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A Novel Signature Based Watermarking Approach for Color Images Based On GA and PSO

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ABSTRACT
This paper presents a novel color image watermarking scheme based on Integer Wavelet Transform (IWT) and Singular Value Decomposition (SVD). A normalization of SVD is carried out through Genetic Algorithm (GA) to obtain the most effective singular components from the host image such that the quality of host image won't be affected. To achieve an optimal watermarking constant at embedding phase, Particle Swarm Optimization (PSO) is accomplished. Since the proposed approach is aimed to the color images, selection of an appropriate color space is very important. The appropriate color space selection is carried out based on the earlier studies. Here YCBCR is chosen as an appropriate color space and the logo watermark is embedded in both CB and CR plane. The proposed scheme also developed a lightweight authentication mechanismso that the extraction phase will be accomplished only if the signatures are matched. The experimental results show that the proposed approach yields awatermark which is invisible to human eyes and robust to wide variety of image processing and geometric attacks.
Keywords: *Image watermarking, IWT, SVD, GA, PSO, Signature, SHA-1.*

I. INTRODUCTION

In the recent past, application and popularization of multimedia technologies and computer networks have made duplication and distribution of multimedia contents such as audio, video or images much easier. From a copyright point of view and also from the security point of view, protection of such data has become an important and challenging task. Digital watermarking [1–3], is the most popular and efficient scheme for multimedia protection. In a digital image watermarking algorithm a watermark structure is embedded within the cover image to protect it from illegal usage. The watermark may be in the form of a visible or an invisible pattern that is embedded in the host data permanently. However, it is the main concern of the watermarking schemes that the embedded watermark should not degrade the quality of the host image and the inserted watermark must be as much invisible as possible.

Based on the domain in which the watermark inserted, the watermarking techniques are classified into two classes such as spatial domain watermarking techniques and frequency domain watermarking techniques. In spatial domain techniques, the watermark is directly inserted into the cover image by altering the pixel values [4,5, 6]. The simplest technique in this category is to modify the least significant bits (LSB) of the host image pixels by watermark image pixels [3]. The spatial domain methods have the advantages of easy implementation and low cost of operation but are generally not robust to geometrical and image processing attacks. In contrast, frequency domain methods transform the representation of spatial domain into the frequency domain and then modify its frequency coefficients to embed the watermark. There are many transform domain watermarking techniques such as discrete cosine transforms (DCT) [7, 8], singular value decomposition (SVD) [9,10], discrete Fourier transforms (DFT) [11], and discrete wavelet transforms (DWT) [12,13,14]. These techniques are more robust against many signal and image processing attacks in comparison to the spatial domain techniques but generally require higher computational cost. Another way to increase the performance of watermarking approaches is to use Artificial Intelligence techniques. Since the watermarking can be viewed as an optimization technique, the AI techniques such as Genetic Algorithm and Particle Swarm Optimization can be used for the purpose of optimization. In earlier various watermarking approaches are proposed based on the GA [15-17] and PSO [18-20]. But all these works have been dedicatedly designed for gray scale image watermarking and the extension of these types of bio-inspired optimization methods to the field of color image watermarking has been neglected.

Most of the above approaches are focused mainly towards the grey scale images. Color is also one important characteristic of the image. Compared with watermarking techniques proposed for grey scale images, the watermarking for color images is difficult. Since a color host image having three color planes, the entire processing needs to be carried out for three planes. Thus the computational time taken for whole process is three times greater than the time taken for grey scale images. Along with the computational time, the computational overhead also increases. These performance metrics are exponentially related to the size of the images considered for watermarking. Though there are some issues with color image watermarking, it is necessary to perform to achieve more security for various types of application which are related with the color of image. GA and PSO like artificial intelligence techniques solve this issue by optimizing the performance in an iterative fashion. Recently, a bio-principle inspired color image watermarking is developed in [21] based on the wavelet transform. In [22], GA is used for the optimization for all the planes in which the watermark is embedded. Though this approach achieved a greater performance, the main drawback of GA is slower convergence.

This paper proposes a new color image watermarking scheme based on Integer Wavelet Transform (IWT), Singular Value Decomposition (SVD), GA and PSO. Here PSO is used as an optimization technique and GA is used to obtain the normalized singular values at which the performance of proposed approach achieves more robustness and imperceptibility. This approach also proposed a new authentication mechanism by which the security increases further. Performance evaluation s carried out through various attacks over the watermarked image.

Rest of the paper is organized as follows: section II illustrates the details of various color space models and their transformation from RGB space. Section III describes the complete details about the proposed watermarking scheme. Section IV describes the experimental results and finally the conclusions are provided in section V.

