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PSO Scaling for Digital Image Watermarking

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Abstract: Digital Image Watermarking used for protecting digital media files and data. It has been an active research field since last decades. Digital Image watermarking is an approach that enables a user from being misused of personal images or information. Here, the term "watermarking" refer to data hiding for copyright protection and image security. Digital Watermarking is becoming a necessity these days for various reasons such as duplication, modification and manipulation of images .In this paper, we have discussed various techniques that enable users to allow a security over their images and data, thus providing a secure transfer of digital files. The main issue in protecting our image files is to secure our data and important information from being viral or open to all, thus making its end to end retrieval that is only required end user is able to access that data.

***Keywords:** Discrete Wavelet Transform(DWT), Singular Vector Decomposition(SVD), Peak Signal to Noise Ratio(PSNR),Normalization Correlation(NC).*

I. INTRODUCTION

When photos are posted online, they are rarely protected, meaning they can be used by anyone who has access to them. Photos can be protected through copyrights, but a trick often used by photographers is to watermark their photos. Traditionally, watermarks were variations in the thickness of a paper that can only be seen in certain light conditions. Digital watermarks are text or logos that are put on top of the image to establish the owner of the photo. Often, watermarks are opaque and look indented. A great way to ensure that no one is using photos without your permission is to add a watermark with Google's Picasa or Adobe Photoshop.

Digital watermarking, a new technology for data protection and intellectual property right verification, provides a promising way of protecting multimedia data from illegal manipulation and duplication.

For example, a watermark can be a tag, label or digital signal. A host may be multimedia object such as audio, image or video but here we will take into consideration the images only.

The advent of the Internet has resulted in many new opportunities for the creation and delivery of content in digital form. Applications include electronic advertising, realtime video and audio delivery, digital repositories and libraries, and Web publishing. An important issue that arises in these applications is the protection of the rights of all participants. It has been recognized for quite some time that current copyright laws are inadequate for dealing with digital data. This has led to an interest towards developing new copy deterrence and protection mechanisms. One such effort that has been attracting increasing interest is based on digital watermarking techniques. Digital watermarking is the process of embedding information into digital multimedia content such that the information can later be extracted or detected for a variety of purposes including copy prevention and control. Digital watermarking has become an active and important area of research, development and commercialization.

II. RELATED WORK

Palak patel[1], In this paper, DWT(Discrete Wavelet Transform), SVD(Singular Value Decomosition) and DCT(Discrete Cosine Transform) have been performed on digital images and DCT Stego image has been obtained using DWT and SVD.Aniyan[2], introduced Watermarking, JPEG compression and DCT(Discrete cosine transform) have been worked upon so that a Robust image can be obtained using JPEG compression. J. S. Tsai[3], In this paper, Robust digital watermarking has been performed for Non-overlapping feature set to increase robustness S.Kuri[4], This paper presents combination of Robust Image Watermarking, PRN sequence, Neural Network, copyright protection and content authentication has been worked upon to generate Pseudo number to increase robustness of digital images. A.Furqan[5], This paper includes steganography, digital watermarks, authentication, copyright material, discrete wavelet transform (DWT), digital cosine transform (DCT), singular value decomposition (SVD), PSNR over images to recover watermark digital image from any four sub bands. Preeti Parashar[6], This paper proposes Digital watermarking, Spatial domain, Least Significant Bit (LSB), Frequency domain, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Discrete Fourier Transform (DFT) for images which concluded that images can be worked upon spatial domain and transform domain. Meenu singh[7], The author introduced Watermarking, DCT(Discrete Cosine Transform , DWT(Discrete Wavelet Transform), Spatial Domain, Frequency Domain which characterized various watermarking techniques to protect important information. Prabhishek singh[8], This proposes concepts of Digital watermarking, Watermarking definition and the main contributions in this field. Neeraj Bhargava[9], This paper proposed Robust

Watermarking, Color Images and Discrete Wavelet Transform (DWT) which provided prototype for watermarking images. Jaishri Guru[10], This paper provides WaterMarking, Copyright Protection, DCT(Discrete Cosine Transform) and LSB(Least Significant Bit) which providSed with some techniques of digital watermarking.

III. PROPOSED APPROACH

3.1 Discrete Wavelet Transform:

Discrete Wavelet Transform(DWT) is a mathematical tool for decomposing an image. The transform is based on waves, and these waves are small called Discrete Wavelet Transform. The DWT divides the inout image into four sub-bands LL(Low-Low), LH(Low-High), HL(High-Low) and HH(High-High). The LL(Low-Low) sub band represents the coarse-scale coefficients of DWT while the LH, HL and HH sub bands represent the fine scale coefficients of DWT. For next coarser scale of wavelets coefficients of DWT, the LL sub band are further processed until the size of cover image and watermark image will be same. LL sub band are divided into LL2, LH2, HL2 and HH2 bands. In which LH2, HL2, and HH2 contains the highest frequency band while LL2 contains the low frequency band.

