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Improved Scaling for Image Quality Enhancement in Digital Image Watermarking

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ABSTRACT*:* Digital information revolution has brought about many advantages and new issues. The protection of ownership and the prevention of unauthorized manipulation of digital audio, image, and video materials has become an important concern due to the ease of editing and perfect reproduction. Watermarking is identified as a major means to achieve copyright protection. It is a branch of information hiding which is used to hide proprietary information in digital media like photographs, digital music, digital video etc. In this paper, a new image watermarking algorithm that is robust against various attacks is presented. DWT (Discrete Wavelet Transform) and SVD (Singular Value Decomposition) have been used to embed two watermarks in the HL and LH bands of the host image.
Simulation evaluation demonstrates that the proposed Technique with stand various attacks.

KEYWORDS*:* Discrete Wavelet Transform (DWT, Singular Value Decomposition (SVD), Peak Signal to Noise Ratio (PSNR) , Discrete cosine transform (DCT).

I. INTRODUCTION

In the present globalization, the availability of the Internet and various image processing tools opens up to a greater degree, the possibility of downloading an image from the Internet, Manipulating it without the permission of the rightful owner. For reason such as this and many others, image authentication has become not only an active but also vital research area. Embedding watermarks [1]-[4] in both signals and images can cause distortion in them. In general, a successful watermarking scheme should satisfy the following fundamental requirements.

1) Imperceptibility: the perceptual difference between the watermarked and the original documents should be unnoticeable to the human eye, i.e. watermarks should not interfere with the media being protected.

2) Trustworthiness [5]–[8]: a satisfactory watermarking scheme should also guarantee that it is impossible to generate forged watermarks and should provide trustworthy proof to protect the lawful ownership.

3) Robustness [9]–[12]: an unauthorized person should not be able to destroy the watermark without also making the document useless, i.e., watermarks
should be robust to signal processing and intentional attacks. In particular, after common signal processing
operations have been applied to the watermarked image like filtering, re-sampling, cropping, scaling, digital-to-analog, analog-to-digital conversions, compression, geometric transformation, rotation, etc., they should still be Detectable . Generally, watermarking can be classified into two groups: spatial domain methods and transform domain methods. In spatial domain approaches, the watermark is embedded directly to the pixel locations [13], [14]. Embedding the watermark in the spatial domain is the direct method. It has various advantages like less computational cost, high capacity, more perceptual quality but less robust and it mainly suits for authentication applications. In transform domain approaches, a mathematical transform is applied to the original image to embed watermark into the transform coefficients, then apply inverse transform to get the embedded image. It has more robust, less control of perceptual quality and mainly suits for copyright application. The most frequent used methods are discrete cosine transform (DCT) domain [15], [16], discrete wavelet transform (DWT) domain [17], singular value decomposition (SVD) domain [18]. They now come into more widespread used as they always have good robustness to common image processing The proposed watermarking scheme is based on DWT and SVD technique. Two watermark images are embedded in the LH and HL bands of the cover image after two level DWT decomposition. The embedding is done by modifying the singular

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values in LH and HL bands of the cover image with the singular values of the watermark images. The paper is organized as follows. Section II discuss
about DWT. Section III explains the SVD. Section IV describes the proposed system. Section V gives the simulation results and section VI projects the performance analysis. Finally section VI gives the conclusion.

II. RELATED WORK

As stated earlier that transform domain based watermarking scheme is always a better choice than spatial domain based watermarking scheme. This can be done by using different transformation
like DCT, SVD and DWT. In this section, we will briefly describe the DCT, DWT and SVD transformations in below.

2.1. Discrete Wavelet Transform (DWT)

The basic idea of DWT in which a one dimensional signal is divided in two parts one is high frequency part and another is low frequency part. Then the low frequency part is split into two
parts and the similar process will continue until the desired level. The high frequency part of the signal is contained by the edge components of the signal. In each level of the DWT (Discrete Wavelet Transform) decomposition an image separates into four parts these are approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) *for* detail components. In the DWT decomposition input signal must be multiple of 2n. Where, n represents the number of level. To analysis and synthesis of the original signal DWT provides the sufficient information and requires less computation time. Watermarks are embedded in these regions that help to increase the robustness of the watermark. A one level DWT decomposition process is shown in Figure 1.

