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Hybrid Data Hiding Scheme in Images using DWT DCT and SVD

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ABSTRACT: Information hiding techniques have recently become important in a number of application areas. Digital audio, video, and pictures are increasingly furnished with distinguishing but imperceptible marks, which may contain a hidden copyright notice or serial number or even help to prevent unauthorised copying directly. The primary focus of the paper is the watermarking of digital images including the development of new watermarking algorithms and new insights of effective design strategies for image security. The paper also explores robust image watermarking algorithms which are resilient to attacks and have applications in protection of copyrighted images. This paper presents a secure data hiding and robust image watermarking scheme that uses the GUI based DWT, DCT and SVD transformations to increase integrity, authentication, and confidentiality. The performance metrics like PSNR, MSE, and correlation for DWT, DCT and SVD are calculated and compared with some of the existing models. The algorithm is verified using GUI model in Mat lab software.

KEYWORDS: Discrete Wavelet Transform, Singular Value Decomposition, Discrete wavelet transform, Watermarking, Peak signal to noise ratio(PSNR), correlation.

I. INTRODUCTION

In recent years, digital watermarking has gained popularity because of its application for authentication and protection of the ownership of multimedia contents. In watermarking, one digital signal is embedded in to another digital signal in such manner so as to obtain the original signal with least possible degradation. Later, on this, embedded signal can be extracted or detected for the purpose of security.

The spatial-domain and the transform-domain are the two methods which are used for insert the watermark in to the host image. Watermark embedding into the component of spatial-domain of the host image is a straightforward method. Complexity is low and easy implementations are the advantages in this image watermarking. But these spatial-domain methods are not good in image-processing or other general attacks. On the other side, the transform-domain techniques embed the watermark by controlling the magnitude of coefficients in a transform domain, such as DCT, DWT and SVD [1]. Although more information embedding and robustness against common attacks can yield by transform-domain methods, the computational cost of these methods is higher than the spatial-domain watermarking methods.

To identify areas in the host image, where the watermark is embedded which is too small to be detect, we use DWT method because of its outstanding spatio-frequency localization properties. One of attractive properties of SVD is that slight changes in the singular values that do not change the visual perception of the cover image. Because of these methods, the watermark embedding procedure motivates to obtain improved transparency and robustness. Therefore, by combining these two methods with different watermarking techniques have been proposed.

Since SVD process is computationally expensive on an image, a hybrid DWT-DCT-SVD-based watermarking scheme has been developed that produces the better performance with less computational time [4]. After decomposing the cover image into four subbands by three-level DWT, we apply DCT, then we apply SVD only to the intermediate frequency subbands and embed the watermark into the singular values of the aforementioned subbands to meet the imperceptibility and robustness requirements [5]. The main properties of this work are1) this approach needs less SVD computation than any other methods. 2) Our approach embeds the watermark directly into the singular values of the host image to get the visual perceptions of images.

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II. LITERATURE SURVEY

Data hiding are a group of techniques used to put a secure data in a host media (like images) with small deterioration in host and the means to extract the secure data afterwards. For example, cryptography, steganography, watermarking can be named.

Cryptography is the first technology that content owners would turn to. It is probably the most common method of protecting digital documents and certainly one of the best developed as a science. Before delivery, the content is encrypted and the decryption key is provided only to those who have permission to access the legitimate copies of the content. Then, the encrypted file can be made available through the Internet, but would be useless to a pirate without appropriatekey.Afterencrypted,thestructureofthemessageischanged.Itis meaning less and unintelligible unless it is decrypted.

Steganography is the technique of hiding confidential information within any media [10]. Steganography is often confused with cryptography because the two are similar in the way that they both are used to protect confidential information. The difference between the two is in the appearance in the processed output; the output of steganography operation is not apparently visible but in cryptography the output is scrambled so that it can draw attention. Steganlys is is process to detect of presence of steganography.

In [11], Digital watermarking may be one of the suitable solutions. It is an analogous technique that has been used to protect valuable hardcopy documents, such as money, cheques and official correspondence, for long time ago. Paper watermarks are faint designs that are embedded by the manufacturer into the paper used to produce such hardcopies. These marks are convincingly hard to fake, and at the same time they do not obstruct the normal processing, i.e.reading, and are impossible to be removed without leaving anyengram or causing severed a mage to the contents of the document. Digital watermarking technologies strive to achieve the segoals in a digital environment by inserting a retrievable watermark directly into the softcopy data stream.