II. RELATED WORK

This section describes the details of the preliminaries used to accomplish the proposed watermarking framework. This work mainly focused on the watermarking of color images. Since the specification of color space is very important for an image, the selection of appropriate color space is very important in the watermarking. Color images are the most important components of the widespread multimedia systems in the modern evolution. The main issue with the color image watermarking is the color artifacts. There is a huge effect on the performance of overall system even though there is a small change in the color component. Thus these color artifacts occurs in the watermarked image need to be removed before processing the image for extraction. There are so many image color models like RGB, HSV, HIS, YCbCr and YIQ. Thus there is necessity of appropriate color space selection among the above specified color models to overcome the general issues with color image watermarking.

A. RGB Color Space

The RGB color space is the simplest color representation system which uses the Cartesian coordination to represent an image. In this system, each color image is composed of three different matrices which are called the R, G and B channels respectively. These three channels are highly dependent on each other but in this investigation, we are concerned about data hiding in each of the mentioned matrices individually and its impacts on the transparency and robustness of the watermarked color image.

B. HSV Color Space

HSV is an M×N×3 image array whose three planes contain the hue, saturation, and value components for the image. The RGB values are divided by 255 to change the range from 0…..255 to 0….1. The conversion formulae are shown in the following equations.

$R' = R/255; G' = G/255; B' = B/255$ (1)

$C_{max} = \max(R', G', B')$ (2)

$C_{min} = \min(R', G', B')$ (3)

$\Delta = C_{max} - C_{min}$ (4)

$$Hue = H = \begin{cases} 0^0 & \Delta = 0 \\ 60^0 \times \left(\frac{G' - B'}{\Delta} mod 6\right), & C_{max} = R' \\ 60^0 \times \left(\frac{B' - R'}{\Delta} + 2\right), & C_{max} = G' \\ 60^0 \times \left(\frac{R' - G'}{\Delta} + 4\right), & C_{max} = B' \end{cases} \quad (5)$$

$$S = \begin{cases} 0, C_{max} = 0 \\ \frac{\Delta}{C_{max}}, & C_{max} \neq 0 \end{cases} \quad (6)$$

$V = C_{max}$ (7)

C. HSI Color Space

In HSI color system, each color image is composed of three different channels which contain the hue, saturation and intensity information, respectively. The HSI system has a great advantage in comparison to the other color systems; it decouples the intensity component from the color-carrying parts of the information which are the hue and saturation matrices in a color image. The following procedure illustrates the process of RGB to HIS conversion.

1. Take an RGB image
2. Represent the original RGB image in the binary format.
3. Find $\theta = \cos^{-1}\left\{\frac{\frac{1}{2}(R-G)(R-B)}{(R-G)^2+(R-B)(G-B)^{1/2}}\right\}$

$$Hue = H = \begin{cases}\theta & if\ B \leq G \\ 360-\theta & if\ B > G\end{cases} \quad (8)$$

$$Saturation = S = 1 - \frac{3}{R+G+B}\min(R,G,B)\ (9)$$

$$Intensity = I = \frac{1}{3(R+G+B)} \quad (10)$$

D. YCbCr Color Space

The YCbCr color space is used widely in digital videos. In this format, luminance information is represented by a single component, Y, and color information is stored as two color-difference components, Cb and Cr. Component Cb is the difference between the blue component and a reference value, and component Cr is the difference between the red component and a reference value. Given a digital pixel represented in RGB format, 8 bits per sample, where 0 and 255 represents the black and white color, respectively, the YCbCr components can be obtained according to equations (11) to (13):

$$Y = 16 + \frac{65.738R}{256} + \frac{129.057G}{256} + \frac{25.064B}{256}\ (11)$$

$$Cb = 128 - \frac{37.945R}{256} - \frac{74.494G}{256} + \frac{112.439B}{256} (12)$$

$$Cr = 128 + \frac{112.439R}{256} - \frac{94.154G}{256} - \frac{18.285B}{256} (13)$$

D. YIQ Color Space

This color space is used in televisions in the United States with the name of NTSC system. In the NTSC color space, image data consists of three components: luminance (Y), hue (I), and saturation (Q). The first component, luminance, represents grayscale information, while the last two components make up chrominance or color information. The following equations gives the conversion from RGB to YIQ space.