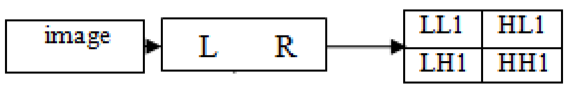

Figure 1. One level DWT decomposition process

2.2. Stationary wavelet transformation (SWT) The stationary wavelet transform (SWT) is a wavelet transform algorithm designed to overcome the lack of translation-invariance of the discrete wavelet transform (DWT). SWT algorithm is very simple and is close to DWT [3]. The SWT is an inherently redundant scheme as the output of each level of SWT contains the same number of samples as the input. So for a decomposition of N levels, there is a redundancy of N in the wavelet coefficients. The following block diagram depicts the digital implementation of SWT. I. Description: Stationary Wavelet Transform performs a multilevel 1-D stationary wavelet decomposition using either a specific orthogonal wavelet or specific orthogonal wavelet decomposition filters. N must be a strictly positive integer and length(X) must be a multiple of 2N. The SWT is preferred as the wavelet transformation, since unlike the other wavelet transforms, the SWT procedures does not include any down sampling steps, instead, a null placing procedure is applied [6]. We simply apply appropriate high and low pass filters to the data at each level to produce two sequences at each level. Instead of decimation, two new sequences will be generated of same length as the original sequence. Instead, filters are modified at each level, by padding them with zeros.The stationary wavelet transform, the image is decomposed into high and low frequency components, called first level decomposition. Once again the low frequency components of first level are decomposed into low and high frequency components, called second level decomposition. The preferred watermark is embedded into the second level decomposed low frequency components for robustness.

2.3 Singular Value Decomposition(SVD)

The singular value decomposition (SVD) is a factorization of a real or complex matrix, with many useful applications in signal processing and statistics.

The fundamental properties of SVD from the viewpoint of image processing applications are: i) the singular values (SVs) of an image have very good stability, i.e., when a small perturbation is added to an image, its SVs do not change significantly; and ii) SVs represent intrinsic algebraic image properties.

In this section, we describe a watermark casting and
Detection scheme based on the SVD. From the viewpoint of linear algebra, we can observe that a

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Discrete image is an array of nonnegative scalar entries, which may be regarded as a matrix. Let such an image be denoted by A. Without loss of generality, we assume in the subsequent discussions that A is a square image, denoted by N N A E where E represents either the real number domain or the complex number domain. The SVD of A is defined as H A X T where N N X E and N N T E are unitary matrices and N N E is a diagonal matrix with nonnegative numbers on the diagonal and zeros on the off diagonal. The nonnegative components of represent the luminance value of the image. Changing them slightly does not change the image quality and
they also don't change much even on attacks, watermarking algorithms normally make use of these two properties. The unique property of the SVD transform is that the potential N2 degrees of freedom (DOF) or samples in the original image now get mapped into SVD has many good mathematical characteristics. The theoretical background of SVD technique in image processing applications to be noticed is:
a) The SVs (Singular Values) of an image has very good stability, which means that when a small value is added to an image, this does not affect the quality with great variation.
b) SVD is able to efficiently represent the intrinsic algebraic properties of an image, where singular values correspond to the brightness of the image and singular vectors reflect geometry characteristics of the image.
c) An image matrix has many small singular values compared with the first singular value. Even ignoring these small singular values in the reconstruction of the image does not affect the quality of the reconstructed image.
Any image can be considered as a square matrix without loss of generality. So SVD technique can be applied to any kind of images. If it is a gray-scale image, the matrix values are considered as intensity values and it could be modified directly or changes could be done after transforming images into frequency domain. The SVD belongs to orthogonal transform which decompose the given matrix into three matrices of same size. To decompose the matrix using SVD technique it need not be a square matrix.

III. PROPOSED METHODOLOGY AND WATERMARKING ALGORITHMS

In the proposed watermarking technique, A DWT, DCT and SVD based hybrid watermarking technique is formulated. In this subsection, we have described the watermark embedding and extraction process by using flowchart and algorithmically.

