A Hybrid Method for Image Watermarking Using 3LWT-FFT-SVD in YCbCr Color Space

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Abstract- *Digital image authentication under varying transmission and acquisition conditions is very challenging and efficient watermarking is an effective approach to solve this problem. In this paper, we propose a transform domain approach in YCbCr color space for enhancing the presentation of 3–level LWT, FFT and SVD. Character phases of the approach are examined and a strive is made to enhance every stage. YCbCr color space is utilized to make use of its decorrelation property in order to improve correlation between original and watermarked image. Lifting Wavelet Transform (LWT) stage selectively makes use of the horizontal and vertical element coefficients of the three–dimensional LWT of an image. LWT are that it drastically reduces the calculation time and pace up the computation approach. The interpretation variance trouble of the LWT is compensated within the following Fast Fourier Transform (FFT) stage, which also exploits the frequency characteristics of the picture. Ultimately Singular Value Decomposition (SVD) is used to implant the watermark data. The system gives better results in phrases of increased PSNR values and is able to withstand a form of picture processing attacks.*

Keywords- LWT; FFT; SVD; YCbCr; Watermarking.

I. INTRODUCTION

Today's generation is witness of developments of digital media. A very simplest example of digital media is a photo captured by phone camera. The use of Digital media is common in present era. Other example of Digital media is text, audio, video etc. We know an internet is the fastest medium of transferring data to any place in a world. As this science grown up the risk of piracy and copyright very obvious thought is in homeowners mind. So Watermarking is a procedure of secure information from these threats, in which proprietor identification (watermark) is merged with the digital media on the sender end and at the receiver end this owner identification is used to recognize the authentication of data. This technique can be practical to all digital media types such as image, audio, video and documents. From many years researchers and developers worked in this area to gain best results [1].

Robustness of the watermarking plan is founded on watermark embedding technique, capacity of watermark, strength of watermark, spreads of watermark over the image and intactness of watermark behind attacks. If it's not viable to generate fake watermark is the noninvertible property and must furnish riskless protection to the rightful possession. To fulfill above standards LWT and SVD performs an extraordinarily foremost position.

The most important motivation of this work is to provide a strong digital signature watermarking, utilizing joint strategy comprising of LWT-SVD to protect pictures in opposition to attacks and validate possession of picture without degrading the quality of image. This algorithm is spread spectrum, semi blind, and non-invertible. It was good gets bigger robustness and improved constancy, which is without doubt one of the principal challenges of the watermarking. Proposed process is semi blind as the SV of real picture is required to retrieve the watermark. [2].

LWT with average four-faucet orthonormal filter with 2 vanishing moments is used for DIW. LWT is a substitute process for DWT to transform picture into frequency domain for actual time applications. Lifting wavelet is the 2nd generation speedy WT. In this, translation and dilation aren't predominant to obtain lifting wavelets. In LWT, up and down sampling is replaced simply by split and merge in each of the level. The poly section accessories of the signal are filtered in parallel via the corresponding wavelet filter coefficients, producing the better outcomes than up and down sampling which is required in traditional DWT approach [3].

Fast Fourier Transform (FFT)

The FFT is applied on spatial domain image to obtain FFT coefficients. The points which can be removed from FFT coefficients are actual phase, imaginary phase, magnitude valued at and part viewpoint. The FFT computation is rapid in comparison with DFT, on account that the number of multiplications compulsory to calculate N-factor DFT are less i.E., Handiest (N/2) [log2N] in FFT as in opposition to N2 in DFT. The features of DWT are obtained from approximation band only. The points of FFT are computed using the magnitude values.[4].

YCbCr color space

YCbCr represents color area as brightness and color change signals whilst RGB represents color as red, green and blue add-ons. In YCbCr, Y is luminance, Cb is the difference of blue component and luminance (B−Y) and Cr is the difference of red component and luminance (R − Y) Cb or Cr are standard chrominance method.

