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Novel Digital Image Watermarking Using LWT-WHT-SVD in YCbCr Color Space

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ABSTRACT: Image authentication under various transmission conditions is very challenging task and to solve this problem I have to do a robust method for watermarking. In this paper, To enhance the performance of watermarking system we propose Walse Hadamard Transform domain approach in YCbCr color space using the unique combination of 2–Level Lifting Wavelet Transform (LWT) and Singular Value Decomposition (SVD).Every stages of the system are tested. YCbCr color space is used to make use of its decorrelation property in order to increase the correlation between cover and watermarked final image. LWT stage selectively uses the detail coefficients of the 2–dimensional LWT of an image. After applying LWT we apply WHT (Walse Hadamard Transform) to find the WHT coefficient and at the final we apply SVD on each coefficient to get the final watermarked image. Through this method we find the PSNR value is increase. So this method gives the better results in terms of increasing PSNR value and is able to withstand a variety of image processing attacks.

KEYWORDS: Digital Image Watermarking, Walse Hadamard Transform, Lifting Wavelet Transform, YCbCr Color Space, etc.

I. INTRODUCTION

In recent years the internet dependency is increasing day by day. In many field such as communication, medical, engineering, defense it is necessary not to copy the data by third person. In communication there may be hacker who may be stealing my content. To improve security we introduced the term that is called watermarking. In this thesis we are discussing a novel method for watermarking scheme this is robust method we can say because the peak signal to noise ratio is better in my method. The all about Wales hadamard transform, lifting wavelet transform is discuss here.Lifting wavelet transform is substitute to the discrete wavelet transform. Lifting scheme is used to produce second generation wavelets, which are not necessarily translation and dilation of one particular function. Three steps are involved in assembling wavelets using lifting scheme viz. Split, Predict and Update. Split phase splits data into odd and even sets. In Predict step, even set is used to anticipate odd set. Predict phase ensures polynomial cancellation in high pass. Update phase will use wavelet coefficients to modernize even set which used to calculate scaling function. Fig. 1 shows lifting wavelet transform scheme. Lifting scheme allows faster Implementation of wavelet transform.

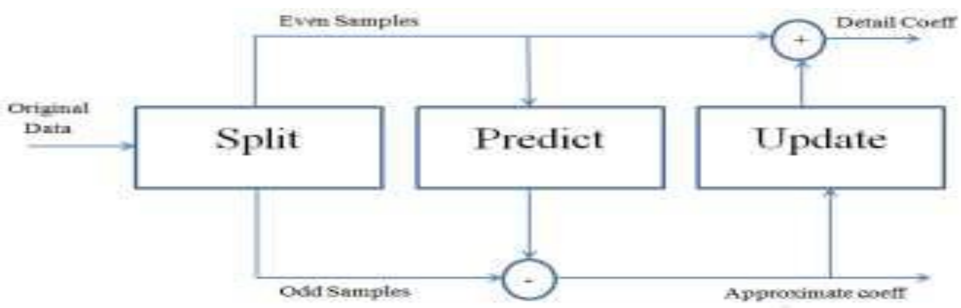

Figure 1 lifting wavelet transform

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Hadamard transform matrix is an orthogonal square matrix which only has 1 and -1 of element value. This transform is also known as Walsh Hadamard transform. H_1 is the smallest Hadamard matrix, and it is defined a –

$$H_1 \quad = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 & 1 \\ 1 & -1 \end{bmatrix}$$

Let,

V = transformed vector of size N×1

U = original cover image vector of size N×1

Then applied hardmard transform vector should be size of N×N

Hardmard matrix is a unitary elementary matrix.

Higher size of matrix can be calculated by simply using this elementary matrix.

$$H_2 = H_1 \times H_1 = \frac{1}{(\sqrt{2})^2}\begin{bmatrix} H_1 & H_1 \\ H_1 & -H_1 \end{bmatrix}$$

$$H_2 = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & 1 & -1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \end{bmatrix}\begin{matrix} \text{(Sequency)} \\ 0 \\ 3 \\ 1 \\ 2 \end{matrix}$$

$$H_3 = H_1 \times H_1 \times H_1 = H_2 \times H_1 = \frac{1}{[\sqrt{2}]^3}\begin{bmatrix} H_2 & H_2 \\ H_2 & -H_2 \end{bmatrix}$$

In general any higher order matrix is computed by generalized formula

$$H_n = H_{n-1} \times H_1 = \frac{1}{[\sqrt{2}]^n}\begin{bmatrix} H_{n-1} & H_{n-1} \\ H_{n-1} & -H_{n-1} \end{bmatrix}$$

The number of sign changes along each row of the matrix in H_2 is called the sequency of the row. These rows can be considered to be samples of rectangular waves with a sub period of $\frac{1}{N}$ units. These continuous functions are called Walsh's functions. The Hadamard matrix is an orthogonal matrix and satisfies the following relation –

$$H \times H^T = \quad I$$

SVD is factorization of a real or complex matrix into three matrices. Consider an m×n real or complex matrix M. Then its SVD is obtained as follows –

$$A = [U][S][V^T]$$

The major advantage of using SVD is that when the singular matrix is used to embed the watermark, lesser number of values of host image are altered. Hence, when a very small disturbance occurs in the image, the variation in singular values can be neglected.

