Optimal Alpha Blending Based Digital Image Watermarking By Using Cwt And Svd

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Abstract: While sharing and processing digital data, many problems arise due to huge evolution in technology. The first and front most important issue is security. In order to conquer this problem a technique known as Digital water marking is applied to digital data while undergoing sharing and processing. In the recent years many researchers have proposed several methods. The selection of optimal scaling factor is a main problem in the watermarking. The proposed technique is a Optimal Alpha based Curvelet and SVD (OACSVD), called the Cuckoo Search (CS) which is used to find the optimal scaling factor for grey image watermarking in CWT-SVD transform domain. The OACSVD method handles secret sharing to accomplish more security of watermark. The proposed technique used many attacks to explore the robustness and various results are obtained. OACSVD method shown PSNR and NCC values as 44.13% and 99.29% respectively.

Keywords: Cuckoo Search, Curvelet, Single Value Decomposition, Peak Signal Noise Ratio.

1. INTRODUCTION

An enterprise of watermarking is copyright manipulation, in which an image owner looks for to avoid prohibited photocopying of the image. There are no facts that watermarking techniques can accomplish the critical objective to recover [1]. The right owner information retrieved from the expected data after all types of content-protect manipulations. Because of the reliability control, watermarks can only be embedded in a limited space in the multimedia data. There is continuously a biased obtain for the attacker whose goal is only to get free of the watermarks by utilizing a range of manipulations in the finite watermarking embedding space. A more logical prospect of applying watermarks techniques for copyright protection may be used to reflect on specific application scenarios.

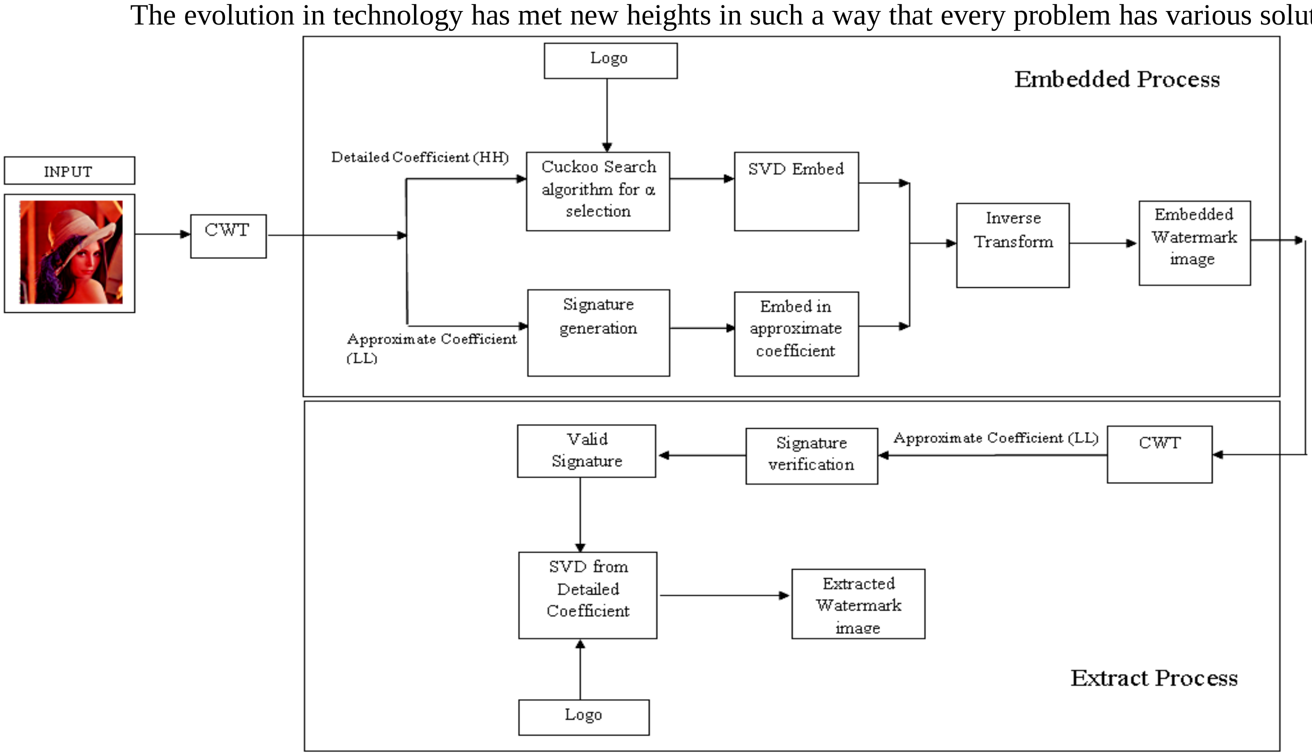
Invisible watermarking and image steganography are mostly used to hide an image using another image but there are few differences between invisible watermarking and steganography. An invisible watermark is an entrenched image which ordinarily cannot be found with human eye. In common invisible watermarking can be done in either spatial domain or frequency domain.

