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Successive and Segmented Watermarking Techniques Based on DWT-SVD and Artificial Bee Colony Algorithm

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***Abstract*—** Multiple watermarks is to convey multiple sets of information designed to suit differing objectives and is used to increase robustness and security with many different methods in which the embedded information is not easily lost. DWT-SVD based successive and segmented watermarking technique is proposed using Artificial Bee Colony Algorithm (ABC). The understanding between the transparency and robustness is considered as an optimization problem and is removed by applying the ABC algorithm. This algorithm is used to obtain the highest possible robustness without losing the transparency. The successive and segmented of multiple watermarking techniques makes the watermarks much more robust to more attacks. The optimization on successive and segmented watermarking achieves more imperceptibility and robustness.

***Keywords*—**Successive and Segmented watermarking, Security, Artificial Bee Colony algorithm, Discrete Wavelet Transform, Singular value decomposition.

I. INTRODUCTION

The recent advancements in digital information have made subtle changes in our society and life. The advantages of digital information also produced new challenges and opportunities. Innovations, supported by powerful software, new devices such as digital camera, camcorder and digital voice recorder, have reached the consumers, worldwide, use manipulate and experience the pleasure in the multimedia data. Internet and wireless communication networks give ubiquitous channels to send and exchange information.

Applications, in digital communication include electronic advertising, real time image, audio, and video delivery, digital repositories and libraries, and web publishing. Jacobson Roberta Beach, a popular Journalist has criticized the misuse of work by writers in websites article 'Copyright and Wrongs' [1]. An important issue that arises in these applications is the protection of the rights of all the participants. It has been recognized, for quite some time, that the current copyright laws are inadequate to deal with the digital data. This has led to an interest towards developing new copy deterrence and protection mechanisms. One such effort that has attracted interest is based on digital watermarking techniques.

A multiple watermarking technique which combined the wavelets based on texture properties to watermark authentication and copyright information inside a cover image is proposed in [2]. The experimental results proved that their algorithm was efficient in terms of quality and the results also proved that storing watermarks using texture properties had also provided high robustness.

The inspiration behind the present work is the motivation of the work done by Mintzer et al. [3] discussed "If one watermark is good, or more better?". In this converse, the multiple watermarks are employed to convey multiple sets of information into image. Hence, it has been decided to investigate the multiple watermarking for the purpose of copyright protection, medical safeties and secured communications.

Andreas Mascher-Kampfer et al. [4] focused on a comparison of blind and non-blind algorithms in successive watermarking technique. In their scheme, the imperceptibility of watermarked image is found to have low PSNR values. This motivated the researcher to implement the discrete wavelet transform (DWT) based successive watermarking technique using different embedding methods.

Sheppard et al. [5] described three multiple watermarking techniques theoretically and the author explained a weakening of detection performance in composite watermarking technique using the Fourier and discrete cosine transform watermarking strategies. The abovesaid studies motivated to implement the practical application of the same. This also

prompted the researcher to undertake a different methodology in multiple watermarking techniques using the DWT and singular value transformation (SVD) with optimization.

Yuancheng Li et al. [6] proposed a novel multiple watermarking algorithm using bandelet transform of different frequency subbands. To improve the performance of their algorithm, the investigator to employ the work on the multiple watermarking algorithm using daubechies wavelet transform of different frequency subbands. Jagadeesh et al. [7] presented a genetic algorithm approach for SVD based digital image watermarking. In their work, the robustness of extracting watermark were found to be low. This inspired the researcher to implement the work on DWT and SVD based multiple watermarking techniques using genetic algorithm.

Comparison of multiple-watermarking techniques based on DWT and SVD using Genetic algorithm for medical images is proposed in [8]. The research elaborates the three main categories of multiple watermarking techniques such as successive, segmented and composite watermarking. The optimization is to maximize the performance of peak signal to noise ratio and normalized correlation in multiple watermarking techniques using genetic algorithms.