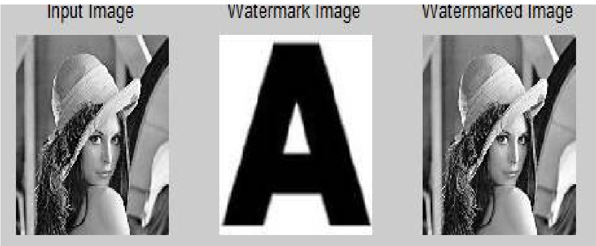

Fig-1(a) Embedding work on Leena image.

1. Embedding Process: Read both input image and watermark image.

- Use 1-level DWT to decompose the input image into four sub-bands (i.e. LL, LH, HL, HH).
- Use 2-level DWT haar to again split LL into four sub-bands (i.e. LL2, LH2, HL2, HH2).
- Apply SVD to LL2 sub band that split the image into I_u, I_ s and I_ v matrix form that extract the singular values.
  Where s = scaling matrix.
  [I_u,I_s,I_v] = svd(LL2)
- Apply DWT to the watermark image to decompose the watermark image into four sub bands
- Apply SVD to LL sub band to extract singular values
  [W_u,W_s,W_v] = svd(WLL)
- Apply optimal scale matrix, that gives best values and stores in alpha variable.
  alpha=get_optimal_scale_matrix(scaleMatrixDim); • For watermarked image use this formula:
  S_n = I_s + (alpha.*W_s); new_LL = I_u*S_n*I_v'; • Apply inverse DWT to get the watermarked image.

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iLL2 = idwt2(new_LL,LH2,HL2,HH2,'haar'); watermarked = idwt2(iLL2,LH,HL,HH,'haar'); •Calculate the PSNR value for input host image and watermarked image using formula[3].

Fig-1(b). extracted watermarked Leena image

2. Extraction Process: • Apply 2 level haar DWT to decompose the watermarked image into four sub bands.

- Apply SVD to WMLL2 sub band to extract the singular values. [Wm_u,Wm_s,Wm_v] = svd(WMLL2)
- Apply 2 level haar DWT on input image to decompose image into four sub bands(i.e, LL2, LH2, HL2, HH2)
- Apply SVD to LL2 sub band [I_u,I_s,I_v]=svd(LL2);
- Compute Sw, where sw is the singular matrix of extracted image. S_w= (Wm_s-I_s)./alpha;
- Apply haar DWT on watermark image to decompose the watermark image into sub bands(i.e, WLL,WLH,WHL,WHH)
- Apply SVD to WLL sub band to extract the singular values.
  [W_u,W_s,W_v] = svd(WLL)
- Calculate new extracted watermark by using this formula:
  new_WLL=W_u*S_w*W_v'
- Apply inverse DWT to get the extracted watermark image.EWatermark_img=idwt2(new_WLL,WLH,WHL,WHH,'haar'); EWatermark_img=uint8(EWatermark_img);
- Check out the correlation coefficient of watermarked image and extracted watermark image that will be noiseless.

Dynamic Scaling: dynamic Scaling helps for providing the best values. In dynamic Scaling, we used two main factors:

Differential Evolution(DE) (1): DE algorithm worked on a population of candidate solutions(called agents). These candidate solutions are moved around in the search space and creating new candidate solution by combining the existing ones according to its simple formula and if the new position of an agent is an improvement than it is accepted otherwise the new position is discarded. Pseudocode of DE are[10] :

Formally, let f : $R\ n \rightarrow$ R be the cost function which must be minimized or fitness function which must be maximized. Let x ∈ $R\ n$ designate a candidate solution (agent) in population. The basic DE algorithm can then be described as follows:

- Initialize all x as agents with random positions in search-space.
- Until a termination condition is met (e.g. number of iterations performed, or an adequate fitness reached), repeat the following:
- For each agent x in the population do:
- Pick three agents u, v and w from the population at random, they must be distinct from each other as well as from agent x
- Pick an random index R $\{1, \dots \dots n\}$ (where,n being the dimensionality of the problem to be optimized).
- Compute the agent's new position y=[y1,……yn] as follows:
- For each i, pick an number that are uniformly distributed r ≡ (0,1)
- If r i < CR(crossover probabiltity) or i=R then set yi=$\alpha i + F *$(v-z)
- otherwise set yi=xi