2. RELATED WORK

Loo et al.[2] first presented a DT CWT based imperceptible watermarking plan respect that the DT CWT impart a possibly proper domain for watermarking as it has projected move invariance and proper directional selectivity properties[3] . As the conclusion, it is turning into a well known decision as a watermark implanting domain[4]-[7]. In [4], the watermark is installed in the best two degrees of a 4-level DT CWT decay of the luminance (Y) channel. Albeit this visually impaired cycle is hearty to mathematical assaults and misfortune pressure, it neglects to manage downscaling in goal. Likewise, as the watermark is embedded in the Y channel, it doesn't food a high-strength watermark which diminishes heartiness at indistinct watermark qualities when contrasted with those made utilizing chrominance (U) channel implanting techniques [8] – [12]. To accomplish heartiness to downscaling in goal, in [13], the watermark is inserted in the low-recurrence discrete cosine change (DCT) coefficients yet it has restricted protection against up scaling, revolution and editing. In [14], the watermark is inserted in the watermark least groupings by changing low-recurrence DCT coefficients. While this cycle is hearty to downscaling in goal, it is as yet lacking for revolution and editing. The SVD is utilitarian on the host picture to recover the particular qualities. The singular values are transformed by adding the watermark and afterward the SVD is acts again on the resultant matrix to compute the altered singular values. At long last, the first singular values are subbed by the adjusted values to acquire the watermarked picture. A backwards activity is accomplished at the decoder to acquire the watermark. A hybrid watermarking framework dependent on the discrete wavelet change (DWT) and SVD was set up by Lai et al. in [15]. In their strategy, the SVD is applied to just the LH and HL sub-groups of an I-level Haar DWT as opposed to the whole picture. Additionally to enhance and control the strength of the watermark, we use a scale factor. An finest watermark embedding method is developed to achieve least watermarking distortion. A secret embedding key is measured to robustly embed the fragile watermarks so that the novel method is strong to imitate, even when the signify attackers are fully disturbed of the watermark embedding algorithm[16]. the singular value factor of the original Image is modified by adding the singular component of the watermark image along with a suitable scaling factor. This scaling factor is optimized by GA with the PSNR values as the robustness criteria in order to accomplish high values or robustness without concession the transparency of the watermark. More application based analysis is made by using the Noise Correlation as a fitness perform to test for better results in robustness[17].

3. METHODOLOGY

The evolution in technology has met new heights in such a way that every problem has various solutions



to it. This evolution has brought an ease in our day to day life to some extent. However, with every positive characteristic there are always certain drawbacks associated with it. One of the most important drawbacks can be illustrated as not having the optimum result to a certain problem. And there in approach the function of techniques that can be used to optimize the results to certain problems. Optimization being an best goal is entirely difficult to attain and can be illustrated as a technique or a clear practice which helps in making a design or a system as effective or perfect as feasible. Cuckoo Search is used to solve optimization problem in digital watermarking. Apply one – level curvelet wavelet transform(CWT) to hide an image resulted through singular values of every sub bands are converted by embedding the watermark repeated by scaling factors. The cuckoo search algorithm enhances to achieve the most important tolerable of robustness by using the scaling factor with good quality. To be concerned about robustness many attacks are made to affect the real watermarked image.[18]. Fig 1 shown the architecture of OACSVD Method.