II.RELATED WORK

Digital image watermarking has various applications in copyright protection and rights management, health care, secured e-voting systems, criminal photograph authentication and transmission, etc [1]. In paper [2] author presented Novel Digital Image Watermarking Using DWT-DFT-SVD in YCbCr Color Space for increasing the value of PSNR.

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The authors in [3] presented a watermarking scheme using DWT and SVD. In which Watermark is converted in to bits consists of 0 & 1. Bits are scrambled using torus auto-morphism. 2D DWT is applied to cover image. LL band is selected and it is divided in to 8*8 blocks. Each watermark bit is embedded to each block. In [4] authors proposed a watermarking scheme based on LWT and SVD. In this scheme Q value is computed and used for comparison with the intensities of the sub-bands. Decompose the image into sub-bands using LWT. The sub band which is having intensity more than Q value is used further for singular value decomposition and watermark is embedded in it. In [5] author represented DWT-SVD combined full band robust watermarking technique for color image in YUV Color space, in which discrete wavelet transform is used to decompose the image into bands and apply singular value decomposition to obtain the final watermarked image. In paper [6] author uses the discrete wavelet transforms watermarking using haar wavelet. Haar wavelet is used to find the wavelet coefficient.

III.PROPOSED ALGORITHM

A. EMBEDDING ALGORITHM

Step 1: Read cover image and watermark image with NXN size.
Step 2: The cover image and watermark image is converted into YCbCr color space from RGB color space and one of the channels is chosen for embedding.
Step 3: Perform 1-LWT on the Y channel of cover image and watermark image to split into four groups.
Step 4: Perform 2-LWT on the HH band of cover image and watermark image to split into four groups.
Step 5: Apply WHT on HL band of cover and watermark image.
Step 6: Perform SVD on the WHT coefficient of the cover.

$$svd(A^J) = U^J S^J V^{JT}$$

Step 7: Perform SVD on WHT coefficient of the watermark image.

$$svd(W_J) = U_J S_J V_J^T$$

Where, J signifies one of the four sub-bands.

Step 8: Add singular values of sub-bands of watermark into the singular values of sub-bands of cover image as follows:

$$S_P = S^J + \alpha \times S_J$$

S_P is the singular values matrix of the watermarked image. α is the factor that controls the imperceptibility and robustness of algorithm.

Step 9: Embed singular matrices with orthogonal matrices for final watermarked matrix as W with below formula:

$$A_W^J = U^J \times S_P \times V^{JT}$$

Step 10: Apply 2D-IWHT to reconstruct the matrix.
Step 11: Perform the two level inverse LWT (ILWT) on the LWT transformed image, to obtain the watermarked final image.

(B) EXTRACTING ALGORITHM

Step 1: Apply two levels LWT transform to decompose the watermarked image W into four overlapping sub-bands.
Step 2: Apply WHT to HL sub band using equation (A).

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Step 3: Apply SVD to all sub-band WHT coefficient and get the singular value of watermarked image S_W^J.

$$svd(A_W^J) = U_W^J \times S_W^J \times V_W^J$$

Step 4: Extracting the singular value of watermarked image by modify the singular value of cover image S^J such that

$$S_W^X = (s_w^J - s^J)/\alpha$$

Step 5: Now for extracted watermark image and cover image extract singular matrices with orthogonal matrices as W with below formula:

$$W = U_W^J \times S_W^X \times V_W^J$$

Step 6 : Apply 2D-IWHT to reconstruct the matrix in equation .
Step 7 : Perform the two level inverse LWT (ILWT) on the LWT transformed image, to obtain the extracted watermark and cover image.
Step 8 : Calculate PSNR and RMSE value of watermarked and cover image.

IV.SIMULATION RESULTS

In this section we want to show you the simulation results. Dataset is the collection of different type of figure we have taken in my dissertation. The name of each figure is mentioned at bottom of every figure

DATASET


(Tulips)


(Pepper)


(Lena)


(House)


(Cameraman)


(Boat)

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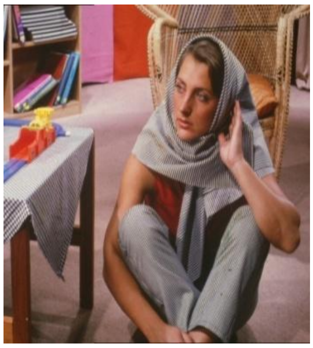
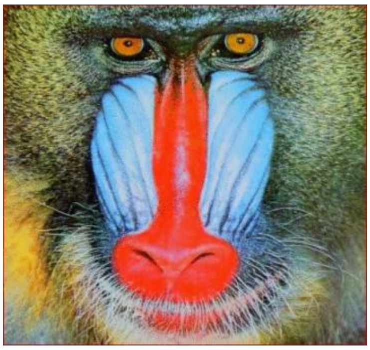
(Aeroplane)