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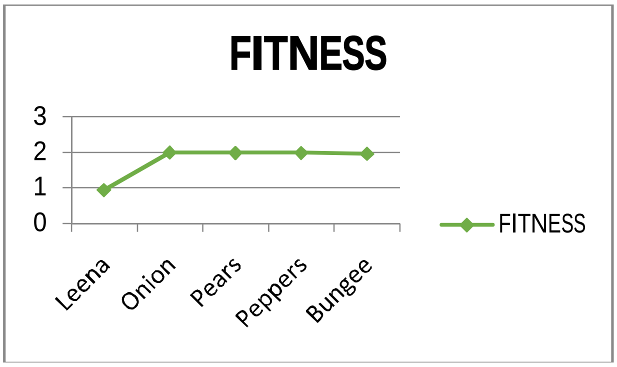
- (In essence, the new position is outcome of binary crossover of agent x with intermediate agent z=u+F*(v-w).)
- If f(y) < f(x) then replace that agent in the population with the improved candidate solution, that is, replace x agent with y agent in the population.
- Pick the agent from the population that has the highest fitness value or lowest the cost value and return it as the best candidate solution.

In which, F∈ [0,2] is the differential weight and CR∈ [0,1] is the crossover probability,and the population size NP>= 4. The choice of F, CR and NP parameters of DE can have a large impact on the optimization performance.

Fitness Function(1) : In this paper, we used PSNR values as fitness function. Computing PSNR function based on scaling factor of the resultant watermarked images from the techniques DWT and SVD for the purpose of measuring the distinctive distortion between the input image and the watermarked image[9]. The value of PSNR been taken to represent fidelity of watermarked image, the fitness function increases with the increase in the value of PSNR(Peak Signal to Noise Ratio). So, optimization of the fidelity takes place for the given value of robustness. As quantitative measure of the degradation effect caused by various attacks we use Peak-Signal-to-Noise Ratio. High PSNR indicates the lower value of degradation hence indicates that the watermarking technique is very much robust against number of attacks. It improves the quality of an image.



Performance matrix :

PSNR Calculation(2) : Peak signal to noise ratio (PSNR) The PSNR is evaluated in decibels and is inversely proportional the Mean Squared Error. It is given by the equation

$$PSNR = 10\log 10 \frac{255}{\sqrt{\mathrm{MSE}}}$$

Higher the value of PSNR better is the quality of the watermarked image.

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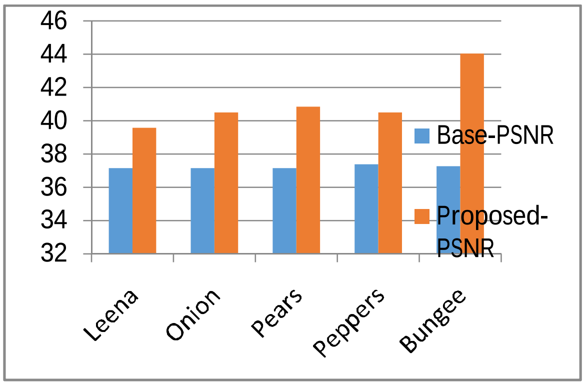

MSE Calculation : The PSNR is employed to evaluate the difference between an original image and watermarked image. For the robust capability, mean absolute error (MSE) measures the difference between an original watermark W and corresponding extracted watermark W1 as shown by equation 3.

$$\text{MSE } (w,w1)=\sum_{i=0} d \left(\frac{w-w1}{w}\right)$$

Generally, if PSNR value is larger than 40db the watermarked image is within acceptable degradation levels, i. e the watermarked is almost invisible to human visual system. A lower mean absolute error reveals that the extracted watermark W resembles the W1 more closely. The strength of digital watermarking method is accessed from the watermarked image, which is further degraded by attacks and the digital watermarking performance of proposed method is compared with that of Chen [4]. If a method has a lower MSE (W, W1), it is more robust.