Fig: 1 Architecture of OACSVD method

3. 1 CWT Method

CWT method used in the grey image is divided into four sub bands and preferred sub bands are selected by embedding processing. In HH and LL two sub-bands selected from selected four sub bands, arithmetic equation of region of best fit is concerned. CWT for watermark region in the binary image to obtain optimal position to be focus by the cuckoo search algorithm. To make display the section of using this algorithm for the watermarking techniques concentrated for patent protection; further the buck outcome to the PSNR values the finest locations are obtained still for the watermark integrated images [19].

3. 2 SVD Method

Singular value Decomposition (SVD) plays vital role in the field of image processing for aspect of real or complex matrix with a number of applications. while a digital image in a matrix structure through its access assigning the intensity value of every pixel in the figure, SVD of an image K among dimensions k x k is given by: K = XSVYT Where, X and Y are orthogonal matrices and S well known as singular matrix is a diagonal matrix transporting positive singular values of matrix K. The columns of X and Y are described left and right singular vectors of K, in that organized. They mostly state the geometry facts of the actual image. Left singular matrix i.e., X denotes the horizontal specifies and right singular matrix i.e., Y denotes the vertical specifies of the real image. The diagonal values of matrix S are locates in decreasing order enhances the important of the decrease entries from first singular value for the last one. This specialty of applicable in SVD based some special technique. Two properties of SVD are significant in digital watermarking technique. Small variants in singular values will not affect the quality of image and singular values of an image have sufficient power that they remain unchanged after several attacks.

3.3Cuckoo Search Method

Yang and Deb initiated cuckoo search, a meta-heuristic in the year 2009 for the purpose of optimization. This algorithm copies the breeding manner of cuckoo bird. the peculiar nature of a cuckoo bird is that it never build nest instead it lays egg inside other bird's nest. unfortunately the egg of cuckoo bird is some time identified by the victim bird. If the victim one successfully in identifying in the cuckoo egg it will either throw the egg or discard the nest of its own and build a new one. The special of feature that it can duplicate the egg of host bird to avoid it egg thrown. Sometime it hatches early than the host bird and throw them away of the eggs of host bird. The egg of cuckoo it’s measured as possible solution in cuckoo search algorithm.

the imitation process of cuckoo bird are as follows

1. It lays only one egg in the random nest.
2. The enhance egg in the nest will be top in the hierarchy.

3. After identifying a cuckoo egg with probability of pa[0.,1], a host bird preferred whether to throw the cuckoo egg or go away the nest and construct new nest wherever it wishes. The number of host nest NP is fixed. The first population of NP keys (nests) is designed using evenly distributed random numbers over the search space. The lower bound (LB) and upper bound (UB) using form the randomly selected initially solution in the search space. The randomly selected initial solution is formed in the search space by the lower bounds (LB) and upper bounds (UB). The initial values of the kth variable of the lth solution is given by the next relation:

$$Z_{l,i,C=0} = LB + rand_i Z(UB_i - LB_i) \quad \textbf{(1)}$$

Where LB_l and UB_l are the ith variables of LB or lower bound and UB or upper bound, respectively; C is the number of the current generation (cycle); $rand_i \in (0, 1)$ is a equally distributed random number and a new for each variable.