$$Y = 0.299 * R + 0.587 * G + 0.114 * B (14)$$

$$I = 0.596 * R - 0.274 * G - 0.322 * B (15)$$

$$Q = 0.211 * R - 0.523 * G + 1.703 * B (16)$$

E. YUV Color space

This color space is used as a part of color image pipeline. It encodes the color image or video taking human perception into account, allowing the reduced bandwidth for chrominance components, thereby typically enabling the compression artifacts to be efficiently masked by human perception. The conversion from RGB to YUV is accomplished through the following formulae;

$$Y = 0.299 * R + 0.587 * G + 0.114 * B (17)$$

$$U = -0.147 * R - 0.289 * G + 0.436 * B (18)$$

$$V = 0.615 * R - 0.515 * G - 0.100 * B (19)$$

From the above specified color space models, selection of an appropriate color space is very important to reduce the color artifacts in the watermarked image. In [22], different color spaces which commonly used to represent color images are tested and compared for wavelet based watermarking approaches in order to find the best candidate with respect to robustness and transparency of the final watermarked image. Based on the simulation results, [22] concluded that the selection of a color channel is completely user dependent but HIS and YCbCr has an optimal performance over the most of cases. Thus this approach also considered YCbCr and HIS models for the proposed watermarking scheme.

III. PROPOSED APPROACH

This section describes the complete details about the proposed watermarking scheme. The proposed system adopts both the GA and PSO as optimization techniques whereas the GA is used for the optimization of singular values and the PSO is used for overall optimization through a fitness function. Further a normalized block processing [23]and Normalized Singular Value Decomposition (NSVD) [23] is proposed to apply over the host image to make it more resilient to rotation and scaling attacks. Initially the color image is transformed into

YCbCr format and the obtained Cb and Cr components are processed for the further process. Here the both planes are processed for embedding. The watermark is embedded into the both planes and finally all the planes are merged and reformulated into the RGB format to obtain the final color watermarked image. In this approach a new authentication mechanism was developed to improve the security performance. A digital signature is generated and embedded in the watermarked image to ensure the authenticity. At the extraction process, initially the sign is extract and compared with original one. If the both are same then only it is allowed for further process. The complete step by stepprocess is illustrated in the following;

A. Embedding Process

Step 1: Let I be original host image in RGB color space. Transform the I form RGB to YCbCr color space, where Y is the luminance and C is the chrominance component. Here the obtained both Cr and Cb components are processed for embedding. So initially the Cr plane is processed followed by Cb. Hence the Cr and Cb components are considered as host image for evaluation.

Step 2: Apply normalized block processing to obtain normalized host image.

Step 3: Apply three level IWT on the normalized image.

$$N_{C_i} \rightarrow \{N_{C_iLL}, N_{C_iLH}, N_{C_iHL}, N_{C_iHH}\}$$

Where $C_i = \{C_b, C_r\}$.

Step 4: Evaluate an optimal normalization constant (γ) [23] through the GA algorithm and then perform the NSVD on the obtained LL band (N_{C_iLL}) of Normalized Host image having invariant blocks to get the largest singular value λ_{max}. Let $ll(i,j)$ be the invariant block at position (i,j).

$$ll(i,j) \rightarrow U_{ll} S_{ll}^{\gamma} V_{ll}^{T}$$

Where $S = diag(\lambda_k), k = 1,2,\dots,N$.

Step 5: Let W be the watermark image. Perform one level IWT on the Watermark image W

$$W \rightarrow \{W_{LL}, W_{LH}, W_{HL}, W_{HH}\}$$

Step 6: Evaluate an optimal normalization constant (γ) through the GA algorithm and then perform the normalized SVD (NSVD) on the obtained LL band of Watermark image W

$$W_{LL}(i,j) \rightarrow U_W(i,j) S_W^{\gamma}(i,j) V_W^{T}(i,j)$$

Step 7: Obtain principal component by multiplying the components U_W and S_W^{γ}.

$$W_{US}(i,j) = U_W S_W^{\gamma}$$

Let $W_{US}(i,j)$ be the principal component at pixel position(i,j), where $i,j = 1,2,\dots,N$.The watermarkprincipal component is embedded into the host image bymodifying the largest singular value.

Step 8: Embed the watermark principal component into the largest singular value of host image for each image block (i,j)using the following formula:

$$\lambda_{max}^{m} = \lambda_{max}(i,j) + \alpha W_{US}(i,j)$$

Where λ_{max}^{m} is the modified singular value of image block (i,j) and α is the watermarking constant can be obtained through the PSO.

Step 9: perform inverse SVD on the obtained singular values of every block (i,j).

$$ll^{m}(i,j) \leftarrow U_{ll} \left(S_{ll}^{\gamma} \right)^{m} V_{ll}^{T}$$

Where $\left(S_{ll}^{\gamma} \right)^{m}$ is the modified singular matrix for the block at position (i,j).

