Watermarking Techniques based on DCT and SVD using PSO

Kapil Kumar Singh, Sandhya Tarar

Abstract: Digital watermarking is the most important technique in today's world for hiding the secret information in a carrier image or cover and to avoid illegal copying of data. This technique can be applied to audio, video, text or images, the features and concepts pertaining to the various watermarking techniques using as DCT and SVD.Herein research paper we are providing a comparative analysis of all the above mention algorithms with Particle Swarm Optimization (PSO).The proposed scheme meets the objective as MSE, PSNR, SSIMand NCC. Finally, it has been concluded that all the proposed schemes are well efficient in watermarking in the still image data. All schemes are works really fast and hence suitable and real-time applications.

Keyword: Discrete Cosine Transform (DCT), Singular Values Decomposition (SVD), Particle Swarm Optimization (PSO).

I. INTRODUCTION

Watermarking is defined [1, 2] as the activity of concealing a message, content, logo or signature into a picture, audio, video or any or other work of media. The digital watermarking field is comparatively youthful and gained fame as a research topic in the latter half of the 1990s. Watermarking can be visible, such as the images are printed on money notes, or invisible, for which the watermark is hidden inside the media.

A watermarking system might be described as a structure that contains two parts: an embedding part and an extractor part. The embedding part takes two data sources.one is cover work that are inserted in the watermark and other is information that needs to hide in the watermark. The watermarked work is either transmitted or recorded. The embedded message can be extracted by using the detector, which determines whether the watermark exists or not. Digital watermarking is utilized to offer proprietorship security, including identification of the copyright owner and protection.

Watermarking, similar to data cryptography, requires mystery keys to recognize legitimate employer; moreover, most applications request additional data to be covered up in the real image. This message may include in possession identifiers, exchange dates, serial numbers, and so forth. Accept a key part when illicit suppliers are being followed. Firmly identified with the embed this message at whatever point possessing the secret key. Much of the time of enthusiasm, it can be a sure possibility of mistake the shrouded data that can be usedfor the execution framework. Plainly, possibilityincrement quantityof the data.

The watermarking strategy gives extraordinary compared to other arrangements among them. This method inserts data with the goal that it isn't effortlessly detectable to the others.

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The implanted watermark ought not to corrupt the nature of the picture and ought to be perceptually imperceptible to keep up its defensive mystery [1].

As indicated by the space in which watermark is implanted, these are partitioned into a spatial area and change space plansinsertingtechnique. It has less computational cost, high breaking point, more perceptual quality, notwithstanding, less energetic and it generally suits for Authentication applications. In the repeat space designs, we embed the watermark with the changed coefficients of host pictures. It has more power, less control of perceptual quality and on a very basic level suits for copyright application. The generosity and perceptual nature of the watermarking plans essentially depend upon what number of levels of the watermark is embedded into having picture i.e., scaling factor.

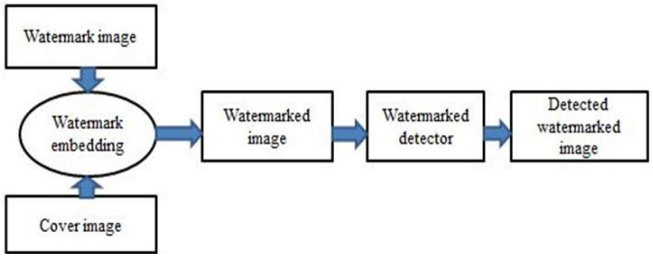

Fig 1.The Watermark Embedding and Detection Process

Rest of apaper organized as follows. Previous works are discussed and analyzed and, we use watermarking methods is implementedand based on theDiscrete Cosine Transform (DCT) and Singular Value Decomposition (SVD) in section II.Represent the data of the proposed methodology in section III. Experimental results and analyses, as well as some related discussions in section IV. finally, the concluding remarks and future scope in section V.

II. RELATED WORKS

In 1997, Cox et al. [3] utilized DCT based spread range correspondence, for interactive media watermarking. This technique has turned out to be extremely well known and has been utilized by numerous specialists. In this strategy, arrangements of autonomous and indistinguishably circulated Gaussian arbitrary groupings are installed in the most perceptually critical frequencies of a picture. As in spread range correspondence, the flag vitality in any recurrence is imperceptible if the limited band flag is transmitted over more extensive transmission capacity. That will make a watermark spread over all frequencies with the goal that vitality in any single recurrence is little. The Cox strategy is an inadequate technique. In this way, it requires the first picture in the extraction procedure.