3.4. Watermark Embedded Process

With the help of CWT, the initial cover image is decomposed into frequency of sub-bands in the embedding process. X,Y and S are the detailed sub-bands of svd decomposed matrices. The watermark image is able to contain watermark information by using the singular values diagonal matrix (Sw1) . Mean while the watermark image is transformed into grey image in which CWT and SVD are applied.

$$S_w = S + \alpha + W, S_w = XS_w S_{w1} Y_W^T \qquad \textbf{(2)}$$

The given equation α denotes scaling factor where as S_w denotes matrix containing the watermark information. After watermark insertion X_w and Y_w are newly generated orthogonal matrices and S_{w1} is customized singular value matrix. Cuckoo search algorithm in embedding and extracting process help to obtain optimum α value.

Algorithm:

3.5. Embed Process

Input: Cover Image (CI), Watermark Logo(WL), Number of Iteration(NI).
Output: Watermark Image(WI), Signature Verification(Sig).
Step1: Decompose CI using Curvelet Transform(CT) up to size of WL.
    CT_{bands} ← CT(CI, level)
Step2: Generate Signature(Sig) for verification from Approximate coefficients of CT_{bands}`.
//Optimal Alpha(α) selection for embedding
Step3: for i ← 1:NI
Step4 : nest ← initialize_nest(LB,UB)
        LB ← Lower Bound
        UB ← Upper Bound
Step5: for each ni ε nest
        WI_{ni} ←embed_watermark using the equation(6) with help alpha in the ni.
        $PSNR_{ni}$ ← evaluate PSNR(CI, WI_{ni})
    End
Step6 : best_alpha ← fitness $_{obj\_max}$($PSNR_{nest}$)
Step7 : update cuckoo nest parameter the best_alpha implementation.
    End
Step8 : WI ← embedded the Watermark Logo(WL) into Cover Image(CI) using equation (6) with help of best_alpha.

3.6. Extract Process

This process enables the signature verification by applying watermark the grey image decomposed using CWT to each approximate component. This signature is perfectly valid the svd decomposes the detailed sub-band of CWT. Embedding watermark information is done in this singular diagonal value in the procedure. The core job of extracting the water mark from the diagonal matrix in the each components is done with help the cover image and signature verification.

In the watermark extracting process, the watermarked grey image first decomposed using CWT is applied to each approximate component for using signature verification. The signature is valid the SVD decomposes the detailed sub-band of CWT. In the embedding process, watermark information is embedded in this singular diagonal value. The cover image and signature verification are used for extracting the watermark from the diagonal matrix of each component. The watermark W_i is calculated by applying the inverse process equation (2) in watermark embedding procedure, which can be expressed as follows:

$$S_w^* = X_w S^w Y_w^T, W_i^* = (S_W^* - S)/\alpha \qquad \textbf{(3)}$$

Algorithm: Watermark Extract Process

Input : Watermark embedded Image(WI), best_alpha, Watermark logo(WL), Signature(Sig).
Output : extract Watermark Logo(WL).
Step1 : Decompose Watermark embedded image(WI), using Curvlet Transform(CT) up to the size of (WL).
CT ← CT(WI, level).
Step 2: Signature verification (sig)
Step 3: if it is valid signature, apply the SVD on the detailed coefficient to extract the watermark logo from the watermark image using the equation(3).

4. RESULTS AND ANALYSIS

Fair comparison is made in the process by testing an image watermarking scheme on different types of cover/host images. . In our experiments 512 × 512 8 bit grey scale test images namely Lena, Barbara, Peppers, Mandril, Barche and logo respectively as shown in fig. 2.

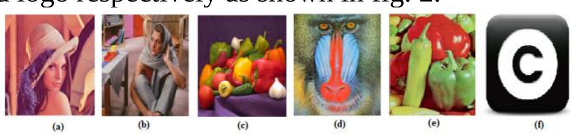


Fig 2- Test images a-e cover f watermark

To examine the robustness of the scheme the watermark images are focus to a range of attacks.
All those experiment are performed on Windows 7-platform.MATLAB 2017b is used for the implementation of the proposed algorithm.

