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Improved Digital Watermarking using DWT, CZT and BFO based modified SVD

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Abstract- **This paper has proposed a new technique based on the Discrete Wavelet Transform (DWT) in combination with the Chirp-z-transform (CZT) and Bacterial Foraging Optimization (BFO) based Singular Value Decomposition (SVD) to improve the efficiency of the digital image watermarking. The proposed algorithm has combined the advantages of these three transforms, therefore have more robust results. The algorithm helps users to satisfy the robustness and imperceptibility characteristics of a good watermarking algorithm by improving the visual quality of the watermarked image and being robust against common signal processing operations and attacks. Also the watermark scrambling is done by using the Arnold transform to protect watermark further. Arnold transform changes the watermark in such a way that it becomes meaningless for the hackers or crackers. The comparisons have also been drawn among the proposed and the existing techniques. The comparisons have clearly shown that the proposed technique outperforms over the available techniques.**

Keywords: Discrete Wavelet Transform, Chirp-z-Transform Singular Value Decomposition, Bacterial Foraging optimization and Arnold Transform

I. INTRODUCTION

With the rapid growth of Internet and digital techniques, digital data can easily be copied and distributed. The omnipresent plagiarism of copyrighted digital data becomes one of the most important issues in the digital industry [1,2]. Hence, ease of these illegal things leads to insecurity in data transmission. Various techniques have been developed for data protection and digital watermark is one of them [3].Digital watermarking is the process of concealing secret information in a digital medium. This information should be imperceptibly embedded in a way that allows it to be extracted or detected later for security purposes [4].It is used to embed an invisible signal (message) known as a watermark directly in the digital content such as image, video, audio or text and integrating it in an inseparable form from the digital content[5]. Watermarking can be grouped in two domains [24] i.e. spatial domain also called Time domain and Frequency domain. Spatial domain methods modify the original image's pixel values directly, simple processing but poor robustness against various attacks and few amount of embedding information. Transform domain algorithm; embed watermark into the transformation domain of the original carrier, and when image is inverse transformed, the watermark is distributed irregularly over the whole image, then it is difficult to detect and modify the watermark information [6 ,7]. Basically, a set of basic requirements is evaluated for a watermarking scheme to be effective. These requirements can be categorized as follows: (1) imperceptibility, (2) robustness, (3) capacity [1, 8]. CZT is an algorithm for evaluating the z-transform of a signal. Z-domain transfer functions can be factored into polynomials with poles and zeros as its roots, where poles model the peak energy concentration of

the frequency spectrum and zeros model the troughs of the frequency spectrum [9].The CZT helps in approximating the transfer function of a system by giving a more accurate picture of zeros and poles of that system (representing the transfer function as ratios of polynomials in z), resulting to a sharper function at an effectively reduced bandwidth. Chirp-z also has the advantage of detecting the fundamental frequency, as it can zoom the analyzed frequency spectrum with a very high resolution. It's usage in watermarking will help to achieve a highly imperceptible and a robust watermarked image, since the
spectrum is sharpened and the frequency resolution is appreciably improved [9]. DWT is very useful to determine areas in the original image where a watermark can be imperceptibly inserted because of its excellent spatio -frequency localization properties. So, it is commonly used for watermarking [10]. DWT is very useful to determine areas in the original image where a watermark can be imperceptibly inserted because of its excellent spatio-frequency localization properties. So, it is commonly used for watermarking[6].When DWT is applied to an image, it separates the image into four different components: Approximation image component (LL), horizontal detail component (HL), vertical detail component (LH) and diagonal detail component (HH).This process of decomposition can be repeated to compute multi-level decomposition[11-13].Use of SVD in digital image processing has some advantages which are listed as follows: (1)The size of the matrices from SVD transformation should not necessarily square and can be a rectangle. (2) Singular values in a digital image are less affected if general image processing is performed. It means that for a small perturbation added to an image, its SVs do not change fast. (3) Singular values contain intrinsic algebraic image properties, where singular values correspond to the brightness of the image and singular vectors reflect geometry characteristics of the image [1,14,26]. The concept of bacterial foraging algorithm is based on the fact that, in nature, animals with low sense of foraging are more probable to be extinct compared with those with high sense of foraging [25]. After many generations, weak animals and weak foraging methods be extinct or are modified into better forms. Escherichia coli bacteria which live in human intestine have a foraging method based on four stages: (1) chemotactic, (2) swarming, (3) reproduction, and (4) elimination and dispersal [15,16].

In this paper we have proposed a new watermarking technique based on CZT, DWT and BFO based modified SVD. This algorithm shows various features of watermarking such as imperceptibility, robustness and capacity .For more security Arnold transform is also used in this paper for protecting watermark.