In 1998, Acken [4] exhibited decided to part of thewatermark as and computerized resources Correspondence of ACM. Piva et al. [5] connected DCT to computerized watermark image. They are technique and recoup advanced watermarking from a messy unique picture.

As of late, Joshi et al. [6] built ongoing video advanced watermarking in view of whole number DCT anti coding. Jagadeesh et al. [7] connected fluffy derivation framework and BP neural system of the picture watermarking. The built hearty advanced picture watermarking in view of DCT. Fazli and Moeini [8] combined DWT, SCT and SVD to develop the vigorous computerized picture watermarking strategy. that may be possible to associate against and change primary geometrical assaults. Dong et al. [9] received to the prototype of examination computerized watermarking in DCT area. Panah et al. [10] looked into properties of non-data to computerized watermark.

Parah et al. [11] built up strong and undetectable watermark strategy in the DCT space in light of the distinction between buries square factor. Ali et al. [12] connected differential development calculation to adjust the tradeoff amongst vigor and indistinctness by investigating numerous scaling factors in picture watermarking. Joshi et al. [13] centres around an undetectable and vigorous video watermarking plan, which can be effortlessly executed as a fundamental piece of the standard coder. As (SIFT) include indicates revolution, and interpretation, visually impaired DWT-SVD watermark strategy against factorial assaults in light of SIFT is proposed by Ye et al.[14]. Wang et al. [15] proposed a strategy in view of a novel delicate and versatile watermark plan. Guo et al. [16] introducea half conditioning many-sided quality. Sadreazami et al. [17].

In over paper, we will discuss about theexamination of watermarking strategies of discrete cosine transform(DCT) and solitary esteem decomposition(SVD) which is broadly utilized as a part of pressure applications and thus in advanced dispersion systems. A diagnostic system that permits to get to the execution of the given watermarking technique in the DCT and SVD area. With PSO the new outcomes have been accomplished the outcomes with PSO, for example, MSE esteems, PSNR esteems, SSIM esteems and Normalized Cross Correlation (NCC)values that are pressure the in the past writing in DCT-space watermarking.

Digital image watermarking methods based on DCT and SVD

A. Discrete Cosine Transform (DCT)

DCT is the symmetrical change that is generally utilized as a part of picture pressure and is broadly acknowledged in the media models. DCT has a place with a group of 16 trigonometric changes [18][19]. The sort 2 DCT changes a square of a picture of size N∗N having pixel forces s(N1,N2) in a change cluster of coefficients S(k1,k2), depicted by the accompanying condition.

$$s(k_1,k_2)=\sqrt{\frac{4}{N^2}}c(k_1)c(k_2)\sum_{n1=0}^{N-1}\sum_{n2=0}^{N-1}s(n_1,n_2)\cos\left(\frac{\pi(2n_1+1)k_1}{2N}\right)\cos\left(\frac{\pi(2n_2+1)k_2}{2N}\right) \quad \ldots(1)$$

The changing exhibit got through condition (1) is likewise of the size N x N, same as that of the first picture square. It ought to be noted here that the change area lists k1 and k2 show the spatial frequencies in the ways of n1 and n2 separately. 0 1 2 k = k = relates to the normal or the DC segment and all the staying ones are the AC segments which compare to higher spatial frequencies as k1 and k2 increment.

B. Singular Value Decomposition (SVD)

Particular esteem deterioration takes a rectangular grid of quality articulation information (characterized as A, where A will be a n x p framework) in which the n lines speaks to the qualities, and the p sections speakto the test conditions. The SVD hypothesis states:

$$A_{nxp} = U_{nxp} S_{nsp} V^{T}{}_{pxp}$$

Where

$$U^{T}U = I_{n\times n}$$

$$V^{T}V = I_{p\times p}$$ (i.e. U and V are orthogonal)

Some quality of SVD

1) Solitary estimations a picture isexceptionally steadiness, i.e. at the point of little annoyance is plus a picture, huge variety of its particular esteem does not happen.