Step 10: reconstruct the complete LL band after getting individual blocks. Thus the reconstructed LL band will be a modified band of the normalized image, can be represented as $N_{C_iLL}^{m}$.

Step 11: Now embed a digital signature [23] into the modified LL as follows;

Step 1: Apply SVD to the modified LL band.

Step 2: consider the U and V matrices and generate a digest for both U and V through SHA-1 algorithm as

Digest(U) = SHA-1(U)

Digest(V) = SHA-1(V)

Step 3: perform bitwise XOR operation between Digest(U) and Digest(V) and name it as TMP1.

Step 4: Generate a secret key having same size of TMP1 and perform XOR operation between TMP1 and Secret key, name it as TMP2.

Step 5: choose first eight bits of the TMP2 as a digital signature.

Step 6: divide the modified LL band into 8*8 blocks.

Step 7: Pick up eight blocks based on the secret key and perform SVD for all eight blocks.

Step 8: Consider the U matrix$(U_{r,c})$ of every block and round of the values in the U matrix to less than or greater than to its nearest integer after multiplying with 10, $U_{r,c}^{m} = \lfloor U_{r,c} \rfloor$.

Step 9: Based on the digital bit stream SG, the $U_{r,c}^{m}$ is modified as follows;

a. If $U_{r,c}^{m}$ is even and the digital signature bit is 1 or if the $U_{r,c}^{m}$ is odd and the digital signature bit is 0, then add one to the $U_{r,c}^{m}$.

b. Otherwise keep $U_{r,c}^m$ unchanged.
Step 10: Perform inverse SVD for all the blocks and reconstruct the modified LL band.
Step 12: perform Inverse IWT (IIWT) to reconstruct the normalized watermarked image (N_I^W).

$$N_{C_i}^W \leftarrow \{N_{C_iLL}^m, N_{C_iLH}, N_{C_iHL}, N_{C_iHH}\}$$

Step 13: perform inverse redistribution and normalization to obtain the final watermarked image $I_{C_i}^W$.
Step 14: here the $I_{C_i}^W$ represents the final watermarked image in the respective plane C_i. After obtaining the watermarked images of both planes they are retransformed into the RGB space as,

$R = 1.164(Y - 16) + 1.596(Cr - 128)$ (20)
$G = 1.164(Y - 16) - 0.813(Cr - 128) - 0.391(Cb - 128)$ (21)
$B = 1.164(Y - 16) + 2.018(Cb - 128)$ (22)

The final watermarked image is represented as I^W.

B. Extraction Process

Further the extraction process is carried out over the distorted watermarked image. Here the distorted watermarked image is represented with I^{W*} and it is given as input for the extraction process. Before going to the extraction process a safety test was performed to protect the proposed scheme from the false positive detection. The authentication process was performed by matching the digital signature with the extracted signature from the watermarked image. If the values are matched, the watermark extraction procedure was continued otherwise the process was stopped due to the high probability of false positive detection. The complete extraction process is represented as follows;
Step 1: Transform the I^{W*} into YCbCr color space using (11-13)to attain $I_{C_i}^{W*}, where\ C_i = \{C_b, C_r\}$, and apply the whole extraction process on both the Cb and Cr planes individually.
Step 2: apply the normalization to obtain the normalized plane$NI_{C_i}^{W*}$.
Sep 3: Apply three level DWT on the obtained normalized plane.

$$NI_{C_i}^{W*} \rightarrow \{NI_{C_iLL}^{W*}, NI_{C_iLH}^{W*}, NI_{C_iHL}^{W*}, NI_{C_iHH}^{W*}\}$$

Step 4: perform signature extraction through the $NI_{C_iLL}^{W*}$as follows;
Step 1: divide the LL band into 8*8 blocks.
Step 2: Select the blocks based on the secret key
Step 3: perform SVD for all the selected blocks
Step 4: Examine the $U_{r,c}$ through the following condition:

$$sig(i) = \begin{cases} 1 & mod(\lfloor U_{r,c} \div 10 \rceil, 2) = 0 \\ 0 & otherwise \end{cases}$$

Where *i*=1,2,…,8 is the digital signature length.
Step 5: Apply NSVD on every block $ll_{C_i}^*(i,j)$ to obtain the maximum singular value $\lambda_{C_imax}^*\ (i,j)$.

$$ll_{C_i}^*(i,j) \rightarrow U_{ll_{C_i}^*(i,j)}^* \, (S_{ll_{C_i}^*(i,j)}^*)^\gamma \, (V_{ll_{C_i}^*(i,j)}^*)^T$$