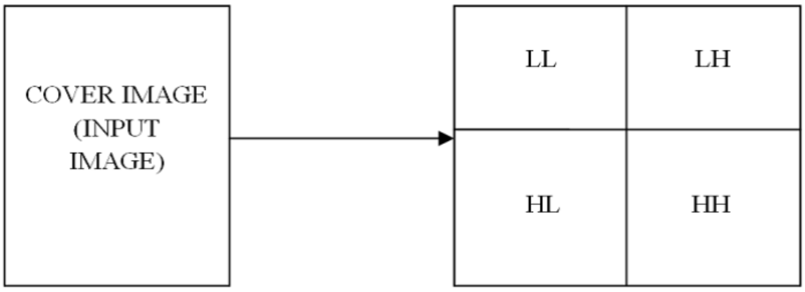

Fig. 1 Level DWT Decomposition

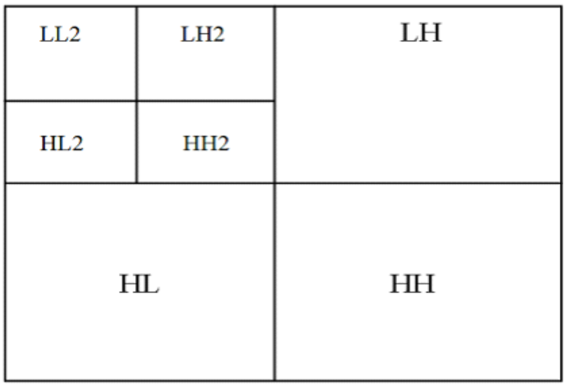

Fig. 2 Level DWT Decomposition

3.2 Singular Vector Decomposition(SVD):

SVD is an linear algebra technique and used to solve mathematical problems. SVD approach used in watermarking because of the fact that singular values obtained after the decomposition of image matrix are stable. The SVD belongs to orthogonal transform which decompose the matrix into three matrices of same size. In this paper we apply SVD to last LL band of input image that decompose the input image into I_u, I_s and I_v matrix form. Like this apply svd to the lowest LL band of watermark image that decompose the image into W_u, W_s and W_v. Through all this our main focus are on scaling matrix that are used to control the strength of watermarked image.

3.3 Quality Measures:

Some of quality measures used in image watermarking are:

3.3.1 Normalized Correlation(NC): It tells about the comparison between original(input) image and extracted image. NC targeted to 2.0.

Wi= Original Watermark, Wj=Extracted Watermark

3.3.2 Mean Square Error(MSE): MSE in watermarking is to measure the average of square of errors between original image and watermark image.

Where M, N is pixel values in host image

Wij = Pixel value of Watermarked Image

Hij = Pixel value of Original Image

3.3.3 Peak Signal to Noise Ratio(PSNR): PSNR determines the Efficiency of Watermarking with respect to the noise. It is given by:

$$PSNR=10*\log(P^2/MSE)$$

Where p= maximum value in original image.

3.3.4 Embedding Process:

1. Read both input image and watermark image.

2. Use 1-level DWT to decompose the input image into four sub-bands (i.e. LL, LH, HL, HH).
3. Use 2-level DWT haar to again split LL into four sub-bands (i.e. LL2, LH2, HL2, HH2).
4. 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)
5. Apply DWT to the watermark image to decompose the watermark image into four sub bands.
6. Apply SVD to LL sub band to extract singular values
   [W_u,W_s,W_v] = svd(WLL)
7. Apply optimal scale matrix, that gives best values and stores in alpha variable.
   alpha = get_optimal_scale_matrix(scaleMatrixDim);
8. For watermarked image use this formula:
   S_n = I_s + (alpha.*W_s);
   new_LL = I_u*S_n*I_v';
9. Apply inverse DWT to get the watermarked image.
   iLL2 = idwt2(new_LL,LH2,HL2,HH2,'haar');
   watermarked = idwt2(iLL2,LH,HL,HH,'haar');
10. ``Calculate the PSNR value for input host image and watermarked image using formula[3].

3.3.5 Extraction Process:

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

3.3.6 PSO- Scaling Matrix: We used two main factors:

3.3.6.1 Particle Swarm Optimization(PSO): PSO algoritm worked on a population of candidate solutions and moving these particles around in the search-space and each particles position is influenced by its local best position and is guided towards the best-known position in search space which are updated as better positions are found by other particles.

```
Initialize a population of particles with random values positions and velocities from D dimensions in the
search space
 while Termination condition not reached do
     for Each particle i do
       {
          Calculate the fitness value
              if fitness is better than personal best fitness value(pBest)
                  set current location as the new pBest
              if fitness is better than global best fitness value(gBest)
                  set current location as the new gBest
       }
     for each particle{
                       Calculate particle velocity
                  Update particle position
              }
```

3.3.6.2 Fitness Function: 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. The value of PSNR has 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) and NC(Normalization Correlation) score. 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.