2) For a picture A, push flipped of An, Art and section Flipped of an, Act have the same non-zero solitary qualities

3) Singular qualities speak to natural properties.

III. THE PROPOSED METHODOLOGY

In this section, we proposed two methodologies, which is based on PSO with three watermarked images and watermarked images are in this fig as follow.

(a) Logo image **(b) Signature image**

Figure 2: The Watermark Images College Logo and Signature Image

A. DCT+PSO

In this method, we are working two algorithms DCT and PSO that are used as a many input original coverimages that are select any one at a time withcollege logo watermark image and noise attack on theselect imageand extract the cover and watermarked images from the watermark image as shown in diagram3.

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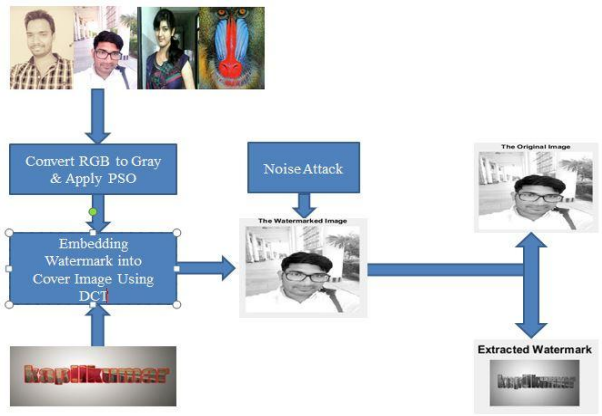

Figure 3: Cover Image Extract Watermark using DCT with PSO

B. SVD+PSO

In this method, we are working two algorithms DCT and PSO that are used as a many input original coverimages that are select any one at a time with college logo watermark image and noise attack on the select image and extract in diagram4.

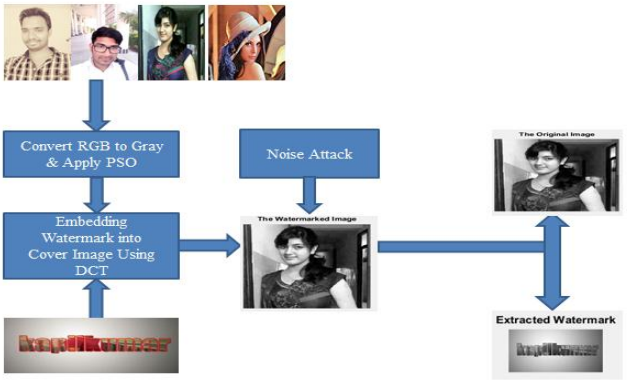

Figure 4. Cover Image Extract Watermark using SVD with PSO

IV. EXPERIMENTAL DETAILS AND RESULTS

In sequence to define the work of the implementation, that are measures such as MSE, NCC, SSIM, PSNR andSSC.

A. Mean Squared Error (MSE)

The mean squared error work of measure and tells you that how to close a regression line of the points. The Square is needed to remove the negative signs. MSE is finding the average set of the "errors".

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(\hat{X}_i - X_i)^2$$

B. Peak Signal-to-Noise Ratio (PSNR)

PSNR is most commonly used as a measureproperty of rearrangementin the image compression. It is calculated by the formula as

$$PSNR = 10\log_{10}\left[\frac{L^2}{MSE}\right]$$

V. RESULTS ANALYSIS

In this section we analyzing the results of the various combination of different kind of hybrid with PSO. The results of a different kind of combination are described in the following parameters values of MSE, PSNR, SSIM, NCC, and SCC with the WPSO and PSO using the SVD and DCT method. We have taken 2 images as cover/host image Lena, Baboon with 3 differenttypes of watermarks namely college logo, make in India logo and my name Kapil Kumar as a watermark. We calculate the different results for every combination and we add the noise as at attacking with 2% Gaussian attack, 2% Salt & pepper attack. The following tables are given below:

Table 1: SVD Results in College Logo Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**
No Attack	**0.8725**	**2.6854**	**48.7228**	**43.8406**	**0.9992**	**0.9637**	**1.0010**	**1.0051**	**0.9977**	**0.9896**
Gaussian Attack 2%	**0.8247**	**0.6194**	**48.9674**	**50.2107**	**0.9992**	**0.9992**	**1.0010**	**1.0022**	**0.9977**	**0.9954**
Salt & Pepper Attack 2%	**0.8644**	**1.0568**	**48.7632**	**47.8905**	**0.9992**	**0.9988**	**1.0010**	**1.0018**	**0.9977**	**0.9962**