The peak signal-to-noise ratio (PSNR) is a normal image quality evaluation index used in the area of image processing. For an image with dimensions of m X n, the PSNR is defined as:

$$\boldsymbol{PSNR} = \frac{\mathbf{10} \times \log_{10}(m \times n \times max(I^2(i,j)))}{\sum_{i=1}^{m}\sum_{j=1}^{n}[I(i,j) - I^*(i,j)]^2} \qquad \textbf{(4)}$$

In the equation I(i,j) represent the grey value of host image pixel whereas (i,j) represent the watermark image pixel m and n height and width of host image. The table which follow clearly say the PSNR value obtained from existing method(DWT and SVD) and proposed method(OACSVD). Figure 3 the represent the comparative graph of (DWT and SVD) and (OACSVD).

PERFORMANCE OF PSNR		
Images	**Existing DWT & SVD**	**Proposed (OACSVD)**

LENA	41.5711	44.3814
MADRIL	32.4937	43.7516
BARBARA	31.8872	44.0247
SHIP	34.2968	44.3518
VOIT	32.1402	44.1828

Table1.Performance of PSNR

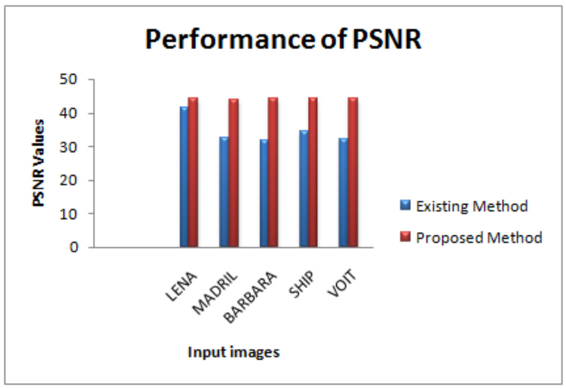


Fig 3. Performance of PSNR

For the above graph, it is clearly found that, the proposed method (OACSVD) attained 9.7% PSNR value more than the existing method (DWT and SVD).

To measure the robustness of the proposed watermarking system is the prime motive. With that motive the Normalized Correlation Coefficient (NCC) of the extracted watermark is watermark is applied in coincidence to the original host. The best robustness of the watermarking process its performed only one the heighest value of the measure is 1.

$$\mathbf{NCC}=\frac{\sum_{i=1}^{N} W_i W_i'}{\sqrt{\sum_{i=1}^{N} W_i^2}\sqrt{\sum_{i=1}^{N} W_i'^2}} \quad \mathbf{(5)}$$

Where: W_i is the size of the original and W_i' extracted watermark bits. Table 2 shows the NCC values of the rebuild watermark with random blocks locations selection for the proposed technique, and also NCC means different types of attacks with the proposed optimization technique. The optimization process does done many significant jobs that are –

a) It enhance the value of PSNR.
b) It will not affect the values of NCC under different types of attack.
c) It sometime polished robustness.

Several attacks are performed to the watermark images to obtain the robustness of the proposed technique. The attacks are stated as -

a) Noisy attack is done by adding density [0.004; 0.3; 0.001] to salt and pepper noise and adding Gaussian noise with mean=0 and variance[0.0001;0.005; 0.5] and speckle noise variance [0.01; 0.04;0.2] to the watermarked image.
b) Median filtering is done window size [3×3; 2×2; 5×5] is applied to the watermarked images.
c) JPEG compression attack is performed by compressing the image with quality factor 75.

These attacks are shown in fig 4 for only one test image.

Fig 4 a) Watermarked image b) Salt and Pepper Noise c) Speckle Noise d) Gaussian Noise e) Median Filter.

