A COMPARATIVE PERFORMANCE ANALYSIS OF DCT, DWT-SVD, DCT-DWT-SVD DIGITAL WATER MARKING ALGORITHMS

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Abstract: The advancement in the internet communication and multimedia data has led to risk of data being misused by unauthorized persons. Digital image watermarking is one such technology that has been developed to protect digital content (text, images, audio, and video) from illegal manipulations. In this project the performance analysis of three different watermarking schemes based on DCT, DWT-SVD and DCT-DWT-SVD is performed and best scheme is proposed. To check effectiveness of the schemes for imperceptibility and robustness PSNR, MSE and NCC parameters are used.
Keywords: Watermark; DWT; DCT; SVD; PSNR; NCC

I. INTRODUCTION

The advancement in the digital media communication has been drastically gained importance in the present era. This is basically because of ease of transmitting the digital media such as image, audio, video etc over internet. As the the communication technology is improved, along with that the severe unavoidable problems has to be faced. The problems related to digital data communication over internet are mainly data integrity, authentication of data, proprietor or ownership of the data, and copyright protection of the digital data. As a solution to the above said problems of digital data communication, the digital water marking techniques has evolved and gained a great importance.

There are many Digital watermarking schemes based on different approach. It can be broadly classified based on Spatial Domain and Frequency domain. Spatial Domain based watermarking schemes performs alterations only to the luminance value of the cover picture. It is more prone to attacks and hence not robust. In frequency domain the watermarking is done after transformation to frequency domain which makes it more robust against various image processing attacks.

Since there are many approaches for digital image watermarking with varying quality and level of protection, in this project the comparative performance analysis of DCT (Discrete Cosine Transform) , DWT-SVD (Discrete wavelet transform-Singular value transform) and DWT-DCT-SVD based water marking algorithms will be done using MATLAB simulation. The performance of these three approaches is checked with all the possible types of attacks using the MATLAB simulation.

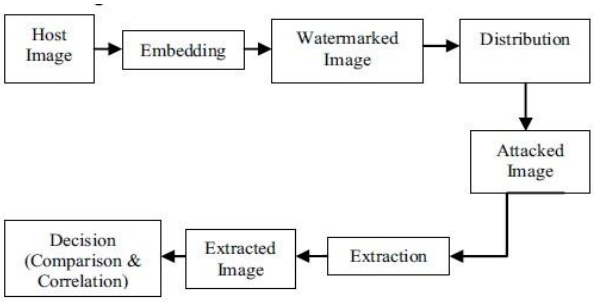

Fig1: General Image watermarking Process

II. RELATED WORK

Authors proposed watermarking algorithm based on DWTDCT and SVD. They apply one level DWT decomposition of cover image and select LL band for watermarking. They apply Arnold transform to get good robustness and imperceptibility. In this paper DC coefficient based watermarking scheme for color image is suggested. They apply wavelet decomposition one level to color image. Then divide the selected band into 4X4 sub blocks and DCT is
applied. First DCT value is selected from all sub blocks. Then SVD is performed on that. The method is tested against various attacks and result is good for LL band in compare to other band. A hybrid block based technique is proposed. In that First singular value is selected for watermark embedding in all different band after first level decomposition. A hybrid technique based on SVD and DCT is proposed. More transparency is obtained using only Singular values of a recognized pattern and LPSNR is adopted to achieve high robustness. Watermarking scheme based on DCT-DWT-SVD. They apply second level decomposition of cover image. DCT is apply to second level HL coefficient and divide it into four quadrant using zigzag sequence. SVD is applied to each quadrant and modified with SVD of watermark. Algorithm gives good PSNR and also robust to various attacks. Robust watermarking scheme is proposed by Navas. In that they combine advantage of three techniques(DCT-DWT-SVD).scheme is very robust for different kind of image processing attacks. Middle band coefficient of DCT based watermarking scheme is given for image authentication. DWT is applied then after DCT of LL is computed. Then mid band coefficient is selected and SVd is applied on it. It is very robust against JPEG compression. R. Mehul has suggested that to get robustness for vast range of attacks watermark insertion can be performed in both low and high value coefficients.

III. PROPOSED SCHEMS

A. DCT based watermarking

Discrete Cosine Transform is a technique which converts specific set of data into frequency components. It expresses a finite number of data into a sum of cosine functions which will oscillate at some frequency. The steps involved in brief are as follows. Dividing host image Ih into 8x8 blocks. Applying DCT to each 8x8 blocks. Embed the watermark image pixel values into the middle frequency component of the each 8x8 block of host image and apply inverse DCT to get watermarked image Iw. Apply reverse approach to extract the watermark and the host image.