Table 2: SVD Results in Signature Logo Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**
No Attack	**2.8188**	**2.3765**	**43.6300**	**44.3713**	**0.9984**	**0.9911**	**1.0023**	**1.0085**	**0.9951**	**0.9929**
Gaussian Attack 2%	**2.7991**	**3.3901**	**43.6606**	**42.8286**	**0.9984**	**0.9877**	**1.0022**	**1.0085**	**0.9952**	**0.9821**
Salt & Pepper Attack 2%	**2.8053**	**5.6509**	**43.6606**	**40.6095**	**0.9984**	**0.9925**	**1.0023**	**1.0059**	**0.9951**	**0.9868**

Table 3 SVD Results Make in India Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**
No Attack	**7.1323**	**7.0539**	**39.5984**	**39.6464**	**0.9965**	**0.9936**	**1.0045**	**1.0068**	**0.9903**	**0.9855**
Gaussian Attack 2%	**6.3316**	**4.8741**	**40.1156**	**41.2517**	**0.9968**	**0.9758**	**1.0042**	**1.0061**	**0.9910**	**0.9873**
Salt & Pepper Attack 2%	**7.0148**	**6.5138**	**39.6706**	**39.9924**	**0.9966**	**0.9609**	**1.0045**	**1.0076**	**0.9904**	**0.9841**

Table 4: Result of SVD with Lena image for College Logo Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**	**WPSO**	**PSO**
No Attack	**0.5528**	**0.5727**	**50.7050**	**50.5512**	**0.9991**	**0.9985**	**1.0007**	**1.0014**	**0.9985**	**0.9971**
Gaussian Attack 2%	**0.5360**	**0.8092**	**50.8389**	**49.0498**	**0.9992**	**0.9981**	**1.0007**	**1.0014**	**0.9985**	**0.9971**
Salt & Pepper Attack 2%	**0.5471**	**0.5654**	**50.7497**	**50.6069**	**0.9991**	**0.9990**	**1.0007**	**1.0012**	**0.9985**	**0.9974**

Table 5 Result of SVD with Lena image for Kapil logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	1.1090	1.2457	47.6811	47.1764	0.9988	0.9975	1.0016	1.0028	0.9965	0.9942
Gaussian Attack 2%	1.1352	0.9573	47.5799	48.3202	0.9988	0.9946	1.0017	1.0024	0.9964	0.9950
Salt & Pepper Attack 2%	1.0978	1.027	47.7252	48.0134	0.9988	0.9939	1.0016	1.0016	0.9965	0.9953

Table 6: Result of SVD with Lena image for make in India logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	3.5746	1.1763	42.5984	47.4255	0.9968	0.9938	1.0032	1.0026	0.9932	0.9946
Gaussian Attack 2%	3.0908	1.1215	43.2300	47.6327	0.9972	0.9980	1.0030	1.0025	0.9938	0.9947
Salt & Pepper Attack 2%	3.5177	0.8967	42.6681	48.6038	0.9968	0.9981	1.0032	1.0024	0.9933	0.9950

Table 7: Result of DCT with Lena image for college logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.6940	4.4878	41.4153	41.6104	0.9494	0.9458	0.9996	0.9999	1.0006	0.9992
Gaussian Attack 2%	4.6696	4.6070	41.4379	41.4965	0.9960	0.9958	0.9998	0.9996	1.0000	1.0002
Salt & Pepper Attack 2%	4.6934	4.4953	41.4158	41.6031	0.9849	0.9802	0.9997	0.9998	1.0005	0.9993

Table 8: Result of DCT with Lena image for Name logo Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.6942	4.4871	41.4151	41.6110	0.9495	0.9458	0.9997	0.9999	1.0006	0.9992
Gaussian Attack 2%	4.6740	4.6028	41.4338	41.5005	0.9960	0.9959	0.9998	0.9996	1.0000	1.0002
Salt & Pepper Attack 2%	4.6937	4.4960	41.4156	41.6024	0.9853	0.9792	0.9997	0.9998	1.0005	0.9993