Step 6: extract the distorted principal component $W_{US}{}^*(i,j)$ through the following formula as,

$$W_{C_i}{}^*(i,j) = \frac{(\lambda_{C_imax}^*\ (i,j) - \lambda_{C_imax}\,(i,j))}{\alpha}$$

Step 7: Perform inverse NSVD by multiplying the obtained principal component $W_{C_i}{}^*(i,j)$ with V_W^T to obtain a distorted block $W_{ll(i,j)}^*$

$$W_{ll(i,j)}^* \leftarrow W_{C_i}{}^*(i,j)V_W^T$$

Step 8: Reconstruct the distorted LL band of watermark image by merging the all obtained distorted blocks.

$$W_{C_iLL}^* \leftarrow \{W_{ll(i,j)}^*\}$$

Step 9: Perform Inverse IWT to obtain the final extracted watermark,W^*.

$$W_{C_i}^* \leftarrow \{W_{C_iLL}^*, W_{LH}, W_{HL}, W_{HH}\}$$

Where $W_{C_i}^*$ is the extracted watermark form the C_ith plane of watermarked image.This entire process repeats for entire population generated for optimization in GA and PSO.

IV. SIMULATION RESULTS

In order to evaluate the efficiency of proposed approach, several experiments are carried out through three standard color images like Lena, Peppers and Mandrill. All these test images are of size 512*512 and a logo is used as a watermark. The proposed approach is implemented using matlab software. Figure.1 shows the test host images and logo watermark.

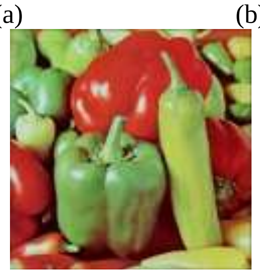
(a) (b)

(c) (d)

Figure.1 test images (a) Lena (b) mandrill (c) peppers (d) Andhra University logo watermark

According to the proposed approach, initially the original host image is transformed from RGB color spac eto YCBCR space and then the logo watermark is embedded into the both CB and CR planes. After embedding both the planes are reverse transfomred into the RGB space. The obtained watermarke dimages are shown below.

(a) (b)



(c)

Figure.2 watermarked images (a) Lena (b) mandrill (c) peppers

To evaluate the performance of proposed approach, four perfomrance metrics such as Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), Normalized Correlation (NC) and Structural Similarity Index Measure (SSIM) were considered and the respective mathematical formulation is given as,

$$MSE = \frac{1}{MXN}\sum_{i=1}^{M}\sum_{j=1}^{N}(w(i,j) - w^*(i,j))^2 \quad (23)$$

Where

w=original watermark image

w^* = extracted watermark image

$$PSNR = 10 * \log(255^2/_{MSE}) \quad (24)$$

$$NC = \sum_{i=1}^{M}\sum_{j=1}^{N}\frac{w(i,j)*w^*(i,j)}{(w(i,j))^2*w^*((i,j))^2} \quad (25)$$

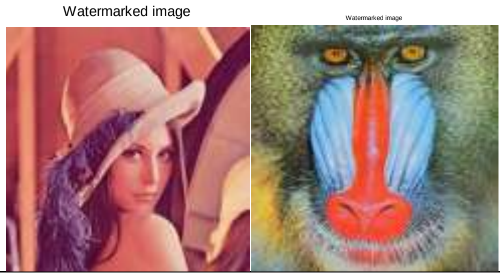
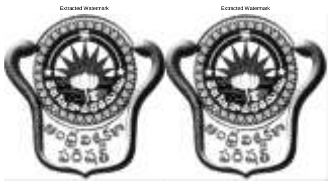
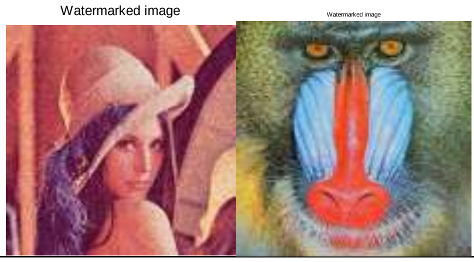
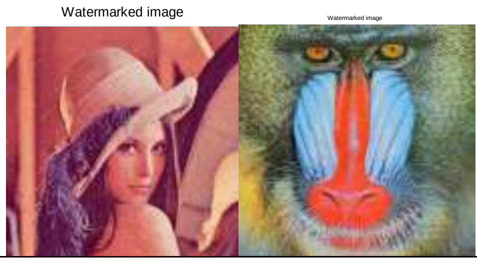
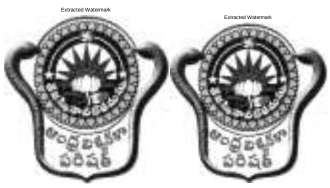
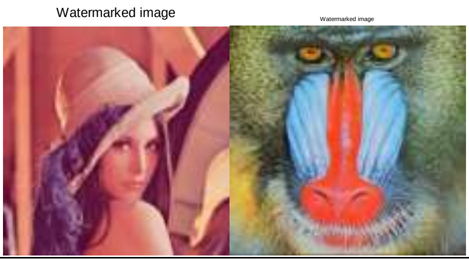
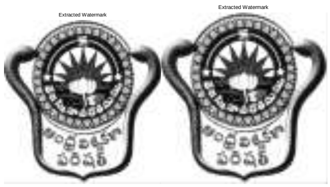
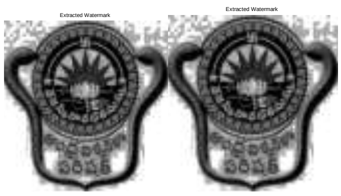
$$SSIM = \frac{\sum_i\sum_i w(i,j)\otimes w^*(i,j)}{\sum_i\sum_i(w(i,j))^2} \quad (26)$$