IV. RESULT AND GRAPH

First of all, The watermark Embedding and Extraction process has been shown in figure (3) & figure (4), Algorithms for Watermark Embedding use Lena input (256*256) Image and watermark Image of size (128*128). The Scaling Factor is 0.025. Figure (3) shows the embedding process, Whereas figure (4) shows the extraction process.

Fig. 3 Embedding Process

Fig. 4 Extraction Process

In Fig 5, the plotted graph is between fitness(PSNR) value and iteration. In which iteration is on the x-axis whereas, fitness value on the y-axis. Main concept of this paper is the fitness function and optimal scaling. Optimization algorithm that has a fitness or objective function should always be maximized to get larger PSNR values and larger NC score value. The value of PSNR has been taken to represent the fidelity of the watermarked image, the fitness increases with the increase in the value of PSNR and NC. So, optimization of fidelity takes place for a given value of robustness. More PSNR and NC value gives less distortion. Optimal scaling or Scaling Function uses PSO algorithm. PSO algoritm worked on a population of candidate solutions and moving these particles around in the search-space and each particles position is influenced by its local best position and is guided towards the best-known position in search space which are updated as better positions are found by other particles. Figure 5 shows the best values in the case of Lena. We are using iteration which is of size 50**.**

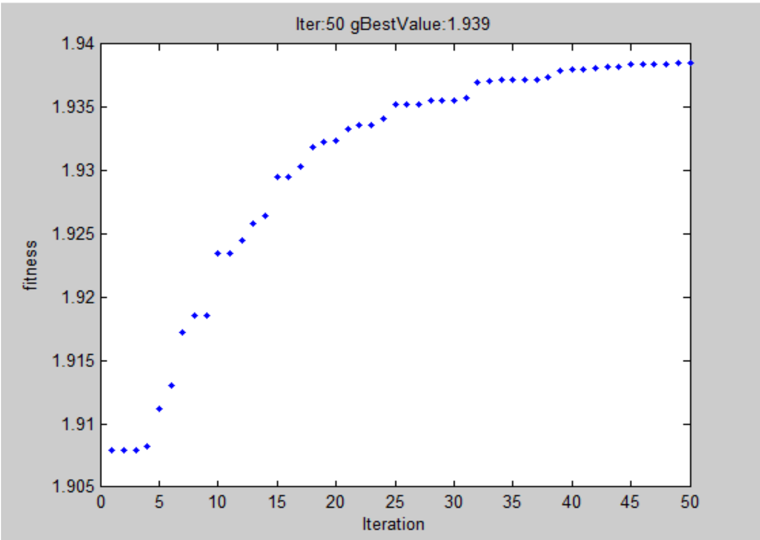

Fig. 5 PSNR in case of Lena

Table 1 presents the results of figure 3 and 4. Table 1 demonstrates the optimized PSNR and NC when Lena image is used as input image. Figure 6and 7 tells about PSNR and NC comparison on both approaches.

Table. 1 Lena images on PSNR Approach and NC Approach

Algorithm	Approach	PSNR	NC
Static-scale	Existing	37.156	0.963
Optimal scale	Proposed	39.1	1

Figure 6 shows the values of both static scaling and optimal scaling values for PSNR. The static values that have been found before applying PSO scaling and optimal values that have been found after applying PSO algorithm over the image. More the PSNR value, less is the distortion.