Table 9: Result of DCT with Lena image for Make in India logo Watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.6937	4.4874	41.4155	41.6108	0.9495	0.9458	0.9997	0.9999	1.0006	0.9992
Gaussian Attack 2%	4.6750	4.6026	41.4329	41.5007	0.9960	0.9459	0.9998	0.9997	1.0000	1.0001
Salt & Pepper Attack 2%	4.6936	4.4947	41.4157	41.6037	0.9844	0.9805	0.9997	0.9998	1.0005	0.9993

Table 10: Result of DCT with baboon image for college logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.7029	4.2820	41.4071	41.8143	0.9918	0.9919	0.9997	0.9997	1.0005	0.9982
Gaussian Attack 2%	4.6853	4.5849	41.4233	41.5174	0.9972	0.9968	0.9997	0.9994	1.0003	1.0002
Salt & Pepper Attack 2%	4.7027	4.2833	41.4073	41.8129	0.9950	0.9945	0.9997	0.9997	1.0005	0.9982

Table 11: Result of DCT with baboon image for Kapil logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.7029	4.2820	41.4071	41.8143	0.9918	0.9919	0.9997	0.9997	1.0005	0.9982
Gaussian Attack 2%	4.6853	4.5849	41.4233	41.5174	0.9972	0.9968	0.9997	0.9994	1.0003	1.0002
Salt & Pepper Attack 2%	4.7027	4.2833	41.4073	41.8129	0.9950	0.9945	0.9997	0.9997	1.0005	0.9982

Table 12: Result of DCT with baboon image for make in India logo watermark

	MSE		PSNR(dB)		SSIM		NCC		SCC	
	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO	WPSO	PSO
No Attack	4.7029	4.2637	41.4071	41.8329	0.9918	0.9917	0.9997	0.9997	1.0005	0.9983
Gaussian Attack 2%	4.6847	4.5783	41.4239	41.5237	0.9972	0.9969	0.9997	0.9995	1.0004	1.0001
Salt & Pepper Attack 2%	4.7028	4.2826	41.4071	41.8136	0.9950	0.9946	0.9997	0.9996	1.0005	0.9983

In the above table1-12are given no attack, Gaussian noise attack and salt pepper noise attack with 2% and In this study we compare the two basic algorithm for watermarking as Singular value Decomposition and Discrete Cosine Transformation with the best optimization algorithm as particle swarm optimization performance. To evaluate the performance of designed algorithm we take MSE, PSNR, SSIM, NCC and SCC with the PSO and Without PSO. In this study we observed that results of DCT with PSO and without PSO is much robust than SVD with PSO and without PSO.

