Digital Image Watermarking using SVD along with other watermarking algorithms

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Abstract

Security is an important factor when a user is handling images,texts,audio as well as other files in the digital era.It is very easy for an outsider to steal the information or contents.Such acts leads to loss of property and other problems for the user.Thus,digital watermarking comes into play here.This process can be done using multiple algorithms but this paper emphasizes on using DWT and DWT-DCT-SVD in order to determine the robust model for digital watermarking.The PSNR value for both are determined and then compared.

Index Terms

Discrete Wavelet Transform (DWT),Discrete Cosine Transform(DCT),Peak Signal to Noise Ratio(PSNR),Singular Value Decomposition(SVD)

I. INTRODUCTION

COPYRIGHTS and protection is a common problem that can be heard among people daily.It can be based on finance,music,games etc.This is because the user/handler doesn't fulfill the necessary requirements/criterias to acquire full ownership legally. Thus,a new age dawned in domain of the internet known as digital watermarking.This process refers to watermarking/embedding an image,audio,text by a means of digital code.A digital watermark is a kind of a marker that is secretly hidden in a noise-tolerant signal.This process is used for identifying the ownership of such copyright of that particular signal.This technique is prominently used for tracing copyright infringements and also for handling authentication. To implant the watermark, this approach uses the cover image's wavelet coefficients (DWT). The image can be watermarked with any of the four sets of wavelet coefficients. The wavelet coefficients' DCT coefficients are computed, and singular values are decomposed. The svd technique is also done to the watermark. The modified singular values of the watermarked image are formed by adding the singular values of the cover image and the watermark. Singular value decomposition triangular matrices are formed by the updated DCT coefficients. After that, the inverse DCT and inverse DWT transforms are used. This is the algorithm that combines the SVD, DCT, and DWT features. This is a brand-new method that has never been used before. This algorithm is used to incorporate a watermark. The watermark created with this approach is virtually undetectable. This scheme is resistant to a wide range of attacks. It has a great capability for data obfuscation.

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II. Literature Review

Many researches have taken place in protecting content in the digital world with the help of digital watermarking.Digital media is incredibly easy to copy and manipulate, resulting in significant corporate losses. As a result, digital watermarking is a feasible solution to this problem.

Author [1]implemented digital watermarking using alpha bending with the help of 1-level discrete wavelet transform.This is used for insertion as well as for the extraction of the digitized watermark.The highlight of the paper was to prove that the technique used was simple and robust.

Author [2] proposed a hybrid scheme of watermarking on videos based on Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA).The DWT decomposes the video frames and adds the binary watermark in the principal components of the low frequency wavelet coefficients.PCA aids in the reduction of correlation among the wavelet coefficients that is obtained from the respective wavelet decomposition of each video frame.This in turn disperses the bits of the watermark and converts it into uncorrelated coefficients.

Author [3] proposed on selecting the blocks within the image used a Gaussian Network classifier.DCT is used with the consideration of 2 constraints.Thus 2 approaches are implemented or assessed.Certain regulations are issued for DCT coefficients in order to produce unique watermarks.

Author [4] implemented digital watermarking using image segmentation and DCT.Several attacks are placed on it in order to review its performance.The paper emphasizes on their proposed system as robust to signal distortions that are the same.

Author [5] implemented a hybrid transform as the cover image that is given is undergone manipulations rather than in DWT. The author also stated that experimental results are available for reference.

Author [6] implemented a digital watermarking scheme using DWT,DCT as well as SVD.The proposed system utilizes an Arnold transform to ensure that the watermark embedded is robust.

III. Theoretical Background

A. Peak Signal to Noise Ratio (PSNR)

As a quality statistic for photographs, the peak signal-to-noise ratio is used. It's the ratio of a signal's greatest possible value (power) to the power of distorting noise, which influences the quality of its representation. The PSNR is commonly stated in terms of the logarithmic decibel scale since signals have such a wide dynamic range.

The mathematical representation of the PSNR is as follows in Fig.1.:

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right)$$

Fig. 1. PSNR Formula

where the MSE (Mean Squared Error) is as follows in Fig.2.:

f -represents the matrix data of our original image g -represents the matrix data of our degraded image in question m- represents the numbers of rows of pixels of the images and i represents the index of that row n- represents the number of columns of pixels of the image and j represents the index of that column MAXf- is the maximum signal value that exists in our original “known to be good” image

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1}\|f(i,j) - g(i,j)\|^2$$

Fig. 2. Mean Squared Error

B. Discrete Wavelet Transform(DWT)

A discrete wavelet transform (DWT) decomposes a signal into a number of sets, each set including a time series of coefficients that describe the signal's time evolution in the associated frequency band.For many natural signals, the DWT gives a sparse representation. In other words, a subset of DWT coefficients that is generally much smaller than the original signal captures the key properties of many natural signals. The signal is ”compressed” as a result of this. You always get the same number of coefficients with the DWT as you did with the original signal, although many of them may be close to zero in value. As a result, you can usually ignore those coefficients while still getting a good signal approximation.