The NC is also used for the evaluation of fitness function of PSO. The fitness function of PSO is defined as

$$fitness\ (s_j) = 1 - Average(NC_j)$$

$$NC_j = \frac{1}{n_{attack}}\sum_{k=1}^{n_{attack}} NC(w, w_j^{*,k}) \quad (27)$$

Where $w_j^{*,k}$ represents the extracted watermark through the proposed approach characterized by the position of the j_{th} particle. The smaller fitness value means the better robustness. Let, n_{attack} signifies the number of attacks, here the n_{attack} is set to 8. Because, totally eight types of attacks are simulated in the simulation. They are (1) Gaussian noise Attack (GNA)(2) salt & pepper noise attack (SPA), (3) Median Filtering attack (MFA), (4) HistogramEqualization attack (HEA), (5) Rotation attack (RA), (6) Contrast Enhancemnet attack (CEA), (7) cropping attack (CA) and (8) Scalling Attack (SA). The obtained watermarked images an dthe extratcted watermarks during all the attack cases are represened below;

No	Attack	Watermarked Image	Extracted Watermark
1	No attack		
2	Gaussian Noise		
3	Salt & pepper Noise		
4	Median Filter		
5	Histogram Equalization		

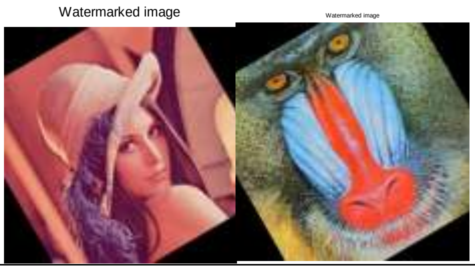
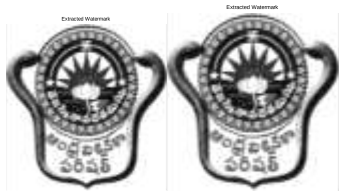
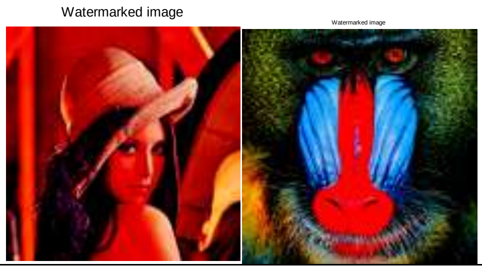
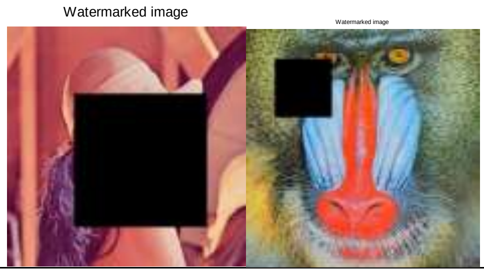
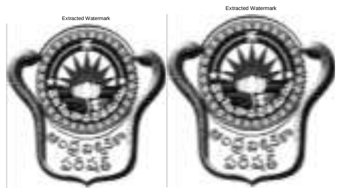
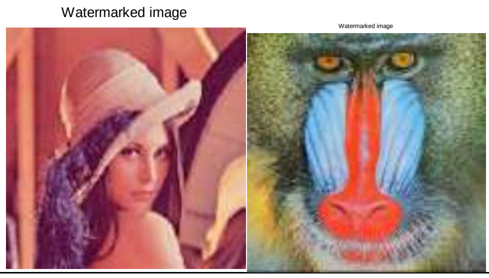
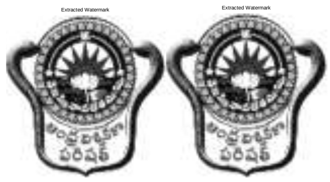
6	Rotation		
7	Contrast Enhancement		
8	Crop		
9	Scaling		