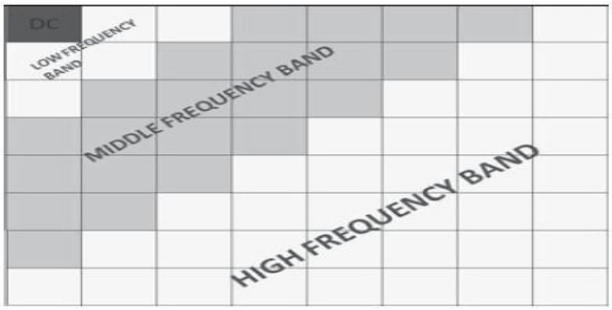

Fig2: Frequency Bands of the DCT Coefficients

The process of extraction of the watermark from the watermarked image is simpler and in reverse order compared to embedding the watermark. First take the watermarked image Iw which is in the spatial domain.

Iw is divided into 8x8 non overlapping sub blocks. Each sub blocks are transformed into frequency domain by applying the 2D DCT. The above steps are repeated for all the blocks. Read the middle frequency coefficients of each blocks i.e. DCT (5, 2) an DCT (4, 3). Based on the following criteria the watermark bits are decided.

W (i,j) = 1 if DCT (5, 2) > DCT (4, 3)
W (i,j) =0 if DCT (5, 2) < DCT (4, 3)

B) DWT - SVD based watermarking

It is a blind algorithm i.e. no need of original image to extract water mark. The DWT processes the image by dividing it into four non overlapping multi-resolution sub-bands LL, LH, HL and HH. LL is lower resolution area with average intensity. LH is the horizontal edge data. HL is the vertical edge data. HH is the diagonal edge data. LL layer is represented by a matrix of order m x n.

Singular Value Decomposition (SVD) is then applied to LL Sub band. SVD performs orthogonal row and column operation yielding diagonal matrix with decreasing values say A. A is decomposed into product of three matrices such that. A=USVt. U and V are orthogonal matrices. S is pseudo diagonal matrix with singular values. Singular values represent the large portion of signals energy. They have good noise immunity. SVD is now applied to watermark image of size m x n to obtain singular values. New singular values are replaced with their counterpart in matrix A to get water marked image.

C) DCT-DWT-SVD based watermarking

To have all the merits of the three transfer domain algorithm this method is proposed. First 2 LEVEL DWT is applied to cover image to obtain 4 sub bands i.e. LL, HL, LH, HH. LL_HH band is then divided into 4x4 sub blocks and DCT is applied to each blocks to obtain DC coefficients. DC coefficients are arranged in matrix and SVD is applied to obtain the singular values. These singular values are then replaced with the counterpart of the watermark image. Inverse SVD, inverse DCT and inverse DWT is performed to get watermarked image during extraction stage.

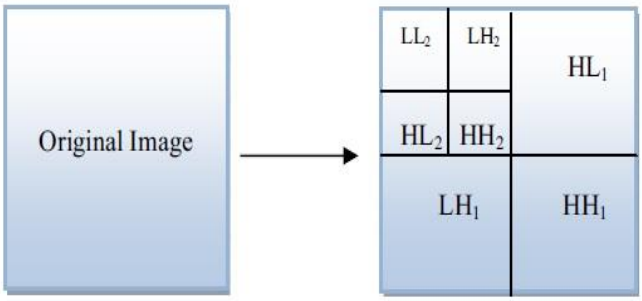

Fig3: Two Level DWT Decomposition

IV. PERFORMANCE PARAMETERS

In this project each algorithm is evaluated based on certain performance parameters to judge its performance. The important performance parameters are

MSE (Mean Squared Error)
PSNR (Peak Signal to Noise Ratio)
NC (Normalized co relation factor)

$$MSE = \frac{1}{MN}\left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(|A-B|)^2\right)$$

$$PSNR = 10.\log_{10}(MAX^2 A / MSE)$$

$$NC = \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * EW\right) / \left(\sum_{i=0}^{M-1}\sum_{j=0}^{N-1} OW * OW\right)$$

V. METHODOLOGY

Watermarking algorithms under the scope of study are DCT, DWT-SVD and DCT- DWT-SVD. Independent MATLAB simulation of algorithms and analysis of the performance parameters will be done. Creating possible image processing attacks using MATLAB simulation and verify the performance of above said algorithms under these attacks. Comparing all the results conclusion of a best method for image watermarking will be proposed.