Attacks	Input Images	Existing (DWT & SVD)	Proposed (OACSVD)
Salt & Pepper Noise (0.3)	Lena	0.7633	0.9932
	Barbara	0.7521	0.9924
	Peppers	0.7636	0.993
	Mandril	0.7551	0.9932
	Barche	0.7873	0.9931
Speckle Noise (0.3)	Lena	0.6615	0.8632
	Barbara	0.658	0.8583
	Peppers	0.651	0.852
	Mandril	0.6536	0.854
	Barche	0.6714	0.8707
Gaussian Noise (0.2)	Lena	0.7948	0.9394
	Barbara	0.7901	0.9412
	Peppers	0.8025	0.9473
	Mandril	0.8005	0.9373
	Barche	0.7862	0.9846
Median Filtering (5 x 5)	Lena	0.7409	0.8011
	Barbara	0.7177	0.8149
	Peppers	0.7239	0.8523
	Mandril	0.7097	0.8797
	Barche	0.7051	0.8086
JPEG Compression	Lena	0.6048	0.9925
	Barbara	0.5143	0.9944
	Peppers	0.5937	0.8812
	Mandril	0.4488	0.9332
	Barche	0.6117	0.9926

Table 2. Performance of OACSVD

From table 2 it is shown that OACSVD method attained 22.87% salt & pepper noise and Gaussian noise 15.51% and Speckle noise 20.1% and Median Filtering 11.2% and JPEG compression 40.41% NCC values more than DWT &SVD.

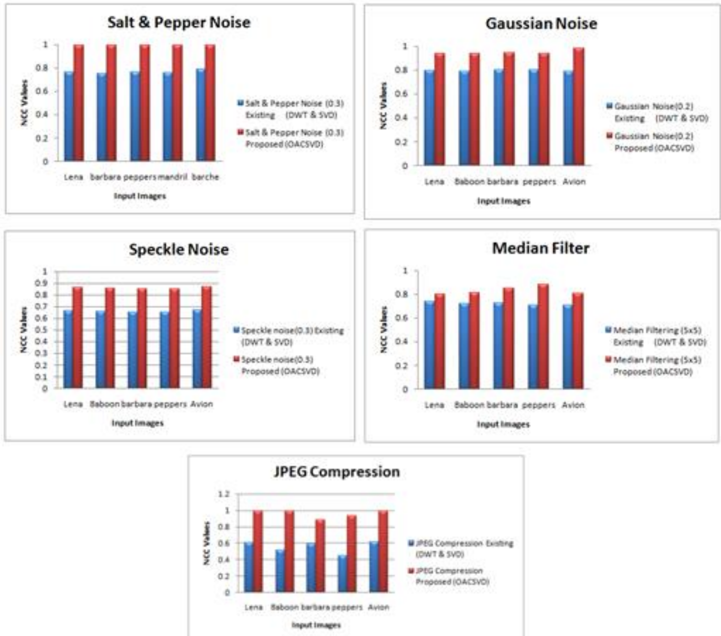


Fig 5. Performance of OACSVD

A transparent perfect scaling transparent scaling curve towards optimum results in shown by figure 5. The exact digital values of maximum fitness for the test images are 44.3814, 43.7516, 44.0247, 44.3518 and 44.1828 for Lena, Barbara, Peppers, Mandril, and Barche respectively. Figure 3 represents the optimal blocks positions used for watermarking based on a OACSVD optimization for the grey scale test images. In addition, the proposed method accomplishes are acceptable performance after different noise and distortion attacks in term of PSNR and NC values exhibiting 44.13846 and 0.91169 respectively.

This analysis clearly expresses that the proposed method bring better result in terms of in terms of PSNR and NCC compared to the various attack method. Comparing to isotropic nature of wavelets, the proposed method is better because of the fine tuning of alpha parameter in embedding process.

5. CONCLUSION

The overall analysis clearly depicts that the optimize watermarking technique is used to select the optimal positions for watermark inclusion based on a optimal Alpha and curvelt and SVD (OACSVD) is proposed. This technique itself has its own notable improvement over successive generation. As a result it occupies a preferable position in the CWT –SVD transform domain of the gray scale images for the watermark embedding which is used as an associated secret key. This analysis gives a clear picture that the quality of the image has been improved a lot though the watermark is established in it. This achievement its possible by CS optimization by choosing optimum embedding locations while keeping robustness at high levels. Comparing to the CWT and SVD method, the proposed method bring the marvelous result.

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