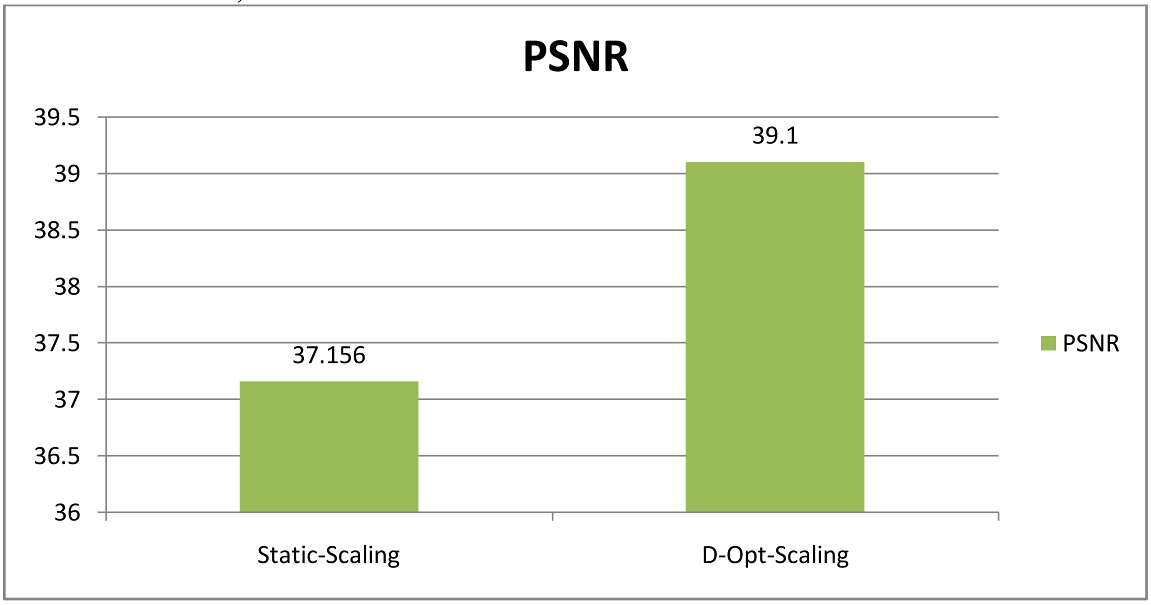

Fig 6: PSNR comparison for Static and Optimal scaling

Figure 7 shows the values of both static scaling and optimal scaling values for NC. The static values that have been found before applying PSO scaling and optimal values that have been found after applying PSO algorithm over the image. More the NC value, less is the distortion.

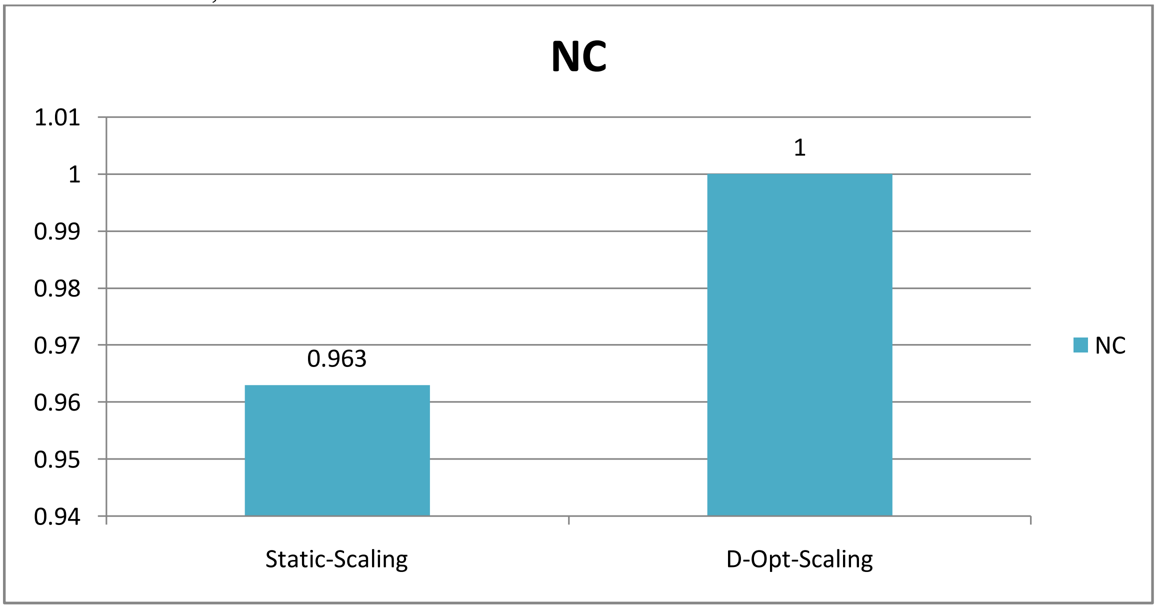

Fig 7: NC score comparison for Static and Optimal scaling

V. CONCLUSION

In this work, we gave the brief discussion of Optimal scaling and fitness function (PSNR and NC). Existing approach work on static scale whereas, Proposed approach use optimal scale. So, we conclude that we increase both PSNR and NC values in case of Lena image. It has also been concluded that the image can be made more precise and watermarked with the help of PSO algorithm including both PSNR and NC. The image has been watermarked by increasing both PSNR and NC.

VI. FUTURE SCOPE

In future, we would also use the concept of Principle Component(pc) that improve the robustness and quality of image. In our research, we used PSNR and NC as fitness functions for the efficiency of image. But in future we would also compare it with Differential Evaluation(DE) and we can use Hybridation(PSNR+NC+DE).

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