Intern Glen E. wheeler et al. [9] discussed the segmented watermarking technique in which the original image is divided into square blocks with each block having a watermark independently. Their segmented watermarking technique has not investigated against the attacks. This prompted the investigator to work on the same line but with a difference in varying the embedding methods and also it is proposed with optimization technique.

A new color image watermarking for copyright protection is proposed in [10]. It was based on embedding multiple watermark bits into the blue component of a color image in DWT domain. The experimental results demonstrate that their proposed method successfully makes the watermark perceptually invisible and robust to some geometric and common image processing attacks.

A multiple watermarking scheme based on discrete wavelet transform is presented for the analysis of imperceptibility and robustness in [11]. The watermarks are embedded into the detail sub-bands of original image using genetic algorithms. Their optimization to improve the performance of imperceptibility on the watermarked image in terms of peak signal to noise ratio (PSNR) and robustness for extracting watermark in term normalized correlation (NC).

Multiple watermarking technique based on Hybrid DWT-SVD and Artificial Neural Network is proposed in [12]. Their proposed multiple watermarking technique use of Artificial Bee Colony Algorithm based on DWT-SVD and artificial neural network. The understanding between the imperceptibility and robustness is considered as an optimization problem and is removed by applying artificial bee colony algorithm.

A robust image watermarking scheme based on singular value decomposition (SVD) and discrete wavelet transform (DWT) with Artificial Bee Colony Algorithm is proposed in [13].

Previous ABC based watermarking algorithms have a major drawback of security and robustness. For solving this problem, the successive and segmented watermarking technique makes use of Artificial Bee Colony Algorithm (ABC) based DWT-SVD is proposed. This algorithm focuses on different multiple watermarking techniques for the applications of copyright protection and medical safety. This paper is organized as follows; the proposed work is explained in section 2. The experimental results and discussion are presented in section 3. Finally, concluding remarks are given in section 4.

II. PROPOSED WORK

The proposed work focuses on successive and segmented watermarking technique using artificial bee colony algorithm. The proposed methodology are discussed as follows,

a. Successive Watermarking Technique

In successive watermarking technique, the watermarks are embedded one after the other. In case the digital information (Image) is sold, the information about original owner and the information about recipient are embedded. If re-selling is possible, every time the sold digital information along with the information of the new recipient can be embedded using successive watermarking technique. In this case, we can trace back the way the origin of the digital information and to reconstruct the entire trading chain.

b. Segmented Watermarking Technique

In the segmented watermarking technique, the original image is segmented into several parts and each watermark is embedded into the specific share. Without the knowledge of any one of the partner, the watermark cannot be recovered.

c. Discrete Wavelet Transform

The heart of wavelet analysis is a multi resolution analysis (MRA). Multi resolution analysis is the decomposition of an image into different sub images of different size resolution levels. MRA is designed at high frequencies, to provide poor frequency resolution and good time resolution. MRA is designed at low frequencies, poor time, frequency resolution and good frequency resolution.

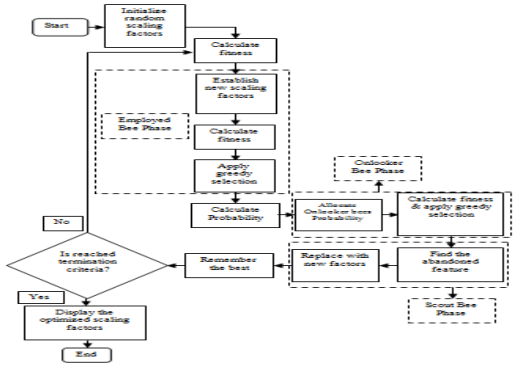
The main advantages of wavelets are that they offer localization in frequency domain and able to separate the fine details in a Signal. This can be used to isolate the fine and coarse details in a signal. A wavelet transform can be used to decompose a signal into component wavelets.

d. Singular Value Decomposition

The SVD is a powerful matrix decomposition tool which has also been used in a variety of applications. From the viewpoint of linear algebra, a discrete image can be represented as a2D matrix with nonnegative scalar entries.

e. Artificial Bee Colony Algorithm

In proposed work, the understanding between the transparency and robustness is considered as an optimization problem and is removed by applying ABC algorithm. By using this technique to obtain the highest possible robustness without losing the transparency. ABC algorithm is a swarm based meta-heuristic algorithm which is enthused by the sharp foraging behaviour of the honey bees. ABC consists of three components such as, employed bees, onlooker bees and scout bees.