$Y = (0.257 \times R) + (0.504 \times G) + (0.098 \times B) + 16$ $Cb = (0.439 \times R) - (0.368 \times G) - (0.071 \times B) + 128$ $Cr = (0.148 \times R) - (0.291 \times G) + (0.439 \times B) + 128$

Singular Value Decomposition (SVD)

SVD is factorization of an actual or elaborate matrix into 3 matrices. Keep in mind an m×n real or intricate matrix M. Then its SVD is achieved as follows, $M = USV^T$ (4) Here U is an m × m real or complex unitary matrix, S is an m×n rectangular diagonal matrix with non–negative real Numbers on the diagonal, V is an n×n actual or intricate unitary matrix. The diagonal entries of S are the SVs of M inside the lowering order. The major advantage of using SVD is that when the singular matrix is used to implant the watermark, lesser number of values of host image is altered. Hence, when a very small disturbance occurs in the image, the variation in SVs can be neglected.[5].

II. LITRETURE SURVEY

[6] A more robust color image watermarking algorithm using a hybrid of DCT and DWT features has been devised. The image is first converting into YCbCr color space, than the luminance component is selected for embedding watermark because of its sensitivity to human eyes. Previous to embedding watermark, the luminance component is split in step with the number of bits in the common watermark into 2 non-overlapping bocks of pixels and DCT is transformation is performed on each block. In addition to the above, it also uses DWT. The algorithm is resilient to various attacks such as noise addition, JPEG compression, cropping, and filtering.

[7] The scheme has a state of artwork efficiency in order the robustness and imperceptibility properties are worried. For secured transmission of data, a precise blend of DWT, DFT and SVD founded watermarking algorithm is offered in.

[8]The watermark size is one fourth as that of the color image. Within each color image components, three images are hidden. DWT is used to decompose each color component into 4 sub components in which 3 pictures are later on hidden. Initially DCT of the watermark is obtained and the result thus obtained is added to a component out of the three components which result from the DWT decomposition after being multiplied by a factor. The R, G and B components are reconstructed by applying Inverse DWT (IWT). Finally, the foremost components are used to reconstruct the outcomes.

[9]On this paper proposed a mighty audio watermarking scheme founded on LWT-DCTSVD, DWT-DCTSVD with exploration of DE optimization and DM quantization. The attractive homes of SVD, LWT/DWT-DCT, DE and quantization technique make our scheme very amazing to quite a lot of original signal processing attacks. Meanwhile, the proposed scheme is not only robust against hybrid and desynchronization attacks, but also robust against the Strimark for audio attacks. The new outcomes validate that the proposed watermarking scheme has just right imperceptibility too. The comparison results with other SVD-based and similar algorithms indicate the superiority of scheme.

[10]in" A New Digital Watermarking Algorithm founded on NSCT and SVD" proposed an new algorithm of digital watermarking based on combining the Non Sub Sampled Contourlet Transform and SVD, they first applied the NSCT to the image and extract the low-frequency sub-band of image, and then decompose the low-frequency sub-band of image by SVD, finally embed the watermarking in the decomposed singular value. The experiment results show that the new algorithm has good ability in standing up to geometric attacking, especially rotation attacks.

[11]In these schemes mentioned, the scaling factor is not image adaptively optimized which is the challenge in this paper. Here we present a novel image adaptive non-blind color image watermarking scheme. Watermarking is done in 'Cb' parts of YCbCr color model using DWT-SVD with optimized scaling factor. YCbCr color model resembles human visual system and is not correlated as RGB channels. The proposed scheme is perceptually optimized as well as powerful against attacks and rotation invariant.

III. PROPOSED WORK

Why we use LWT over DWT?

Wavelet transform is a time domain localized analysis method. It decomposes the picture into extraordinary spatial do-main important and impartial frequencies. When the picture is DWT converted, it is decomposed into four districts above all LL which is a low frequency area and three high frequency districts mainly LH(level detail), HL(Upright detail) and HH(Diagonal detail). Figure 1 shows the one level DWT decomposition process. One drawback of DWT is that the use of better DWT basis functions or wavelet filters produces blurring and also ringing noise close edges in pictures. This disadvantage of DWT is overcome in LWT. Other advantages of LWT are that it significantly reduces the computation time and speed up the computation process.

We presented a hybrid method for digital watermarking using 3-level LWT-FFT and SVD. In this algorithm, we insert watermark picture into cover image in low frequency band of picture through editing the singular parameters and produce a cozy watermarked image underneath a number of attacks likes motion blur, and average attacks. Let the size of the cover image color picture is MXN and measurement of the watermark picture grey picture is NXN.

