paper DWT-DFT replaced by LWT-WHT due to various advantages. One disadvantage of DWT is that the use of larger DWT basis functions or wavelet filters produces blurring and also ringing noise near edges in images. This disadvantage of DWT is overcome in LWT. Other advantages of LWT are that it significantly reduces the computation time and speed up the computation process. This method provides better results in terms of enhanced PSNR values and is able to withstand a variety of image processing attacks and besides this processing time also reduced.

Keywords- *DWT, SVD, LWT, Hadmard Code, Watermarking, PSNR*

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I. INTRODUCTION

Due to huge research in recent time various latest and advanced technologies came into existence. One should keep in mind if technologies not used in right direction then definitely have adverse effect on entire world. In these days there is huge demand of internet and it is growing exponentially day by day. Now a day's popularity of internet brings its own set of disadvantages in the form of piracy, theft, ownership issues [1]. To ensure security various techniques came into existence which can help to protect our confidential data available on internet for example these techniques include steganography, watermarking and encryption and many more.

In recent time watermarking technique is tremendously used. There are different types of watermarking like transform domain and spatial domain watermarking. Digital image is made up of pixels and in spatial domain watermarking technique directly used on image pixels [2]. On the other hand in transform domain watermarking technique, coefficients are changed and it can be achieved using different methods for example discrete cosine transform [6] which is robust to JPEG compression but susceptible to geometric distortions. DCT basically used for image compression. Discrete Fourier transform method used in [7], [8] is rotation invariant and translation resistant and due to these it gives better resistance in case of geometric attacks. LWT disintegrate an image into different four wavelets or sub band LL, LH, HL and HH. These sub bands actually represent authenticity of original image. LL sub band provide the entire information of image into low frequency domain and HH, HL and LH gives diagonal, vertical and horizontal features of image. Besides this here L stand for low pass filter and H stand for high pass filter and as per requirement of our application suitable sub–band is selected and after that watermark is embedded [9], [10]. Singular value decomposition is a matrix method to get smaller set of values which consists optimized signal content [13], [5]. Singular values of the watermark which are achieved after SVD are embedded with singular values which obtained from SVD transformed host to give least truncation error. This also enhances robustness of the watermarked image as it is withstand to various attacks. There are various techniques used for watermarking for example discrete wavelet transform singular valued decomposition based watermarking technique used in [13] and this concept further extended to YUV color space [7]. DWT–DCT–SVD based watermarking technique is used in [6]. Besides this a combination of DWT–DFT–SVD is used in Ref. [3] which merges benefits of DFT, DWT and SVD methods.

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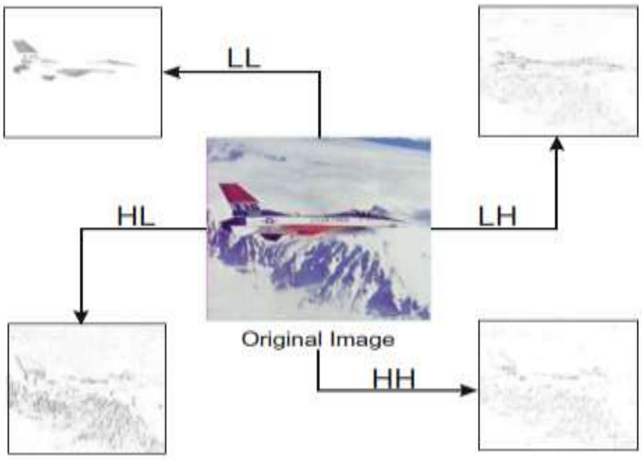

Figure 1 Decomposition of the image into four components [2]

II. FUNDAMENTAL CONCEPT

A. *Problem Defination*

First of all very first task of research is to find out problem and to fetch need to study various research papers deeply and analyzing the result. After gone through so many research papers, main problem came into existence is the low value of PSNR (peak signal to noise ratio). If PSNR value will be high then it represents high quality of the watermarked image and vice versa. On the other hand if there is high value of correlation which signify the immunity of the watermarked image to different types of attacks. Therefore to achieve objectives, a propose technique which will be illustrated below:

1. Usage of YCbCr color space instead of RGB color space due to its high decorrelation value as compared to RGB color space which ensures better correlation.
2. Combination of two level LWT, WHT, SVD is used to watermark an image which actually combines the advantages of all the transforms.