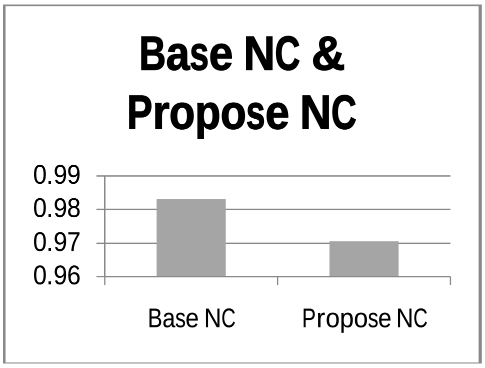

Fig 3 show the comparison between base NC and Propose NC.

CC Calculation : Correlation coefficient detects how similar the two images of same size are. The value of CC lies between 0 and 1. The value of 1 for CC is considered as the idol value. The formula given in Equation (3) is used to calculate the value of CC, where C and S represents cover image and watermarked image, respectively. The values M1 and M2 are mean pixel values of C and S, respectively

$$CC=\frac{(C(i,j)-M1)(S(i,j)-M2)}{\sum \sqrt{\sum(C(I,J)-M1)^2}\sqrt{\sum(S(I,J)-M2)^2}}$$

Structural similarity index measure is a metric used to detect that how much dissimilar the distorted image is when compared to the original image in terms of structural information.

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IV. SYSTEM DETAILS

A. Hardware details

We have validated our results on machine with the configuration of installed memory (RAM 3GB), 64- bit Operating System, having processor Intel(R) Core(TM) i3-2310M CPU @ 2.10GHz. Here, we have our own created Dataset e.g., images of Flags of different countries.

B. Software details

MATLAB 7.0,WINDOW 7

The Experimental work is done on the MATLAB.

MATLAB is a software package for high performance numerical computation and visualization. It provides an interactive environment with hundreds of built-in functions for technical computation, graphics and animation. The name MATLAB stands for **Matrix Laboratory**. MATLAB is an efficient program for vector and matrix data processing. It contains ready functions for matrix manipulations and image visualization. MATLAB provides a suitable environment for image processing. Although MATLAB is slower than some languages (such as C), its built in functions and syntax makes it a more versatile and faster programming environment for image processing. In this paper, proposed work is done on MATLAB as it contains ready-made functions so this tool is easy to use. We are going to compare existing and proposed approach.

IV. SIMULATION RESULTS

In this Paper " Improved scaling for image quality enhancement in digital image watermarking" the 'Leena image' show four screen shot to prove that original image (host image)and watermark image better result in watermarked image .In first Fig-1(a) show the embedding process which show the input image and watermark image and watermarked image. In second Fig-1(b) show the extraction process which show the watermark image and extracted image. In Fig-1(c) show the fitness function graph takes 50 iterations when this iterations are completed then it gives global best value of Leena image 1.933.in Fig-1(d) show the PSNR value=39.592987 and NC value = 0.9363 are best result.

Fig-1(a) Embedding work on Leena image.

Fig-1(b). extracted watermarked Leena image

V.CONCLUSION AND FUTURE WORK

In this table show the result of all tested images which are gives the better result for using the dynamic scaling and fitness function and doing the propose work on base work.

EXITING WORK TABLE				PROPOSE WORK TABLE		
Sr.no.	Image	Base-PSNR	NC	Proposed PSNR	NC	FITNESS
1	Leena	37.15657	0.9638	39.59299	0.9363	0.933
2	Onion	37.14614	0.9945	40.4921	0.9891	1.989
3	Pears	37.14579	0.9922	40.83591	0.9874	1.985
4	Peppers	37.37293	0.991	40.50524	0.9851	1.984
5	Bungee	37.27592	0.9744	44.02476	0.9546	1.953
		37.21947	41.0902	41.0902	0.9705	1.7688

Fig-5 in this table show the result of all images and its average also.

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VI. CONCLUSION

In this study techniques for image watermarking are reviewed their achievements and gaps .performance evaluation of dynamic scaling ,fitness function ,and calculating the Base PSNR Base NC, FITNESS FUCTION and Propose PSNR Propose NC. Experimental result phase the propose value result of each image is much better than base PSNR . in my result phase I have take five images leena image ,onion image , pears image, peppers image and bungee image .

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