II. RELATED WORK

The strength and limitations of current watermarking schemes was studied in [17] to develop new schemes to use copyright protection and authentication to overcome limitations. The simplified watermarking embedding method was adapted to improve imperceptibility and lower computational cost. Comparison was also made on watermarking robustness, tamper detection and computational cost Cryptography and Steganography [18] were also used to enhance the security and reliability of message as the message is encrypted and then use steganography to hide it to other carrier like digital image, video file or any other. Steganography, Cryptography and Watermarking are the popular techniques available to hide data securely. An algorithm embeds the image is divided into non-overlapping blocks of size 2x2. A robust watermarking technique [19] based on the frequency domain is proposed. Arnold transform is used to increase security of the constructed watermark

from the image. This proposed algorithm is checked against various common image attacks. The watermark is extracted without the presence of original image, so the blind scheme was obtained. [22] proposed algorithm based on DCT-DWT watermarking. By this method we can do secure image transmission. We can say that proposed algorithm proves its robustness against attacks. The whole system designing in this approach tends to decrease noise and gives imperceptibility and robustness to watermarked image for desired application purposes. [23] proposed an algorithm of color image watermarking based on DCT. This scheme decomposes RGB for the color image and embeds the algorithm of multiple watermarks in the gray scale image of R,G. Robustness is achieved by embedding watermark in the frequency domain to resist Shearing attack. The feasibility of the proposed BFO technique [20] has been tested on ten standard test images and benchmarked with particle swarm optimization algorithm (PSO) and genetic algorithm (GA). The experimental results show that the proposed method outperforms the other methods in terms of solution quality, stability and computation efficiency. [21] presented an approach for edge detection in a binarized image using bacterial foraging algorithm. The edge detection problem is handled by first converting the input image into binary image and then running the modified bacterial foraging algorithm on that image. Bacteria detect the edges by evaluating the difference between intensity values of the present pixel with each of the neighbouring eight pixels.The binary watermark image deals with error-correction coding Arnold scrambling transform[27], and then embed into the bit plane of the original color image, which effectively improve the security of the algorithm. The embed position was chosen according to the secret key which is obtained during the course of the best scrambling degree calculation in Arnold transform.

III. PROPOSED ALGORITHM

This section provides the various steps required to successfully accomplish the objectives of the paper. The diagram of proposed embedding algorithm is shown in Fig.1 and extracting algorithm is shown in Fig.2.

Terms used:

WI- Watermarked Image

OI- Original Image

AT- Arnold Transform

BFO- Bacterial Foraging Optimization

EW- Extracted Watermark

In the embedding algorithm, process of embedding watermark in the original image is shown. The watermark is scrambled by using Arnold transform in order to provide more security. Modified SVD is used in this by using Bacterial Foraging Optimization. Then the watermarked image is obtained.

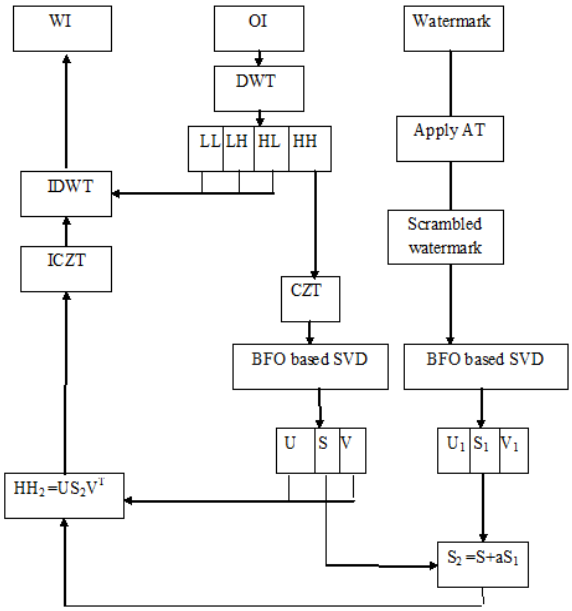


Fig.1 Embedding Algorithm

In Fig.2 Extraction algorithm is shown in which the watermark is extracted from the watermark image and by combining features of original image and watermark. The inverse of Arnold transform is used so as to remove scrambling form it and obtain the correct watermark from this process.