B. *YCbCr Color Space*

YCbCr color space actually represents brightness and signal color difference on the other hand RGB depicts color as red, green and blue components. In YCbCr, Y represents luminance, Cb is actually B-Y means difference of blue component and luminance component and in the same way Cr is the difference of red component and luminance component (R − Y). YCbCr given by following equation

$$Y = (0.257 \times R) + (0.504 \times G) + (0.098 \times B) + 16$$
$$Cb = (0.439 \times R) - (0.368 \times G) - (0.071 \times B) + 128$$
$$Cr = (0.148 \times R) - (0.291 \times G) + (0.439 \times B) + 128$$

C. *Singular Value Decomposition*

Singular value decomposition is factorization three matrices and these matrices can be complex or real. Consider an m×n matrix M which could be complex or real and its Singular value decomposition represented as follows,

$$M = USV^T$$

Here U is an unitary matrix of order m×m which could be complex or real, S is a rectangular diagonal matrix of order an m×n with non–negative real numbers on the diagonal, V is an also unitary matrix of order n×n which could be complex or real. The diagonal entries of S are the singular values of M in the decreasing order. Main advantage of SVD is that very few values of host image changed that's why little disturbance occurred in an image and these small alteration in singular values can be avoidable.

III. METHODOLOGY

A. *Lifting Wavelet Transform*

With pace of time so many techniques came into existence for watermarking. Wavelet transform is a time domain localized analysis method. Wavelet transform disintegrate the image into four various spatial domains. Discrete wavelet transform basically used to compress an image. Actually it is better technology than discrete cosine transform.

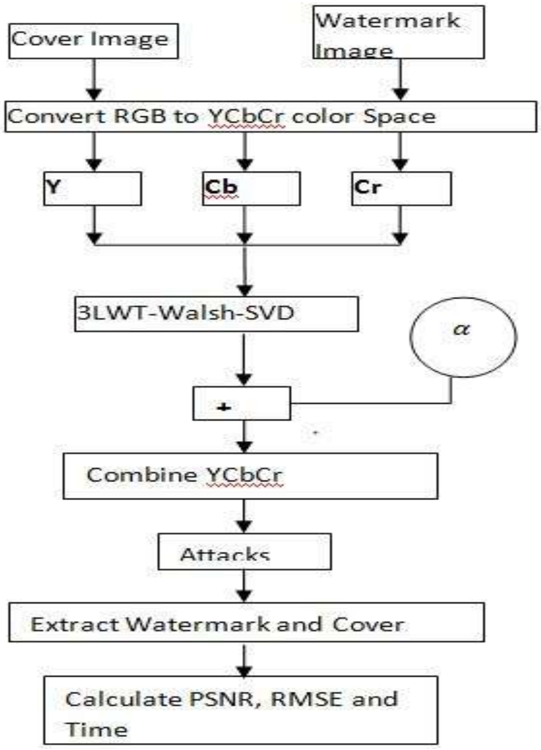

Figure 2 Block Diagram of Proposed Architecture

These sub band are known as HH, HL, LL and LH. Out of these one sub band is low frequency band and rest of three are high frequency band. Figure 1 depicts the one level discrete wavelet transform decomposition process. Lifting wavelet transform can be also applied in same manner as DWT and this is known as first level transform. In second levele transform out of these four sub band, again one sub band is selected as per requirement of application and then again LWTapplied and further four sub band produce that why it is known as second level LWT. One disadvantage of DWT is that the use of larger DWT basis functions. Besides this wavelet filters generate ringing and blurring noise near edges in images. DWT disadvantage overcome by lifting wavelet transform technique. Besides this comutational time of LWT is fatser than DWT. Therefore LWT significantly reduces the computation time and speed up the computation process.