Figure.3 Watermarked images and Extracted Watermark images under various cases

Here initially the logo watermark is embedde in the lena image and the obtained MSE, PSNR, NC and the SSIM are represneted in the following tables. Table.1 represnets the obtained results for three planes under the case of no attack scenario. Table.2 an dtable.3 represnets the obtained results under the case of image processing attacks and geomerical attacks respectively.

Table.1 Observed results for three planes (R, G and B) of cover image Lena under no attack scenario

Cover Image		Conventional [24]			Proposed		
Metric		PSNR	NC	SSIM	PSNR	NC	SSIM
NA	R	42.3358	0.9905	0.9810	50.2234	0.9932	0.9845
	G	41.8520	0.9910	0.9799	51.4129	0.9939	0.9853
	B	40.7518	0.9907	0.9807	50.3960	0.9948	0.9882

Table.2 Observed results for three planes (R, G and B) of cover image Lena under Image processing attacks

Cover Image		Conventional [24]			Proposed		
Metric		PSNR	NC	SSIM	PSNR	NC	SSIM
GNA	R	39.8874	0.9826	0.9816	49.7859	0.9886	0.9696
	G	39.8745	0.9824	0.9819	50.1274	0.9893	0.9703
	B	40.0012	0.9822	0.9823	49.9986	0.9876	0.9710
SPA	R	40.1285	0.9856	0.9638	46.9752	0.9896	0.9498
	G	40.2471	0.9872	0.9630	47.2354	0.9887	0.9503
	B	40.4978	0.9844	0.9644	47.5589	0.9885	0.9512
MFA	R	39.1222	0.9319	0.9447	45.3987	0.9404	0.9526
	G	39.2072	0.9328	0.9453	45.7986	0.9415	0.9493
	B	39.3524	0.9332	0.9463	45.9963	0.9425	0.9523
HEA	R	30.4241	0.9266	0.9363	39.0021	0.9311	0.9395
	G	30.4496	0.9287	0.9381	39.3548	0.9328	0.9408

	B	30.5873	0.9293	0.9374	39.5687	0.9330	0.9399
CEA	R	33.9952	0.9355	0.9328	39.7441	0.9413	0.9442
	G	33.8257	0.9385	0.9353	39.7863	0.9429	0.9458
	B	33.6647	0.9397	0.9347	39.8964	0.9457	0.9466

Table.3 Observed results for three planes (R, G and B) of cover image Lena under geometrical attacks

Cover Image		Conventional [24]			Proposed		
Metric		PSNR	NC	SSIM	PSNR	NC	SSIM
RA	R	25.8823	0.9764	0.8754	38.6682	0.9866	0.8817
	G	25.6894	0.9771	0.8763	38.7549	0.9875	0.8828
	B	25.7541	0.9779	0.8761	38.6889	0.9882	0.8836
CA	R	23.9687	0.9642	0.8519	28.8025	0.9725	0.8696
	G	23.5478	0.9653	0.8522	28.9347	0.9735	0.8654
	B	23.7412	0.9660	0.8532	28.8561	0.9741	0.8683
SA	R	29.9683	0.9901	0.9614	37.3358	0.9915	0.9720
	G	30.2258	0.9896	0.9618	37.4478	0.9917	0.9722
	B	30.5579	0.9893	0.9609	37.5008	0.9905	0.9718