C. Discrete Cosine Transform(DCT)

DCT is similar to the Fast Fourier Transform (FFT), but with fewer coefficients. The DCT is a method for converting a signal into its fundamental frequency components. The input signal is represented as a linear mixture of weighted basis functions that are connected to its frequency components in the DCT. The DCT does not, in general, reduce the amount of bits needed to represent a block. Due to the range of coefficient values, the DCT creates an 8 8 of 11-bit coefficients for an 8 8 block of 8-bit pixels. However, because the DCT concentrates on low-frequency coefficients and the other coefficients are mostly zero, compression can be done by sending the near-zero coefficients.

D. Singular Value Decomposition

Singular Value Decomposition (SVD) is a widely used technique to decompose a matrix into several component matrices, exposing many of the useful and interesting properties of the original matrix. Using SVD, we can determine the rank of the matrix, quantify the sensitivity of a linear system to numerical error, or obtain an optimal lower-rank approximation to the matrix. The SVD of mxn matrix A is given by the formula in Fig.3. :

where: U: mxn matrix of the orthonormal eigenvectors of AA^t

VT: transpose of a nxn matrix containing the orthonormal eigenvectors of A^tA .

W: a nxn diagonal matrix of the singular values which are the square roots of the eigenvalues of AA^t and A^tA.

$$A = UWV^T$$

Fig. 3. SVD formula

IV. METHODOLOGY

The watermarking embedding process is broken down into eight steps, which are briefly discussed below:

Step 1: Resize the cover picture (I) and watermark image (W) to 512x512 pixels.

Step 2: To embed the cover picture, this method uses the wavelet coefficients (DWT) of the image watermark.

Step 3: The image can be watermarked with any of the four sets of wavelet coefficients. Here,The LL coefficient is used. We calculate the matrices as U3,S3,$V3^t$, where U3 and V3 are orthogonal matrices and S3 is a diagonal matrix, using DCT and SVD.

Step 4: We apply SVD to the watermarking image to obtain Uw,Sw,Vw^t matrices.

Step 5: The acquired diagonal matrices (S3 and Sw) are changed as follows: S32=S3+alpha*Sw The constant alpha is set to 10 throughout the code.

Step 6: SVD the matrix S32 once more to obtain the diagonal matrix, Ss.

Step 7: Multiply the adjusted Ss by the orthogonal matrices produced by performing the SVD of LL. U3* Ss* V3t is the coefficient (U3 and V3t).

Step 8: Finally, we obtained by applying IDCT followed by IDWT to the obtained matrix image with our watermark (Iw).

V. EXPERIMENTAL RESULTS

Here in this section, we calculate psnr value of the watermarked images that was used for DWT and DWT-DCT-SVD respectively as shown in Fig.4.:

PSNR value for DWT is 60.92538343086213

PSNR value for DWT_DCT_SVD 85.03977978726881

Fig. 4. PSNR values

The embedded watermarked image is obtained of DWT as shown in Fig.5.:

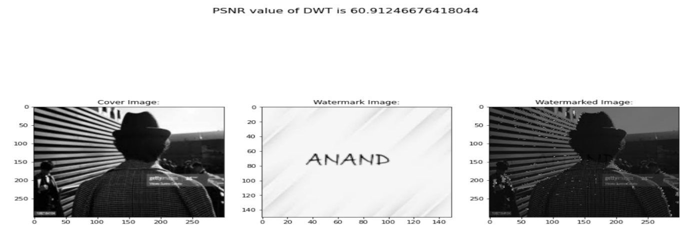

Fig. 5. DWT values

The embedded watermarked image is obtained of DWT-DCT-SVD in Fig.6.:

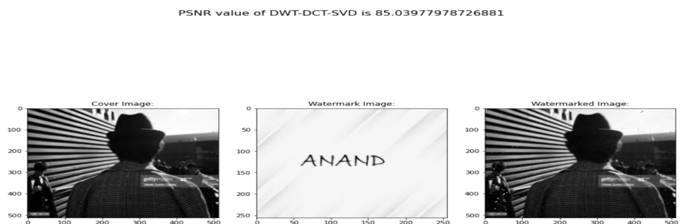

Fig. 6. DWT-DCT-SVD values

VI. Conclusion

In this paper,the respective psnr values for both DWT as well as DWT-DCT-SVD has been computed.It can be observed that psnr value of DWT-DCT-SVD is much lesser than that of DWT.Hence,the optimum solution has been achieved.Thus,the method of combining DWT-DCT-SVD is more robust than using DWT only.

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