(Mysail)



(Barbara)

(Hunter)



(Baboon)

(Cover image)

(watermark image)

(Final Watermarked Image)

Table for MSE for Different Channel after Blurring Attack

Cover image	Watermark Image	Y channel	Cb Channel	Cr Channel
Airplane	Boat	45.50	18.97	15.31
Pepper	Airplane	37.86	13.72	18.35
Tulips	House	60.20	25.13	33.10
Lena	Cameraman	38.54	13.98	14.81
Baboon	Hunter	69.67	18.20	17.61
Airplane	Barbara	45.50	18.97	15.31
Lena	Mysail	38.54	13.98	14.91

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Table for MSE for different channel after Cropping Attack

Cover Image	Watermark Image	Y Channel	Cb Channel	Cr Channel
Airplane	Boat	89.85	88.41	88.49
Pepper	Airplane	87.82	87.60	87.67
Tulips	House	95.02	87.73	87.76
Lena	Cameraman	89.64	87.65	87.73
Baboon	Hunter	93.31	87.67	87.69
Airplane	Barbara	75.29	67.45	67.75
Lena	Mysail	89.64	87.65	87.73

Table for comparison of Proposed and reference PSNR for Different Channel

Cover Image	Watermark Image	Ref. PSNR (Y Channel) [in db]	Pro. PSNR (Y Channel) [in db]	Ref. PSNR (Cb Channel) [in db]	Pro. PSNR (Cb Channel) [in db]	Ref. PSNR (Cr Channel) [in db]	Pro. PSNR (Cr Channel) [in db]
Airplane	Boat	35.47	50.79	35.11	58.90	34.92	59.48
Pepper	Airplane	35.82	64.11	34.82	70.59	35.67	70.67
Tulips	House	31.71	42.95	31.96	63.82	31.95	63.26
Lena	Cameraman	33.86	49.57	32.50	68.95	32.54	68.58
Baboon	Hunter	33.06	45.29	32.6	67.45	33.15	67.75
Airplane	Barbara	34.29	50.77	33.85	58.97	33.52	59.08
Lena	Mysail	34.87	49.54	33.73	68.95	33.74	68.57

Final PSNR

Cover Image	Watermark Image	Final PSNR[in db]
Airplane	Boat	59.80
Pepper	Airplane	65.44
Tulips	House	52.91
Lena	Cameraman	59.04
Baboon	Hunter	55.24
Airplane	Barbara	59.08
Lena	Mysail	59.03

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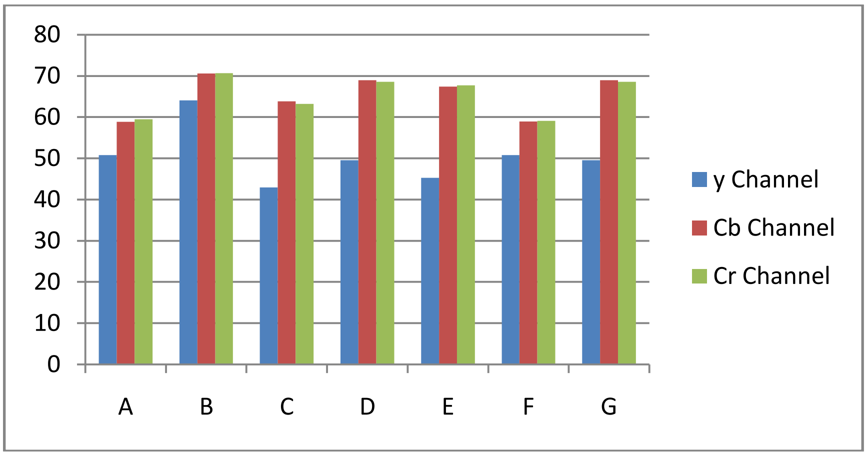
Graph for PSNR Between Different channel



V. CONCLUSION AND FUTURE WORK

In this research, we found that the digital watermarking is more understandable and easier technique for data hiding. In this research, we presented a new approach for DIW using 2-LWT-WHT-SVD on YCBCR elements for extra safety and quality. It achieves secure watermarking in an efficient manner and increase robustness. It increases PSNR value after applying various attack on it. Color Image processing in this study provides more security because Embedded Watermark can only discover by knowing the selected Color Component. The work can be prolonged of equipment execution and performance examination in other change areas like wavelet discrete transform. In future we want to improve the work efficiency with embedding multiple watermarks. In our work use of color and gray scale pictures, in future we can also use satellite pictures as well .In the future, we will work on several attacks like scaling, compression, Gaussian blurred etc. and also improve performance.

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