Proposed Algorithm

Embedding Algorithm

Input: Cover Image (CI) & Watermark Image (WI)

Output: Watermarked Image

1) Read CI 'P' and WI with NXN size.
2) The CI image and WI is converted into YCbCr color space from RGB color space and one of the channels is chosen for embedding.
3) Perform 1-LWT on the Y channel of P and WI to split into four groups.
4) Perform 2-LWT on the LH band of P and WI to split into four groups.
5) Perform 3-LWT on the LH band of P and WI to split into four groups.
6) Apply FFT on both the images using HL band.

$$X(k) = \sum_{n=0}^{N-1} x(n).e - j\left(\frac{2\pi}{N}\right) nk(k = 0,\dots,N-1) \quad (1)$$

   N points x(n) signal is transformed to N points X(k) by 2D-FFT
7) Perform SVD on the FFT coefficient of the O and WI image.

$$[U_j, S_j, V_j] = svd(X(k)) \quad (2)$$

8) Change the singular value (SV) of S_i by embedding the SV of WI such that

$$S_e = S_i + alpha * S_j \quad (3)$$

   Where WI is customized matrix of S_j and alpha denotes the scaling factor, is used to have power over the signal S_j power of watermark.
9) Embed singular matrices with orthogonal matrices for finish watermark picture as W with under formula:

$$W = U_i * S_e * V_i' \quad (4)$$

10) Apply 2D-IFFT to reconstruct the matrix.

$$x(n) = \frac{1}{N}\sum_{k=0}^{N-1} X(k).e\ j\left(\frac{2\pi}{N}\right) nk\ (n = 0,1,,N-1) \quad (5)$$

11) Perform the three level inverse LWT (ILWT) on the LWT transformed image, to obtain the WI on four coefficients.

Input: Watermarked Image

Output: Attacked Image

12) Apply Motion Blur (MB) and Average attack (AA) on WI for security and robustness.

Extraction Algorithm

Input: Watermarked Image

Output: Extracted Watermark Image

13) Apply three level LWT transform to decompose the WI W into four overlapping sub-bands.
14) Apply FFT to HL sub band using equation (1).
15) Apply SVD to X_m sub band i.e.,

$$[U_m, S_m, V_m] = svd(X_m) \quad (6)$$

16) Modify the SV of S_i by extracting the SV of WI such that

$$S_j = (S_m - S_i)/alpha \quad (7)$$

17) Extract singular matrices with orthogonal matrices for final extracted WI and CI as W with below formula:

$$W = U_m * S_j * V_m' \quad (8)$$

18) Apply 2D-IFFT to reconstruct the matrix in equation (5).
19) Perform the three level inverse LWT (ILWT) on the LWT transformed image, to obtain the extracted watermark and CI on four coefficients.
20) Calculate PSNR and RMSE value of watermarked and cover image.

$$RMSE(x) = \sqrt{\frac{1}{N}\|x - x^{\wedge}\|^2 = \frac{1}{N}\sum_{i=1}^{N}(x - x^{\wedge})^2} \quad (9)$$

Where x is cover image, x^ is watermarked image, N is the size of the cover image