The employed bees are coupled with the food sources in the region of hive and they transfer the information to the onlookers about the nectar quality of food sources they are exploiting. The onlooker bees are watching the dance of employed bees inside the hive to pick from one food source to exploit according to the information provided by the employed bees. In the employed bees whose food source is abandoned become Scout and seek new food source arbitrarily. The number of food sources denote the location of probable solutions of optimization problem. Figure 1 shows the flowchart for artificial bee colony algorithm.

f. Employed Bee Phase

In the employed bee phase, new population parameters are generated using the equation given below:

$$V_{i,j} = x_{i,j} + \phi_{ij}\left(x_{i,j} - x_{k,j}\right) \quad (1)$$

where,

$V_{i,j}$ Is the new value of the j^{th} position

j is a randomly selected index,

$X_i = \{x_{i,1}, x_{i,2}, ..., x_{i,n}\}$ represent the i^{th} solution in the swarm, where n is the dimension size

ϕ is randomly produced number in the range [-1, 1] and

X_k is a randomly selected candidate solution $i \neq k$.

The fitness value is computed for every new generated population parameters of food sources. From the computed fitness value of the population, the best value of population parameter is selected. After selecting the best population parameter, the probability of the selected parameter is computed using the following equation.

$$P_j = \frac{F_j}{\sum_{j=1}^{d} F_j} \quad (2)$$

where,

Pj is the probability of the jth parameter.

g. Onlooker Bee Phase

After computing the probability of the selected parameter, the number of onlooker bees are estimated. Generate new solutions Vi,j for the onlooker bees from the solutions xi,j based on the probability value Pj. The fitness function is calculated for the new solution. Then, apply the selection process in order to select the best parameter.

h. Scout Bee Phase

Scout bees are determining the abandoned parameters. If any abandoned parameter is present, then replace with the new parameters discovered by scouts using the equation (2) and evaluate the fitness value.

i. Watermarking Embedding and Extraction Method

The DWT-SVD based watermark embedding and extracting process can be described as follows

Successive Watermark Embedding

1. I is the Original input image
2. Apply DWT to the input image. By applying DWT the image is decomposed in to four sub bands HH, HL, LH and LL.
3. Apply SVD to the LL band.
4. The watermark image are embedded in the original image using additive embedding method
5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.
6. Apply Inverse SVD and apply Inverse DWT.
7. Finally the watermarked image1 can be obtained
8. Similarly, the second watermark is embedded into watermarked image1 to get the watermarked image 2

Successive Watermark Extraction

1. Input watermarked image 2 and 1.
2. Apply DWT to the watermarked images. By applying DWT both the images are decomposed in to four sub bands HH, HL, LH and LL.
3. Apply SVD to the LL band.
4. The second watermark image is extracted from the watermarked image2 and the watermarked image2 using additive extraction method
5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.
6. Apply Inverse SVD.
7. Finally the second watermark image will be obtained.
8. The first watermark is extracted from the watermarked image1 and original image. By repeating the above steps.