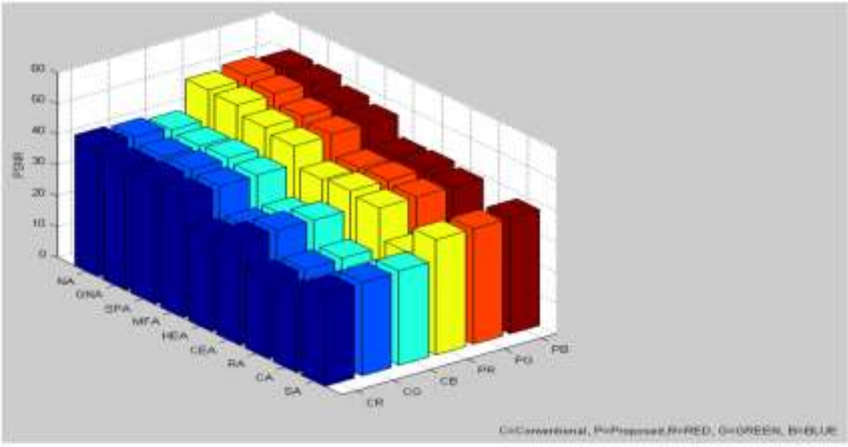


Figure.4 PSNR observations for cover image of Lena under various attack cases

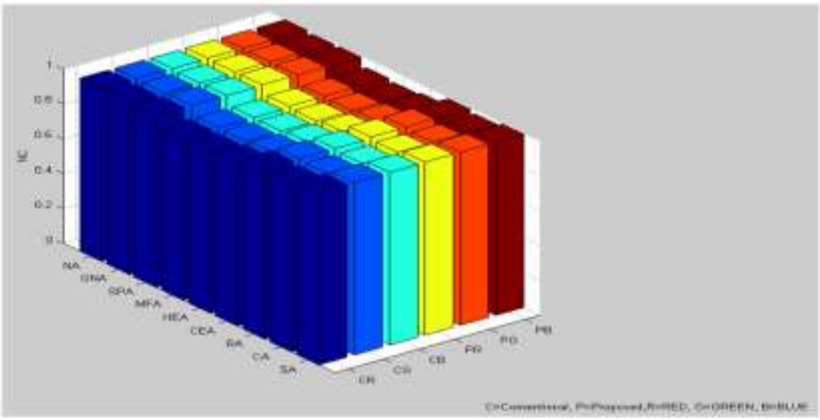


Figure.5 NC observations for cover image of Lena under various attack cases

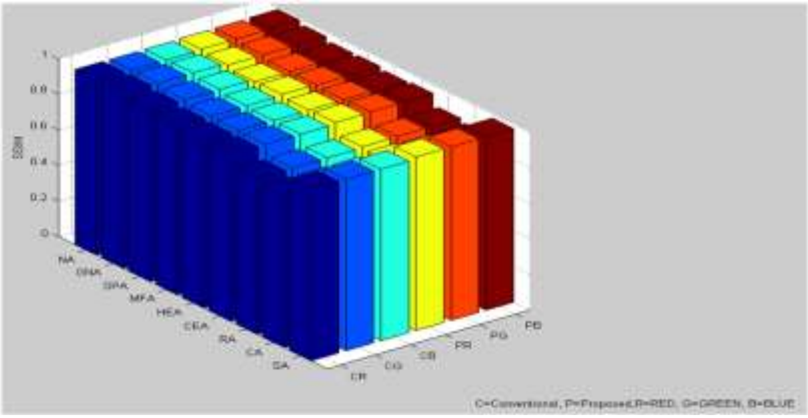


Figure.6 SSIM observations for cover image of Lena under various attack cases

Figure.4 describes the PSNR details for various simulations performed. In every test case, the proposed approach is compared with conventional approach and observed that the PSNR of proposed approach is high compared with conventional one. Similarly the observed NC and SSIM results for all simulation are shown in figure.5 and figure.6 respectively. From figure.5 and figure.6 it was observed that the NC and SSIM of proposed approach is high compared with conventional approach. Since the proposed approach is applying two optimization techniques at feature extraction phase and embedding phase, there is more optimization compared with conventional approach. The proposed approach also tried to increase the security by proposing a new signature embedding mechanism. Here the proposed approach generated a signature without any additional overhead. Thus, the proposed approach achieved an enhanced NC with less complexity only.

V. CONCLUSION

A new digital image watermarking scheme is developed in this paper to provide the security for image information like Logos, Symbols etc., which require a strict authentication. Here the proposed approach applied two state optimization scheme by considering both GA and PSO as optimization techniques. GA is used to optimize the feature selection and PSO is used to optimize the embedding performance. Since the singular values carried more useful information in images, the selection of Singular values for embedding is most critical. The selection of Singular values should be in such a way that the quality of host image should not be degraded due to embedding. Here the proposed NSVD extracts the normalized singular components from the host image and the singular values of watermark image are embedded into them. GA optimizes the normalization constant through an iterative process. Various test images are processed during the simulation to evaluate the performance of proposed approach and for the extracted watermark images, a numerical evaluation is performed by measuring the metrics like PSNR, NC and SSIM. The simulation is also carried out for various types of attacks and the obtained results illustrate the efficiency of proposed approach.

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