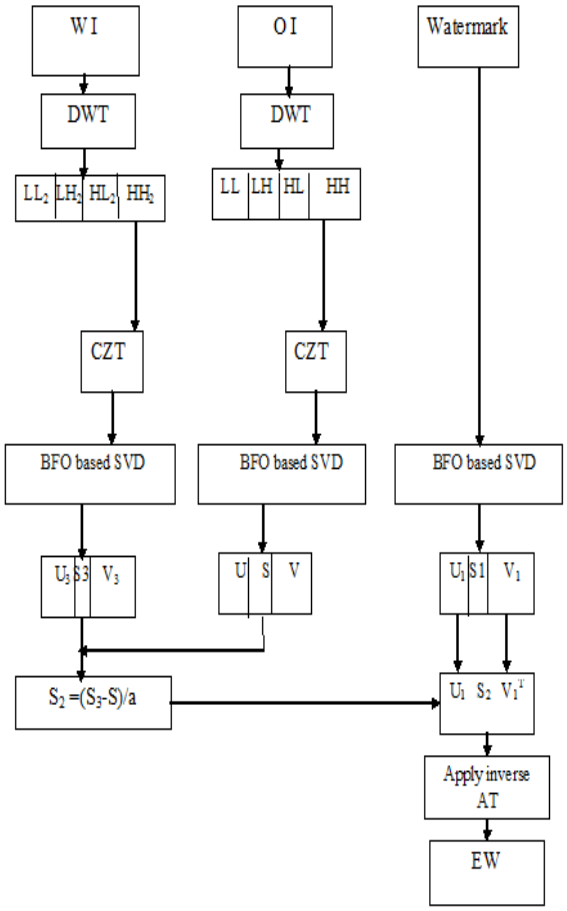


Fig.2 Extraction Algorithm

IV. EXPERIMENTAL RESULTS

A MATLAB simulation of BFO algorithm is done to evaluate the performance. In this section we have evaluated the performance of the proposed BFO based SVD scheme and compare it with the existing techniques.

Table 1 shows the comparison between existing technique and proposed technique of PSNR values. The values of proposed technique are better than the existing one. The higher PSNR values, more is the resemblance of reconstructed image to the original image.

Table 1 PSNR Values

Cover Image	Existing	Proposed
Lena	32.8502	39.3245
Baboon	33.1388	39.7851
Peppers	33.6705	37.4625
Barbara	33.4751	39.4086

Table 2 Cross correlation values for extracted watermark images based on **Lena** image.

	Symmetric		Non Symmetric	
Attacks	Existing	Proposed	Existing	Proposed
Sharpening	0.9834	0.9917	0.9823	0.9921
Gamma Correction	0.9879	0.9938	0.9871	0.9940
Histogram Equalization	0.9820	0.9921	0.9828	0.9922
No attack	0.9872	0.9943	0.9890	0.9948

Table 3 Cross correlation values for extracted watermark images based on **Babbon** image.

	Symmetric		Non Symmetric	
Attacks	Existing	Proposed	Existing	Proposed
Sharpening	0.9836	0.9899	0.9824	0.9904
Gamma Correction	0.9856	0.9924	0.9851	0.9931
Histogram Equalization	0.9824	0.9909	0.9818	0.9918
No attack	0.9875	0.9943	0.9893	0.9948

Table 4 Cross correlation values for extracted watermark images based on **Pepper** image.

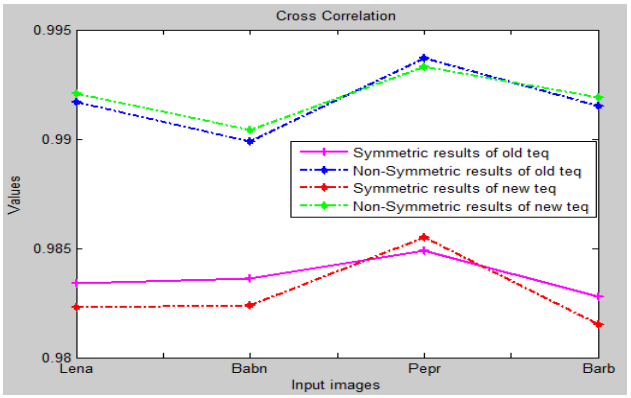
	Symmetric		Non Symmetric	
Attacks	Existing	Proposed	Existing	Proposed
Sharpening	0.9849	0.9931	0.9855	0.9933
Gamma Correction	0.9857	0.9930	0.9860	0.9937
Histogram Equalization	0.9879	0.9934	0.9868	0.9937
No attack	0.9875	0.9943	0.9893	0.9948

Table 5 Cross correlation values for extracted watermark images based on **Pepper** image.