Segmented Watermark Embedding

1. The original image (I) is partitioned into two sub images such as odd sub image (Iodd) and even sub image (Ieven). The odd sub and even sub images are Input Original image
2. Apply DWT to the input images. By applying DWT the images are decomposed in to four sub bands HH, HL, LH and LL.
3. Apply SVD to the LL band.
4. The watermark images are embedded in the odd sub and even sub image using additive embedding method
5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.
6. Apply Inverse SVD and apply Inverse DWT.
7. Finally the odd and even watermarked images will be obtained
8. The two sub images are combined to get a final watermarked image

Segmented Watermark Extraction

1. Input odd and even watermarked images.
2. Apply DWT to the odd and even watermarked images. By applying DWT both the images are decomposed in to four sub bands HH, HL, LH and LL.
3. Apply SVD to the LL band.
4. The watermark images are extracted from the odd and even watermarked images and the odd and even original images using additive extraction method
5. Scaling factor is optimized using artificial bee colony algorithm. Random solutions are generated and scaling factors are chosen based on the PSNR values.
6. Apply Inverse SVD.

Finally the watermark images will be obtained.

III. RESULTS AND DISCUSSION

In this paper, a robust multiple successive and segmented watermarking technique is proposed based on wavelet domain for Color images. Fig.2(a - h) shows the original images of size 512×512 and the image watermarks of size 48×48 as shown in Fig.2(i) and Fig.2(j).

Figure 2 Set of Original images and Its Watermark Images

a. Evaluation of Results

The quality of the system is evaluated using the quality metrics. The quality metrics calculated in our proposed work are PSNR and NC.

b. PSNR (Peak Signal to Noise Ratio)

PSNR is the logarithmic value of ratio between signal and noise. It is expressed in decibels. The PSNR is used to measure quality of watermarked image as follows:

$$PSNR(dB) = 10\log_{10}\frac{255^2}{MSE} \quad (3)$$

MSE = Mean square error
I (i,j) = Pixel values of the original image
W (i,j) = Pixel values of the watermarked image

c. NC (Normalized cross Correlation)

Normalized Correlation (NC) is used to measure the quality of the watermark after recovery. The NC between the embedded watermark W (i, j) and the extracted watermark W' (i, j) is given by

$$NC = \frac{\sum_{i=1}^{H}\sum_{j=1}^{L} W(i,j) \times W'(i,j)}{\sum_{i=1}^{H}\sum_{j=1}^{L} [W(i,j)]^2}$$

Table 1: PSNR and NC values on successive watermarking (Before and After Optimization)

Images	Before optimization using ABC				After optimization using ABC			
	Scaling Factor	PSNR (dB)	NC 1 Values	NC 2 values	Scaling Factor	PSNR (dB)	NC 1	NC 2
(a)	0.8992	37.9634	1	1	0.8992	37.9823	1	1
(b)	0.8292	38.0820	0.9999	0.9898	0.8292	38.6123	1	1
(c)	0.7219	38.7064	1	1	0.7219	38.9136	1	1
(d)	0.9123	38.0398	0.9923	1	0.9123	38.4928	1	1
(e)	0.7234	38.0489	1	1	0.7234	38.6836	1	1
(f)	0.8471	37.0826	0.9894	1	0.8471	37.0826	1	1
(g)	0.8626	37.6591	1	0.9952	0.8626	37.8912	1	1
(h)	0.7921	37.9974	0.9943	1	0.7921	37.9834	1	1

Table 2: PSNR and NC values on segmented watermarking (Before and After Optimization)

Images	Before Optimization				After Optimization			
	Scaling Factor	PSNR (dB)	NC 1	NC 2	Scaling Factor	PSNR (dB)	NC 1	NC 2
(a)	0.8210	39.9373	1	1	0.8210	39.9421	1	1
(b)	0.8471	39.9581	1	0.9498	0.8471	39.9980	1	1
(c)	0.7098	40.1757	1	1	0.7098	40.2391	1	1
(d)	0.9110	40.0338	0.9239	1	0.9110	40.4092	1	1
(e)	0.8482	40.0432	0.9912	1	0.8482	40.2202	1	1
(f)	0.8992	38.9581	1	0.9012	0.8992	38.9919	1	1
(g)	0.7239	39.6411	1	1	0.7239	39.9181	1	1
(h)	0.7921	39.9893	0.9219	1	0.7921	39.9999	1	1