However, if the host image is attacked by noise in this DWT technique, it will be distorted while extracting which constitutes the less values of PSNR and correlation. Because of these reasons, the method which is the combination of DWT, DCT and SVD constitutes invisible watermark scheme which is strong against the several attacks with better PSNR and correlation values and significant reduction in the computation time when compared with the DWT and SVD transformations.

III. PROPOSED METHOD

DWT-SVD BASED WATERMARKING:

(A)Discrete Wavelet Transform:
Discrete Wavelet Transformation is a powerful tool both for analysis and synthesis of the digital signal, with a significant reduction in the computation time in method [6]. The host image is high-pass filtered, producing three large images, each describing local changes in brightness in the host image. Then it is low-pass filtered and downscaled, producing an approximation image which is high-pass filtered to produce the three smaller images in detail, and finally the low-pass filter is used again to produce the approximation image in the upper-left. In Fig(1), one level decomposition of a two dimensional data is showed. Decomposition level forms four sub band data called LL, HL, LH and HH subbands. This process can be continued up to reach desired level.

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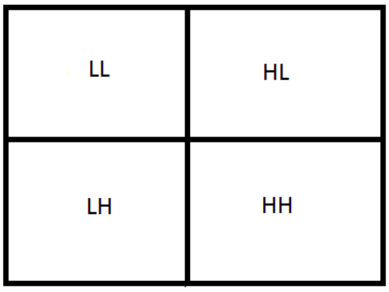

Fig (1): Sub bands obtained from one level decomposition of Image

Proposed watermarking algorithm initially decomposes the host image into sub bands as in [6], afterwards determines the singular values of each subband and modifies these singular values with the watermark by scaling with the scaling factors.

(B) Discrete cosine transform:

Discrete cosine transform (DCT) is widely used in image processing, especially for compression. Some of the applications of two-dimensional DCT involve still image compression and compression of individual video frames, while multidimensional DCT is mostly used for compression of video streams. DCT is also useful for transferring multidimensional data to frequency domain, where different operations, like spread spectrum, data compression, data watermarking, can be performed in easier and more efficient manner. A number of papers discussing DCT algorithms are available in the literature that signifies its importance and application.

The 1D DCT of a 1× N vector x(n) is defined as

$$Y(k) = C(k)\sum_{n=0}^{N-1} x[n]\cos[\frac{(2n+1)k\pi}{2N}]$$

where k = 0,1,2,..., N −1 and

$$C[k]=\begin{cases} \sqrt{\frac{1}{N}} & for\ k=0 \\ \sqrt{\frac{1}{N}} & for\ k=1,2,3\ldots N-1 \end{cases}$$

The original signal vector x(n) can be reconstructed back from the DCT coefficients Y[k] using the Inverse DCT (IDCT) operation and can be defined as

$$X(n) = C(k)\sum_{n=0}^{N-1} Y[k]\cos[\frac{(2n+1)k\pi}{2N}]$$

where n = 0,1,2,..., N −1

$$Y(j,k) = C(j)C(k)\sum_{n=0}^{N-1} X[m,n]\cos[\frac{(2m+1)k\pi}{2N}]\cos[\frac{(2n+1)k\pi}{2N}]$$

where j, k,m, n = 0,1,2,..., N −1.

$$C[j]\text{ and }C[k]=\begin{cases} \sqrt{\frac{1}{N}} & for\ k=0 \\ \sqrt{\frac{1}{N}} & for\ k=1,2,3\ldots.N-1 \end{cases}$$

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Similarly the 2D IDCT can be defined as

$$X(m,n) = C(j)C(k)\sum_{n=0}^{N-1} Y[j,k]\cos[\frac{(2m+1)k\pi}{2N}]\cos[\frac{(2n+1)k\pi}{2N}]$$

The DCT is a real valued transform and is closely related to the DFT. In particular, a N × N DCT of x(n1,n2) can be expressed in terms of DFT of its even-symmetric extension, which leads to a fast computational algorithm. Because of the even-symmetric extension process, no artificial discontinuities are introduced at the block boundaries. Additionally the computation of the DCT requires only real arithmetic. Because of the above properties the DCT is popular and widely used for data compression operation.