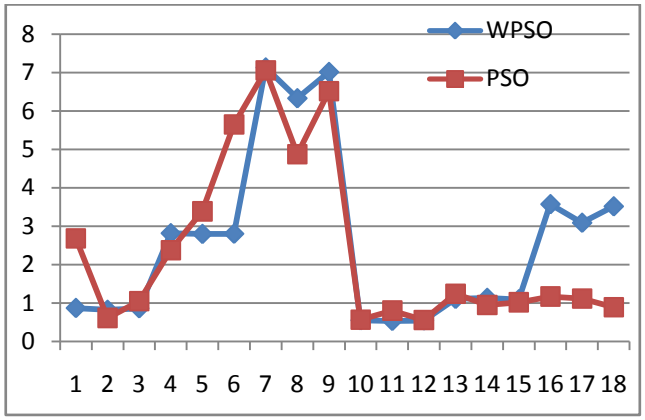

Figure 4.1: MSE of SVD using WPSO and PSO

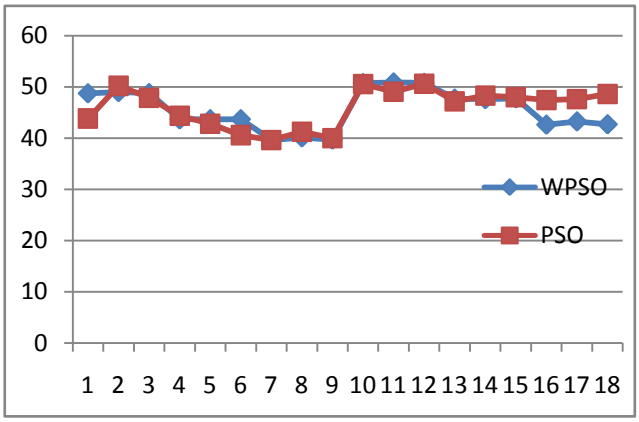

Figure 4.2: PSNR of SVD using WPSO and PSO

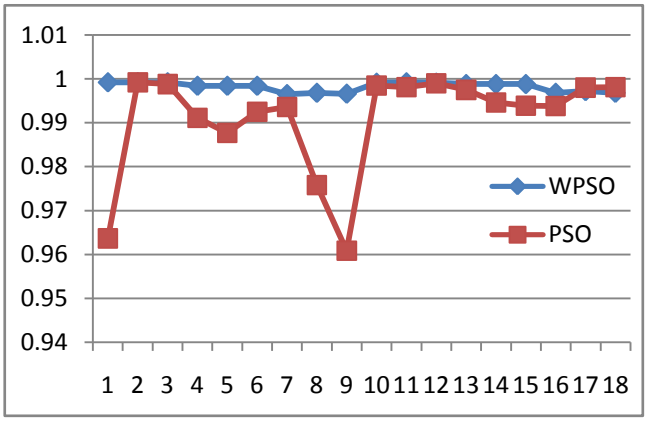

Figure 4.3: SSIM of SVD using WPSO and PSO

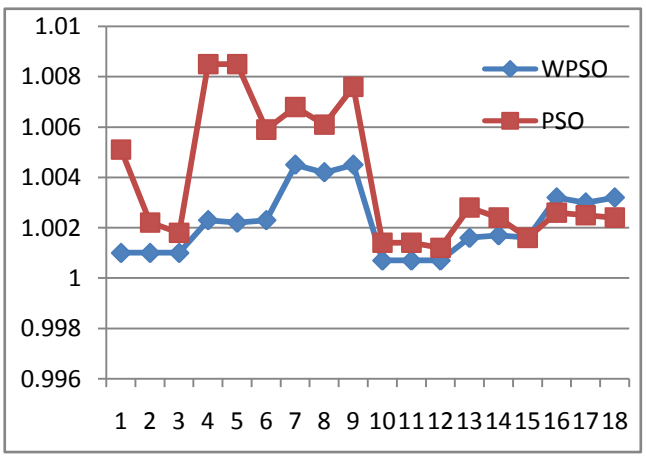

Figure 4.4: NCC of SVD using WPSO and PSO

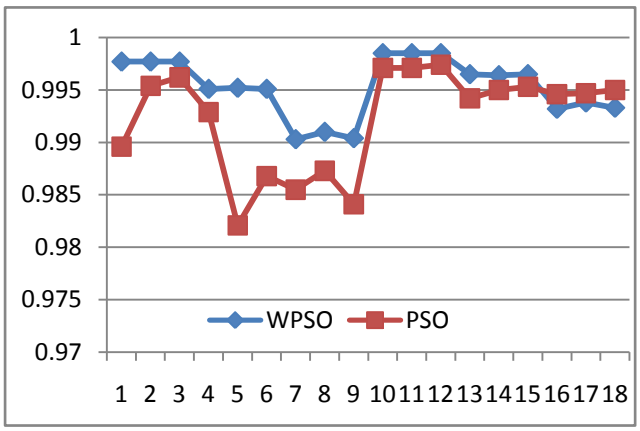

Figure 4.5: SCC of SVD using WPSO and PSO

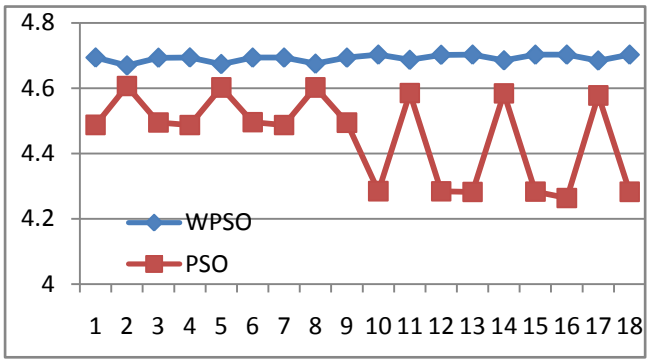

Figure 4.6: MSE of DCT using WPSO and PSO

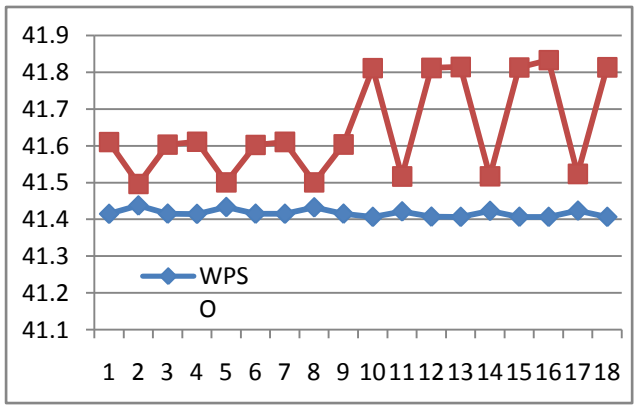

Figure 4.7: PSNR of DCT using WPSO and PSO

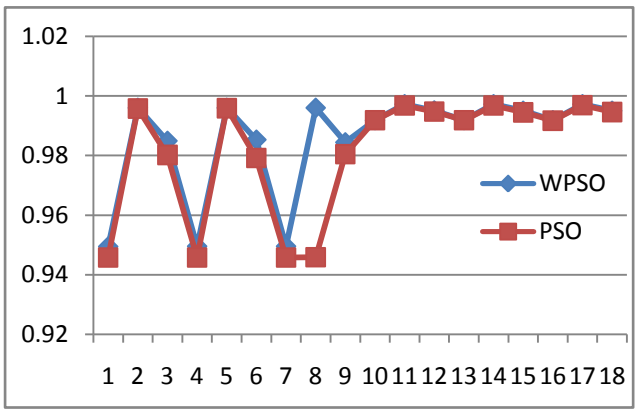

Figure 4.8: SSIM of DCT using WPSO and PSO

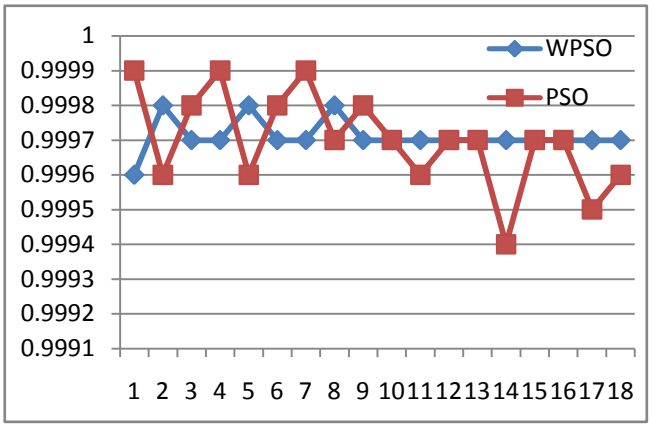

Figure 4.9: NCC of DCT using WPSO and PSO

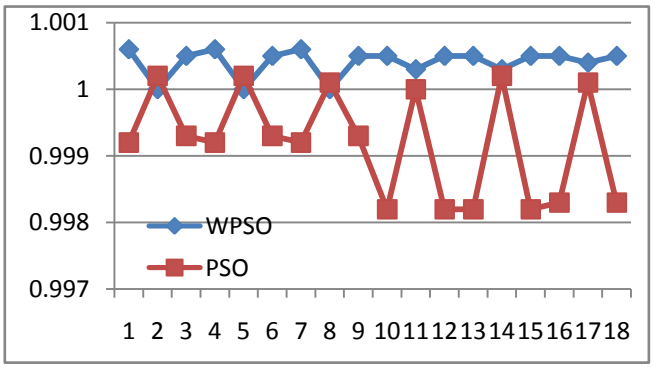

Figure 4.10: SCC of DCT using WPSO and PSO

VI. CONCLUSION

In this work,we are discussed a comparative study about two most popular watermarking techniques SVD and DCT with a most popular optimization algorithm named as Particle swarm optimization. In the literature is available various type of watermarking techniques with different kind of methodology.

The experimental analysis were conducted using 2 cover image which are publically available and 3 watermark images like one my name , one my college logo and last is make in India logo. We find out that DCT with optimization algorithmPSO is much more robust in comparison of SVD with PSO. In case of noise attacking with cover image its gives the best watermarking approach.

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