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B. *Walsh Hadmard ransform*

Fourier transforms is basically used to convert time domain into frequency domain and Hadamard transform is an example of this class. Hadamard matrix is tremendous to calculate various complicated problem into simple way. It executes an orthogonal, symmetric, linear operation on 2^m complex numbers or real number but it is known that Hadamard matrix is purely real. The Hadamard transform can be regarded as being built out of size-2 discrete Fourier transforms (DFTs). It disintegrates an input vector into a superposition of Walsh functions. Hadamard transform matrix is a square matrix and which having only two element -1 and 1 besides this it is orthogonal matrix. This transform is also known as WHT (Walsh Hadamard transform). $H1$ is the smallest Hadamard matrix, and it is defined as [15]

$$H_1 = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

Higher size of matrix can be calculated by simply using this elementary matrix.

$$H_2 = H_1 \times H_1 = \frac{1}{(\sqrt{2})^2}\begin{bmatrix} H_1 & H_1 \\ H_1 & -H_1 \end{bmatrix}$$

In general any higher order matrix is computed by generalized formula

$$H_n = H_{n-1} \times H_1 = \frac{1}{[\sqrt{2}]^n}\begin{bmatrix} H_{n-1} & H_{n-1} \\ H_{n-1} & -H_{n-1} \end{bmatrix}$$

IV. EXPERIMENTAL RESULT

SOFTWARE: MATLAB R2015A: It is powerful software that provides an environment for numerical computation as well as graphical display of outputs. In Matlab the data input is in the ASCII format as well as binary format. It is high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.

Figure 3 Experimental Dataset

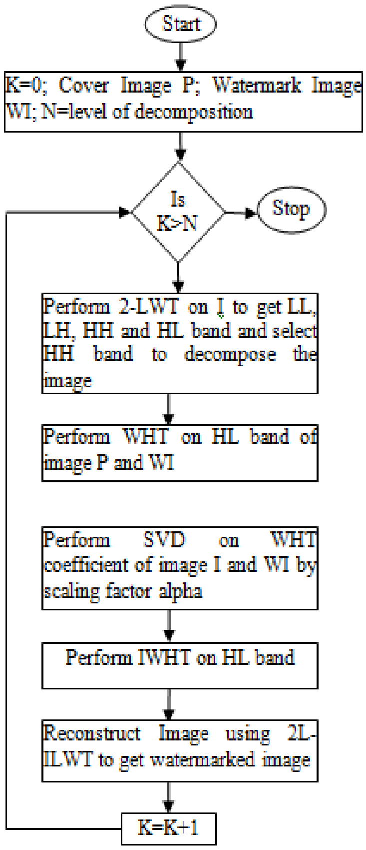

Figure 4 Flow Chart of Embedding System

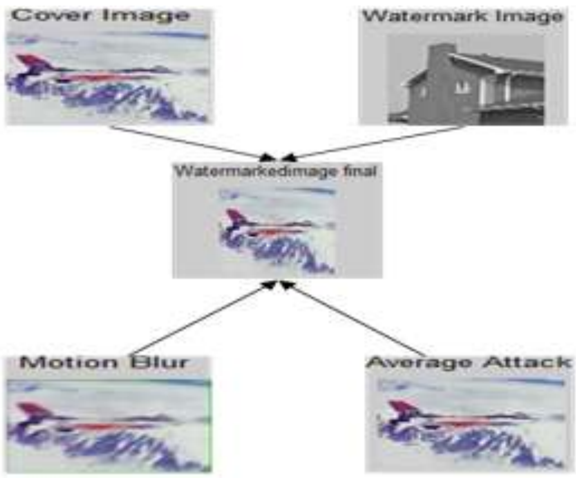

Figure 5 Complete output overview of Algorithm

Figure 6 Extracted cover and watermark image

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PSNR and RMSE value of watermarked and cover image calculated by given equations

$$RMSE(x) = \sqrt{\frac{1}{N}||x - x^{\wedge}||^2 = \frac{1}{N}\sum_{i=1}^{N}(x - x^{\wedge})^2}$$