(C)Singular Value Decomposition:

In [7], R. Liu and T. Tan explained the visualization of the SVD of a two dimensional matrix A. The SVD decomposes A in to three simple transformations: an initial rotation V^*, a diagonal matrix S and a final rotation U. In linear algebra, the singular value decomposition has many applications in signal processing and statistics in which it is a factorization of a real or complex matrix.

The singular value decomposition of an m×n real or complex matrix M is a factorization of the form

$$A = USV^T$$

Where U is a MxM real or complex unitary matrix, S is an MxN rectangular diagonal matrix with non-negative real numbers on the diagonal and V^T (the conjugate transpose of V, or simply the transpose of V if V is real) is an NxN real or complex unitary matrix. The diagonal entries $S_{i,i}$ of S are known as the singular values of A. The M columns of U and the N columns of V are called the left-singular vectors and right-singular vectors of A, respectively.

When the rank of A is r, S=diag($\sigma_1, \sigma_2, \sigma_3 \ldots \ldots \sigma_n$) satisfies$\sigma_1 \geq \sigma_2 \geq \ldots \geq \sigma_r \geq \sigma_{r+1} = \sigma_{r+2} \ldots\ldots = \sigma_n = 0$.

Let us consider matrix A whose elements are pixel values of an image. The image can be written as:

$$A=\sum_{i=0}^{r} \sigma_i\, u_i\, v_i^T$$

Applications of SVD include computing the least squares fitting of data, matrix approximation, pseudo inverseand determining the rank, null space and range of a matrix.

The main reason of combining 3rd level DWT and SVD in this scheme constitutes hybrid, invisible watermark scheme that robust to several attacks when compared with single level DWT and SVD.

IIIWATERMARK EMBEDDING AND EXTRACTION ALGORITHMS:

(A)Watermark Embedding:

1. Decompose the cover image A by applying Haar DWT into 4 subbands: LL, HL, LH, and HH.
2. Apply DCT to the sub bands of DWT.
3. Apply SVD to each sub band image:

$$A^k = U^k S^k V^{k^T} \quad k=1, 2, 3, 4 \qquad (1)$$

and λ_i^k, i=1,...,N are the singular values of S^k

4. Apply SVD to the visual watermark: T

$$W=U_W S_W V_W^T \qquad (2)$$

Andλ_{Wi}, i=1... N are the singular values of S_W

5. Modify the singular values of the host image in each Sub band with the singular values of the watermark:

$$\lambda_i^{*k}=\lambda_i^k + \alpha_k \lambda_{Wi}\, , \; i=1,..., N \text{ and } k=1,2,3,4. \qquad (3)$$

6. Obtain the 4 sets of modified DWT coefficients:

$$A^{*k}=U^k S^{*k} V^{k^T}, \; k=1, 2, 3, 4. \qquad (4)$$

7. Apply inverse DCT to the subbands.
8. Apply the inverse DWT by using the 4 sets of modified DWT Coefficients to produce the watermarked image.

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(B)Watermark Extraction:

1. Using haarDWT, decompose the watermarked (and possiblyattacked) cover image A_{dW} into 4 subbands: LL, HL, LHand HH.
2. Apply DCT to subbands in order to eliminate the lossy high frequency components.
3.Apply SVD to each subband image

$$A_{dW}^{k} = U_{dW}^{k} S_{dW}^{k} V_{dW}^{k^{T}}, \text{ k=1,2,3,4.} \qquad (5)$$

4. Extract the singular values from each subband:

$$\lambda_{dW_i}^{k} = (\lambda_{di}^{k} - \lambda_{i}^{k})/\alpha_k, \text{ i=1,..., N and k=1,2,3,4.} \qquad (6)$$

5.Construct the four visual watermarks using the singular vectors:

$$W_k^{*} = U_W S_{dW}^{k} V_W^{T}, \text{ k=1, 2, 3, 4.} \qquad (7)$$

6. Apply Inverse DWT to the visual watermark. We get Extracted Watermark Image and cover image.

(C) Quality Matrices:

The quality metrics used for transparency are
Peak signal to noise ratio

$$PSNR= 10\log(255^2 /MSE) \qquad (8)$$

Where mean square error

$$MSE=\frac{M}{N} \sum_{i=1}^{M} \sum_{j=1}^{N} [A(i,j) - A^{r}(i,j)]^2 \qquad (9)$$

The quality metrics used for Robustness are
Normalized Correlation

$$NC=\frac{\sum_i \sum_j A(i,j) A^{*}(i,j)}{\sum_i \sum_j A(i,j)^2} \qquad (10)$$

The two dimensional correlation values are calculated for the watermark image and recovery watermark images (CORRW = corr(W, W*)) under certain attacks are calculated

IV. RESULTS

In this paper, we choose 512x512 image as a host image and 64x64 image as a watermark image. In this, we executed the hybrid watermarking scheme in encrypted images by using dwt, dct and svd [4] by considering the PSNR and correlation values.To evaluate the performance of the proposed scheme, several experiments were conducted host Image and watermark image that are illustrated in Figure 2(a) and (b) respectively.

(a) (b) (c)
(b)

Fig 2: (a) Host Image (b) Watermark Image (c) Watermarked Image

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To measure of the quality of a watermarked image which in the figure (C),our approach uses peak signal-to noise ratio (PSNR) and mean square error (MSE).

In this work, the robustness of the proposed watermarking algorithm is evaluated using the attacks that are commonly employed in literature [6]. In this procedure, some major attacks are used. They are Gaussian (GN), average noise filtering (AV) (or median filter), Row Column Copying, Row Column blanking, Brightness, Image Adjust and Gamma correction (GC). Due to the flexibility of the developed system, the other attacking schemes can easily be added to the system or replaced with those used in the process.

(a) (b) (c) (d) (e) (f)

Figure (3): Attacked watermarked images (a) Resizing (b) Median (c)Cropping (d)Row column blanking (e) Row column copying (f)Brightness.

The table(1) which is shown below consists of PSNR values of different transform domain techniques i.e., Discrete Wavelet Transform, Discrete Cosine Transform, and Singular Value Decomposition which are calculated from the Graphical User Interface method which are as shown as follows.

Image	DCT	DWT	SVD
Lina	47.398	57.2298	56.1064
Blue hills	48.3115	69.7163	57.7586
Sunset	43.9786	49.0956	58.5243
Water Lilies	48.5849	47.3865	59.7329
Winter	49.0474	51.9378	55.5919

Table (1): The performance measures of PSNR for GUI basedDWT, DCT and SVD transformations for different watermarked images.

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Image	DWT-SVD	DWT-SVD-DCT
Lina	56.9644	64.2298
Blue hills	71.4583	79.7163
Sunset	53.9786	59.0956
Water Lilies	57.4212	57.3865
Winter	59.0474	61.9378

Table (2): The performance measures of PSNR for DWT-SVD with DWT-SVD-DCT for different watermarked images.

We calculate the values of correlation for the proposed method in order to know the robustness of watermark image after the extraction method. The correlation values for the Lina as Cover image and AU as Watermark Image

Attacks	DWT-SVD	DWT-SVD-DCT
Median filtering	0.8738	0.9580
Cropping i.e., 25%	0.5940	0.5959
Crossing i.e., 12%	0.8122	0.8357
Resizing	0.7112	0.8974
Row column copying	0.9154	0.9812
Row column Blanking	0.8544	0.9031

Table (3): The performance measures of correlation values for different attacks.

It is clearly observed that the proposed method can be done very efficiently with better PSNR values and correlation values in comparison with other existing image watermarking schemes which are based on one level DWT-SVD.

V. CONCLUSION

In this paper, we present a novel watermarking scheme using a combination of DWT-DCT-SVD transformations in order to insert the watermark into a cover image. The DWT-DCT-SVD based method offers better capacity and imperceptibility properties than the classical one level DWT-SVD, while the obtained results show that our proposed scheme can resist several types of image watermarking attacks, i.e., geometric transformation attacks, noises attacks, and JPEG compression attacks. In our future work, we intend to extend the scheme for color image watermarking by inserting the different watermark images into the RGB color plans.

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