Table 3 PSNR and NC Values for Different Attacks on Successive and Segmented Watermarking Techniques using ABC Algorithm

Attacks	Successive Watermarking						Segmented Watermarking					
	Without ABC			With ABC			Without ABC			With ABC		
	PS	N	N	PS	N	N	PS	N	N	PS	N	N
Salt & Pepper Noise	20.2391	0.8391	0.9992	20.5187	0.8989	1	20.5544	0.8142	0.9992	20.8701	0.8821	1
Gaussian Noise	20.2029	0.7910	0.9962	20.8579	0.7992	1	20.7291	0.8769	0.9743	21.8901	0.8923	1
Speckle Noise	27.9012	0.9982	0.9929	28.8574	1	1	27.4310	0.9586	0.9978	27.9812	0.9981	1
Median Filtering	33.4770	0.9919	1	33.9534	1	1	33.8123	0.9078	0.9834	34.7813	0.9821	1
Gaussion Filtering	20.5003	0.6723	0.9981	20.8572	0.7213	1	20.2656	0.8769	0.7891	21.8923	0.9213	0.8142
JPEG Compression	16.7104	0.9989	0.7129	16.8230	1	0.7987	15.9879	0.9993	0.9323	17.8912	1	0.9912
Translation	18.7880	0.3340	0.9991	18.9103	0.4393	1	18.7024	0.3932	0.3012	19.0321	0.4921	0.3813
Cropping	9.8218	0.1332	0.9712	9.9952	0.1934	1	8.4120	0.0157	0.1923	8.8231	1	1
Rotation	35.3390	1	0.9320	35.8045	1	0.9899	35.9823	0.9981	0.9989	36.0142	1	1
Sharpening	25.3829	0.8890	0.9923	25.5910	0.9230	1	23.9231	0.9965	0.9923	24.0832	1	1
Smoothing	37.0359	0.9129	1	37.7528	0.9984	1	36.8321	0.9982	0.9834	37.1039	1	1
Row-Column Blanking	12.7903	0.0140	0.9992	13.1272	0.1101	1	12.1431	0.1240	0.1049	12.9832	0.2340	0.3910
Row-Column Copying	18.6997	0.8388	0.9982	18.9367	0.8891	1	18.8023	0.9213	0.9359	18.9321	0.9823	0.9941

Figure 3 and 4 shows the watermarked Lena image under several attacks on successive and segmented watermarking techniques.