Where x is cover image, x^ is watermarked image, N is the size of the cover image

$$PSNR(x) = \frac{10\ X\log((255))}{RMSE(x)}$$

Where m is the maximum value of the cover image

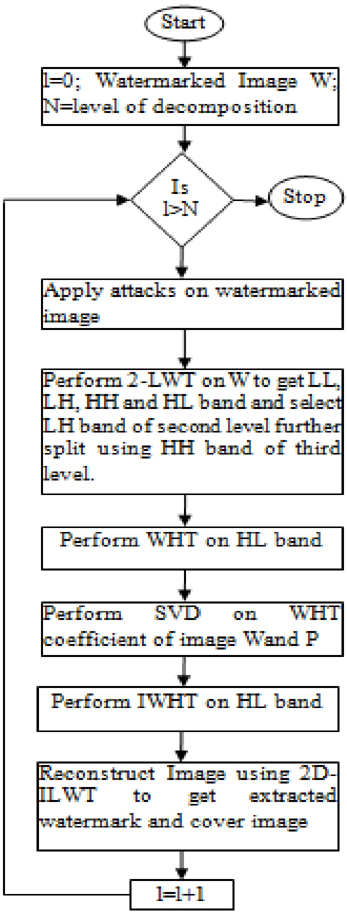

Figure 7 Flow Chart of Extraction System

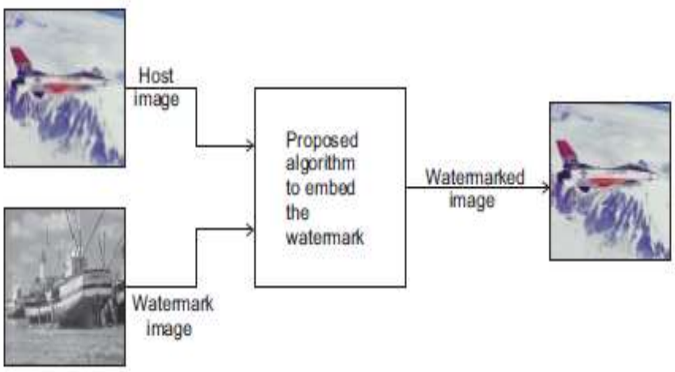

Figure 8 Process to get watermark image

TABLE I PSNR COMPARISON BETWEEN REF AND PROPOSED FOR WATERMARKING.

Tick Label	Cover Image	Watermark Image	Ref PSNR	Proposed PSNR
A	Airplane	House	52.1186	59.80
B	Tulips	Pepper	52.1670	52.91
C	Pepper	Airplane	52.1812	**65.44**
D	Lena	Cameraman	52.0408	59.04
E	Baboon	Lifting body	52.1232	55.24
F	Bridge	Boat	52.2080	51.56

TABLE II TIMECOMPARISON BETWEEN REF AND PROPOSED FOR EMBEDDING.

Tick Label	Watermarked Image	Ref Embedding Time	Proposed Embedding Time
A	Airplane	0.8413	0.5476
B	Tulips	0.7334	0.5756
C	Pepper	0.6598	0.5278
D	Lena	0.5987	0.5948
E	Baboon	0.6806	0.5341
F	Bridge	0.6450	0.5396

Table II shows the comparison between Ref and proposed scheme using Embedding Time. It describes the time of adding two images using proposed algorithm.

TABLE III PSNR COMPARISON BETWEEN REF AND PROPOSED WHEN DIFFERENT CHANNELS ARE CHOSEN TO EMBED.

Tick Label	Ref PSNR (in dB)			Proposed PSNR		
	Y	Cb	Cr	Y	Cb	Cr
A	24.46	10.67	10.84	50.79	58.90	59.48
B	14.57	10.75	9.36	42.95	63.82	63.26
C	13.54	9.79	7.89	64.11	70.59	70.67
D	12.55	12.03	11.31	49.57	68.95	68.58
E	14.67	14.64	8.95	45.29	67.45	67.75
F	22.41	9.48	13.37	41.41	57.21	57.69

TABLE IV RMSE AFTER VARIOUS ATTACKS WHEN Y-CHANNEL WAS USED FOR WATERMARKING.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	45.50	11.21
B	Tulips	Pepper	60.20	24.53
C	Pepper	Airplane	37.86	4.46
D	Lena	Cameraman	38.54	10.84
E	Baboon	Lifting body	69.67	31.12
F	Bridge	Boat	59.70	33.19