VI. SIMULATION RESULTS

The simulation of three water marking schemes is performed in MATLAB simulation and the comparative analysis is done based on the performance parameters discussed in section IV.

Fig4: Cover Image

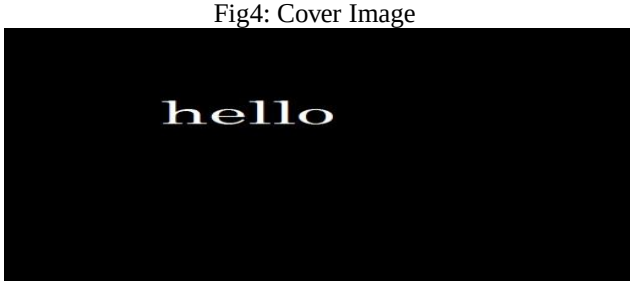

Fig5: Water mark Image

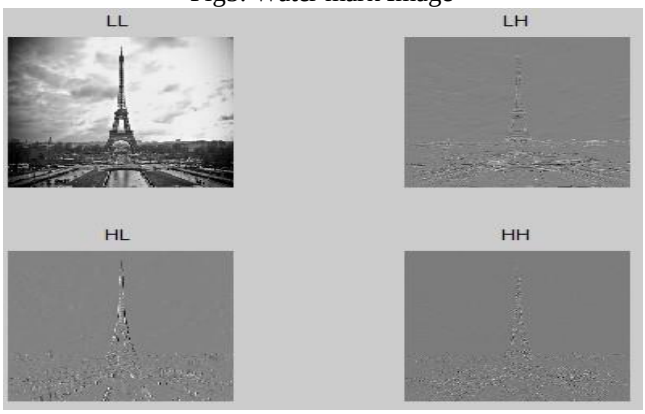

Fig6: Decomposed layers of cover image

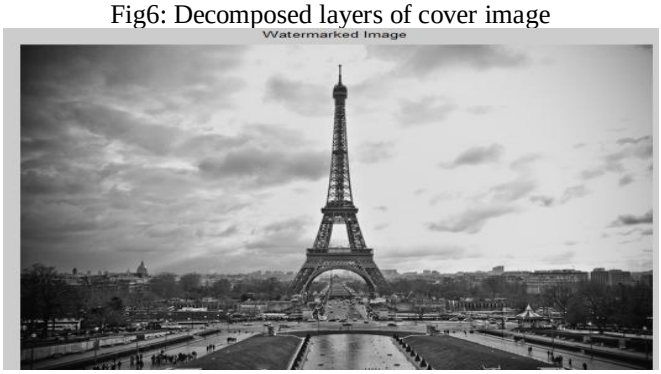

Fig7: Watermarked Image

Fig8: Extracted Watermark

Fig9: Cover Image after watermark extraction

TABLE I

Parameter	Watermarking Scheme		
	DCT	DWT-SVD	DCT-DWT-SVD
PSNR	77.0703	115.08	164.363
MSE	29.2388	0.6535	0.00473
NC	0.9994	1	1
Host Image Size	512 x 512	512 x 512	512 x 512
Watermarked Image Size	512 X512	512 X512	512 X512
Original Watermark image size	20x50	512 x 512	512 x 512
Extracted Watermark image size	20x50	512 X512	512 X512

TABLE II: Comparision

Scheme	Advantage	Disadvantage
DCT Based water marking	High robustness to JPEGcompression attacks	Large overhead
		Not resistant to geometric attacks
DWT SVD based hybrid method	Strong robustness	Complex method
	Good Imperceptibility	Extraction is not good
Combined DCT DWT SVD method	Good stability	Requires large computation

VII. CONCLUSION

The watermarking schemes based on DCT, DWT-SVD and DCT-DWT-SVD algorithms have been successfully simulated using MATLAB. The result has shown that DCT approach is not resistant to various attacks as it has less PSNR. DWT-SVD scheme is though robust under normal

condition, its robustness decreases as change in frequency. The scheme based on DCT-DWT-SVD has proved to be robust under normal and also under various attacks. The PSNR value being highest among all other approaches it can be concluded that this approach is best suited for the digital image watermarking.

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