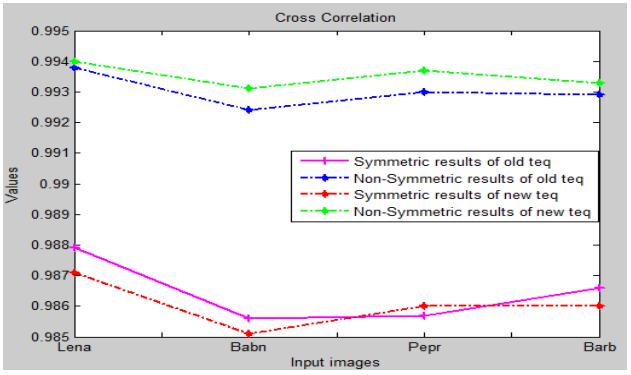
	Symmetric		Non Symmetric	
Attacks	Existing	Proposed	Existing	Proposed
Sharpening	0.9828	0.9915	0.9815	0.9919
Gamma Correction	0.9866	0.9929	0.9860	0.9933
Histogram Equalization	0.9877	0.9926	0.9879	0.9930
No attack	0.9875	0.9943	0.9893	0.9948

Table 2,3,4,5 shows the cross correlation values for extracted watermark based on different images with various attacks which were measured and compared with existing technique and proposed technique. It is also distinguished on the basis of symmetric and non-symmetric watermark. The values of proposed technique show the superiority over the existing one.

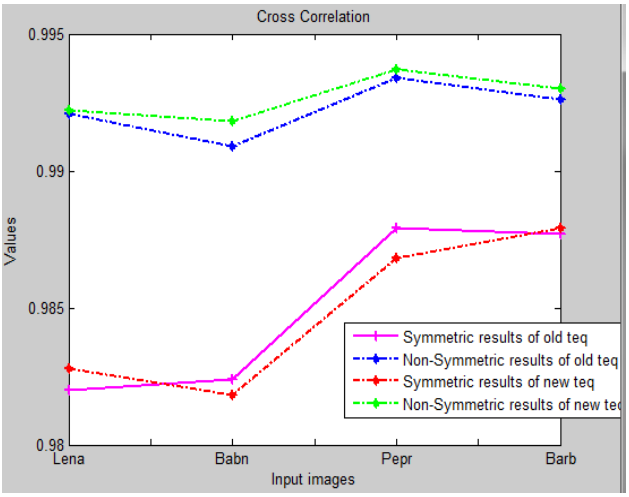
Figure3, 4, 5, 6 shows the comparison graph where x-axis represents the input images and y-axis represents the cross correlation values. It illustrates the values of symmetric and non-symmetric results of old and new technique. We can easily compare the values and can say that new technique values are better.



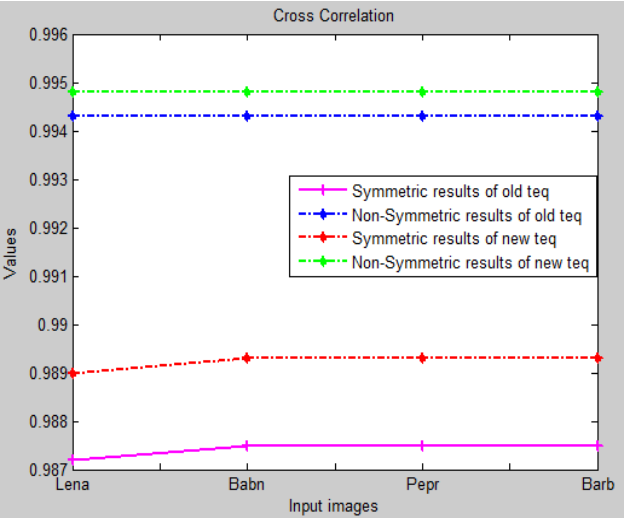
The graph shows cross correlation for sharpening attack on various images in figure



The graph shows cross correlation for gamma correction attack on various images in figure 4.



The graph shows cross correlation for histogram equalization attack on various images in figure 5



The graph shows cross correlation for no attack on various images in figure 6.

V. CONCLUSION

This paper has proposed a new technique which has utilized the features of DWT with CZT and Bacterial Foraging Optimization based SVD. The proposed algorithm satisfy the features of watermarking as

robustness and imperceptibility by improving the visual quality of the watermarked image and being robust against common signal processing operations and attacks. Also the Arnold transform is used for watermark scrambling for security purpose. Arnold transform transforms the watermark in such a way that it becomes meaningless for the hackers or crackers. The comparisons have been made among the proposed and the existing techniques and it has clearly shown that the proposed technique results are better than the existing ones. This work has not considered the effect of the DCT which is beneficial technique especially for jpeg images. Therefore in near future we will integrate DCT with the proposed technique. Also Fast Fourier transform (FFT) will also be considered in place of DWT to enhance the results further.

AUTHOR BIOGRAPHY

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