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TABLE V RMSE AFTER VARIOUS ATTACKS WHEN CB-CHANNEL WAS USED FOR WATERMARKING.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	18.97	3.2366
B	Tulips	Pepper	25.13	2.55
C	Pepper	Airplane	13.72	2.15
D	Lena	Cameraman	13.98	2.18
E	Baboon	Lifting body	18.20	2.20
F	Bridge	Boat	21.71	4.81

TABLE VI RMSE AFTER VARIOUS ATTACKS WHEN CR-CHANNEL WAS USED FOR WATERMARKING.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	15.31	3.2306
B	Tulips	Pepper	33.10	2.5511
C	Pepper	Airplane	18.35	2.11
D	Lena	Cameraman	14.91	1.49
E	Baboon	Lifting body	17.61	2.22
F	Bridge	Boat	18.04	4.16

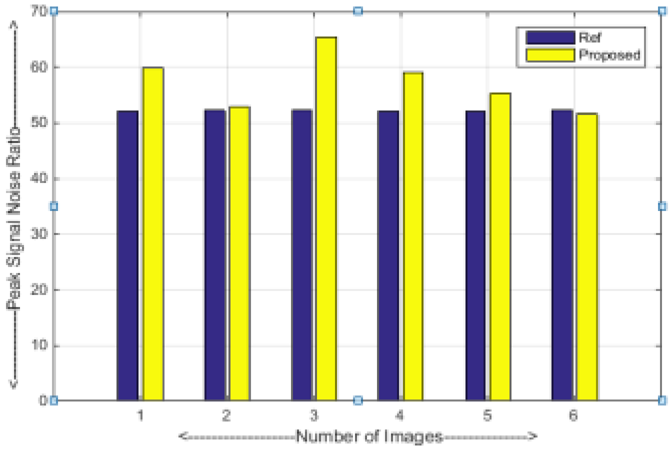

Figure 9 PSNR Comparision of LWT WHT SVD and DWT DFT SVD (Base)

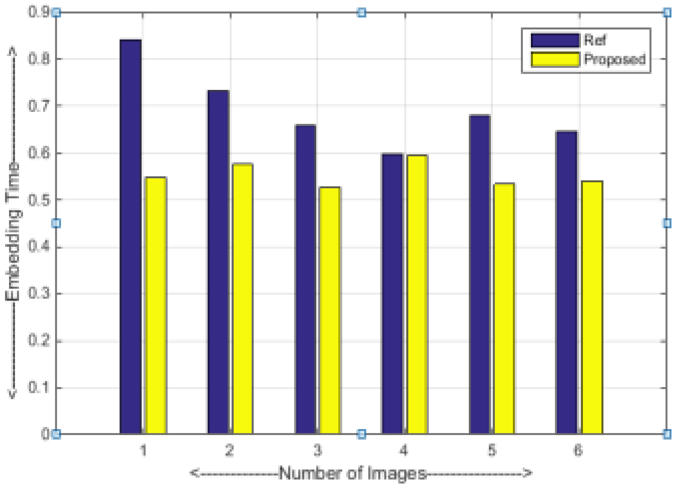

Figure 10 Processing Time Comparision of LWT WHT SVD and DWT DFT SVD (Base)

V. CONCLUSION

In this research we proposed a two level LWT-WHT-SVD Watermarking method on YCrCb color space. In base paper DWT-DFT-SVD watermarking method is used and value of peak signal to noise ratio is very less. Now in our research prime focus is to enhance the value of PSNR. Now a day's privacy of people is prime concern and to shield their data. Therefore to shield valuable information present on internet there are various advanced techniques for example watermarking technique, cryptography technique, steganography and many more. On the other hand watermarked images are robust against various numbers of attacks like blurring, average, crop and Gaussian etc. In this paper lifting wavelet transform applied in same manner as DWT in base paper. In research paper two levels LWT technique is used. When first level LWT applied on an image then four sub band generated and in second level transformation out of these four sub band, again one sub band is selected as per requirement of application and again LWT applied and further four sub band produced that why it is known as second level LWT. One afterdeal of DWT is that it uses larger basis functions. Besides this wavelet filters generate ringing and blurring noise near edges in images. This disadvantage of DWT is overcome in LWT. Other advantages of LWT are that it significantly reduces the computation time and speed up the computation process. Finally in this research paper value of PSNR enhanced as compared to base paper and processing time also reduced. This algorithm could be extended to watermark the images using color images as the watermarks. Further this research can be extend on different color space for example HSV, CMYK to find the color space with maximum efficiency using different techniques like FWT, SWT.