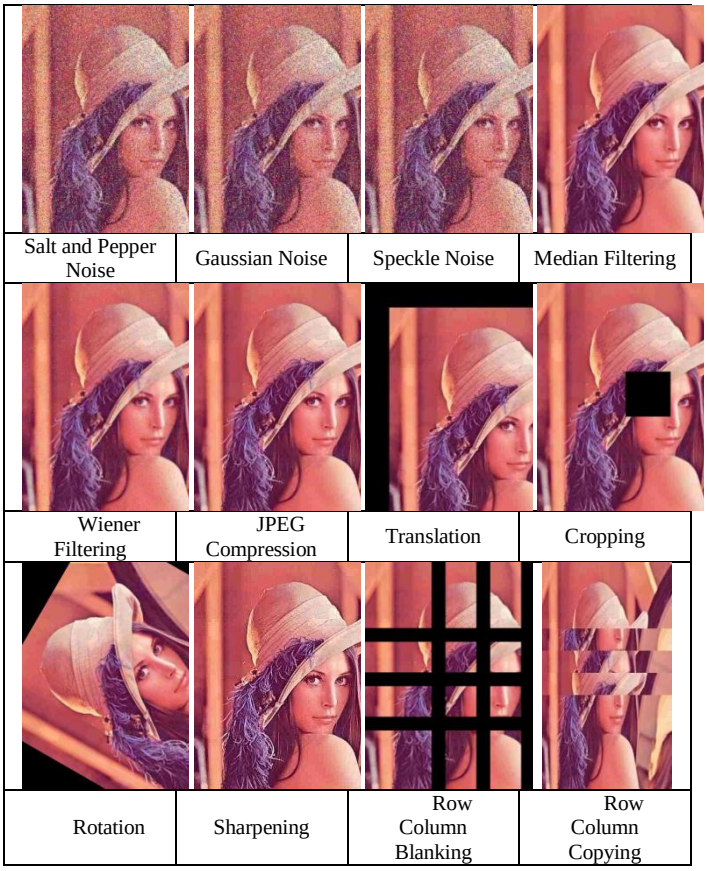
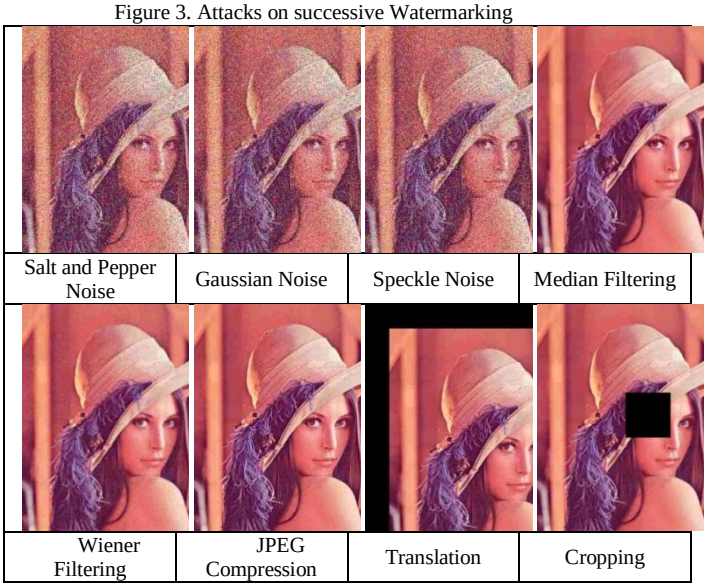


Figure 3. Attacks on successive Watermarking



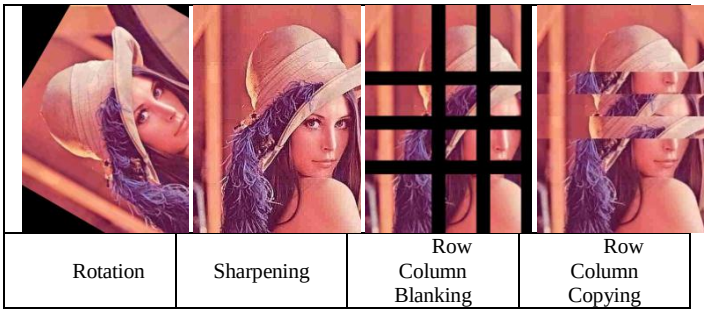


Figure 4. Attacks on Segmented Watermarking

d. *Comparison to Existing Method*

To prove the effectiveness of the proposed ABC algorithm, the imperceptibility and robustness values are compared with existing method [13]. A robust image watermarking scheme based on SVD and DWT with ABC Algorithm is proposed in [13]. The ABC based watermarking algorithm has a drawback of security and robustness. For resolving this problem, the successive and segmented watermarking techniques makes use of ABC based Hybrid DWT-SVD is proposed. The values are listed in Table 4, and it is evident that the robustness of our proposed method is superior to the existing method.