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REFERENCES

[1] Advith J, Varun K R and Manikantan K, "Novel Digital Image Watermarking Using DWT-DFT-SVD in YCbCr Color Space" International Conference on Emerging Trends in Engineering, Technology and Science (ICETETS), 24-26 Feb 2016, **DOI:** 10.1109/ICETETS.2016.7603032

[2] Nikhil Purohit, M. Chennakrishna and K. Manikantan, "Novel Digital Image Watermarking in SWT+SVD Domain" Proceedings of the International Conference on Signal, Networks, Computing, and Systems, in Electrical Engineering 395, DOI 10.1007/978-81-322-3592-7_2

[3] Rahim Ansari, Mrutyunjaya M Devanalamath, K. Manikantan and S. Ramachandran, "Robust Digital Image Watermarking Algorithm in DWT-DFT-SVD Domain for Color Images" 2012 International

Conference on Communication, Information & Computing Technology (ICCICT), Oct. 19-20, Mumbai, India

[4] Amit Kumar Singh, Mayank Dave and Anand Mohan, "Hybrid Technique for Robust and Imperceptible Image Watermarking in DWT–DCT–SVD Domain" The National Academy of Sciences, pp. 351–358 India 2014, 19 July 2014

[5] V. Santhi and Arunkumar Thangavelu, "DWT-SVD Combined Full Band Robust Watermarking Technique for Color Images in YUV Color Space" International Journal of Computer Theory and Engineering, Vol. 1, No. 4, October 2009 , 1793-8201

[6] Huang–Chi Chen, Yu–Wen Chang, Rey–Chue Hwang, "A Watermarking Technique based on the Frequency Domain," Journal of Multimedia, Vol. 7, No. 1, 2012.

[7] Huang–Chi Chen, Yu–Wen Chang, Rey–Chue Hwang, "A Watermarking Technique based on the Frequency Domain," Journal of Multimedia, Vol. 7, No. 1, 2012.

[8] Ante Poljicak, Lidija Mandic, Darko Agic, "Discrete Fourier transform–based watermarking method with an optimal implementataion radius," Jounal of electronic imaging, 2011

[9] Awanish Kr Kaushik, "A Novel Approach for Digital Watermarking of an Image Using DFT," IJECSE, Vol. 1, No. 1, pp. 35–41, 2012

[10] Pallavi Patel, D. S. Bormane, "DWT Based Invisible Watermarking Technique for Digital Images," International Journal of Engineering and Advanced Technology, Vol. 2, No. 4, 2013

[11] Anuradha, Rudresh Pratap Singh, "DWT Based Watermarking Algorithm using Haar Wavelet," International Journal of Electronics and Computer Science Engineering, Vol. 1, No. 1, 2012.

[12] R. A. Ghazy, M. M. Hadhoud, M. I. Dessouky, N. A. El–Fishawy,F. E. Abd El–Samie, "Performance evaluation of block based svd image watermarking," Progress In Electromagnetic Research, pp. 147–159, 2008.

[13] Kuo–Liang Chung, Wei–Ning Yang, Yong–Huai Huang, Shih–Tung Wu, Yu–Chiao Hsu, "On SVD based watermarking algorithm," Applied Mathematics and Computation, pp. 54–57, 2007.

[14] Chih–Chin Lai, Cheng–Chih Tsai, "Digital Image Watermarking using Discrete Wavelet Transform and Singular Value Decomposition," IEEE Transactions on Instrumentation and Measurement, Vol. 59, No. 11, 2010.

[15] Piyush Pandey, Rakesh Kumar Singh, "Novel Digital Image Watermarking Using LWT-WHT-SVD in YCbCr Color Space" International Journal of Innovative Research in Computer and Communication Engineering, Vol. 5, Issue 6, June 2017