Table 4 Comparison of PSNR and NC values during Attacks

Attacks	Existing Method [13]		Proposed Method					
			Successive Watermarking			Segmented Watermarking		
	PSNR (dB)	NC	PSNR (dB)	NC1	NC2	PSNR (dB)	NC1	NC2
Median Filtering	29.28	0.9999	33.9534	1	1	34.7813	0.9821	1
Gaussion Blurring	25.66	0.9956	30.8921	0.9991	1	31.3219	1	1
Cropping	11.08	0.8465	9.9952	0.1934	1	8.8231	1	1
Gaussian Noise	21.59	0.8465	20.8579	0.7992	1	27.9812	0.9981	1
JPEG Compression	29.25	0.9999	16.8230	1	0.7987	17.8912	1	0.9912
Histogram Equalization	19.58	0.8852	21.2232	0.9121	0.9234	22.3213	0.9431	0.9401

IV. CONCLUSION

Multiple image watermarking work is done by using ABC based on DWT-SVD. The low frequency components of image in DWT domain is modified with SVD in order to embed the singular value of watermark to the singular value of DWT coefficient. In this proposed approach, the original image is segmented into two sub images, and then the two watermarks are embedded in the singular values of each sub image separately. In the extraction process, the watermarks are extracted from the singular values of the watermarked sub

images. The successive and segmented watermarking processes makes the watermarks much more robust. The selection of multiple watermarking techniques can be preferred depending on the applications for superior result. Segmented watermarking is used for finger printing application which requires a high robustness against standard data processing attacks.

REFERENCES

[1]. Jacobson, Roberta Beach, 2001. Copyrights and Wrongs, e-zine focusing on European life and culture, Articles: Part 23.

[2]. Radharani, S. and Valarmathi, M.L., 2011. Multiple Watermarking Scheme for Image Authentication and Copyright Protection using Wavelet based Texture Properties and Visual Cryptography, International Journal of Computer Applications, 23 (3), pp. 0975 – 8887.

[3]. Mintzer, F. and Braudaway, G. W., 1999, If One watermark is Good, are More Better?, Proceedings of the International Conference on Acoustics, Speech, and Signal Processing, 4, pp. 2067–2070.

[4]. Mascher–Kampfer, A. Stogner, H. and Uhl, A. (2006) "Multiple Re-Watermarking Scenarios", Proceedings of the 13th International Conference on Systems, Signals, and Image Processing (IWSSIP), pp. 53–56.

[5]. Sheppard, N. P. Shafavi-Naini, R. and Ogunbona, P. (2001) On Multiple Watermarking, Proceedings of the ACM Multimedia and Security Workshop (MMSW), pp. 3–6.

[6]. Yuancheng Li. and Xiaolei Wang. (2009) A Novel Multiple Watermarking Algorithm Based on Bandelet Transform, IEEE Global Congress on Intelligent Systems, pp. 238–242.

[7]. Jagadeesh, B. Rajesh Kumar, P. and Chenna Reddy, P. (2012) Genetic Algorithm Approach for Singular Value Decomposition and Quantization based Digital Image Watermarking, International Journal of Engineering Research and Applications, 2 (2), pp. 1229–1235.

[8]. Mohananthini, N and Yamuna G. (2016) Comparison of Multiple Watermarking Techniques, Journal of Electrical Systems and Information Technology, 3, pp. 68-80.

[9]. Wheeler, GE. Sheppard, NP. andSafavi-Naini, R. 2004 Weighted Segmented Digital Watermarking, Third International Workshop on Digital Watermarking, pp. 89–100.

[10]. Ibrahim AlsonosiNasir and Ahmed b. Abdurrman, 2013 A Robust Color Image Watermarking Scheme based on Image Normalization, In Proceedings of the World Congress on Engineering, 3.

[11]. Mohananthini. N and Yamuna G. 2016 Performance Optimization of Multiple Watermarking Using Genetic Algorithms, International Journal of Enterprise Network Management, 7 (3), pp. 237- 249.

[12]. Mohananthini. N and Yamuna. G. 2015 Multiple Image Watermarking Technique Based on Hybrid DWT-SVD and Artificial Neural Network, International Journal of Applied Engineering Research, 10 (3), pp. 7275-7297.

[13]. Yongchang Chen, Weiyu Yu, and JiuchaoFeng. 2012 A Reliable SVD-DWT Based Watermarking Scheme with Artificial Bee Colony Algorithm, JDCTA, 6.(22), pp. 430 - 439.