$$PSNR(x) = \frac{10\,X\log((255))}{RMSE(x)} \quad (10)$$

Where m is the maximum value of the cover image

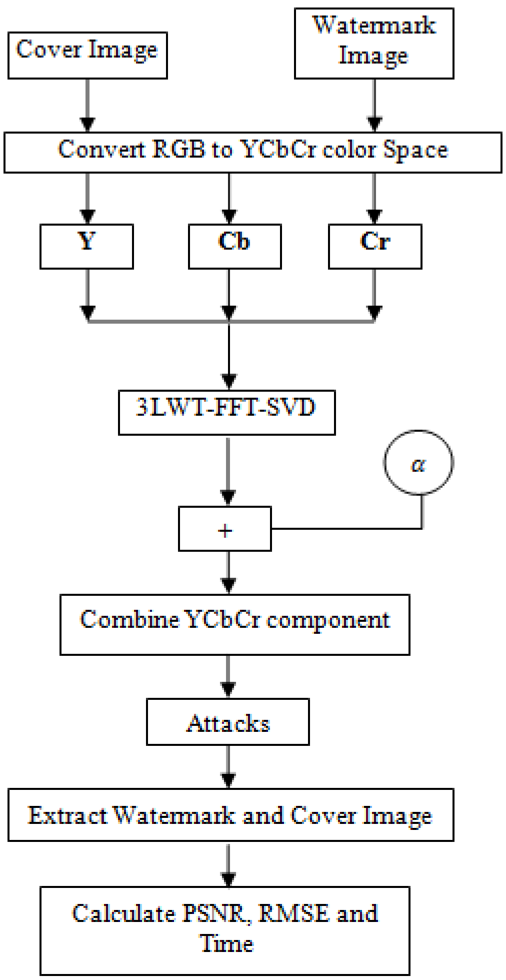

Fig. 1. Block Diagram of Proposed Architecture

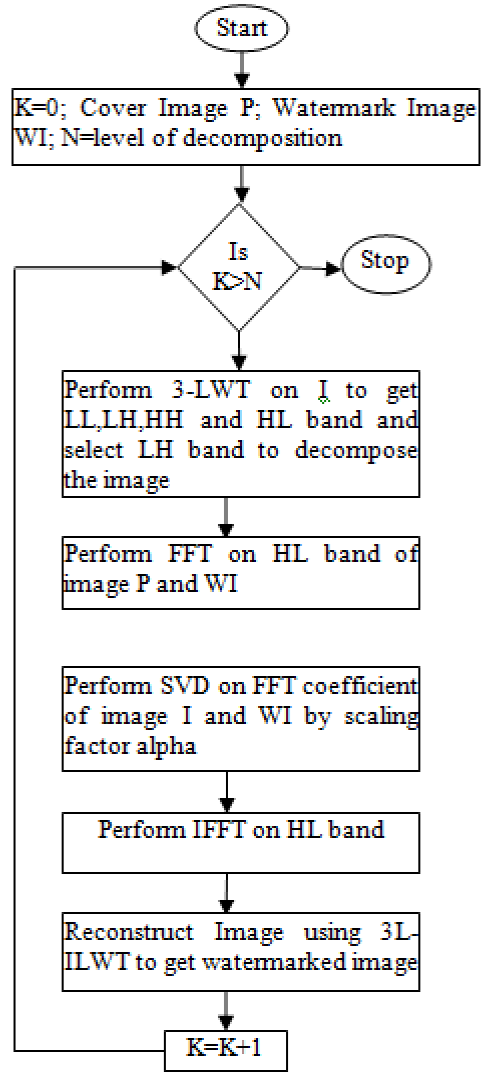

Fig. 2. Flow Chart of Embedding System

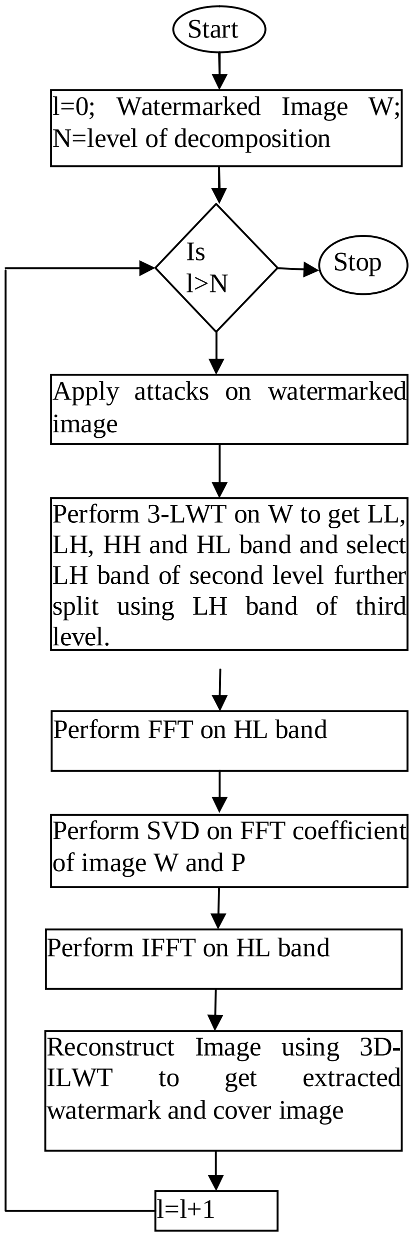

Fig. 3. Flow Chart of Extraction System

IV. RESULT ANALYSIS

Table-1: psnr comparison between ref[5] and proposed for watermarking.

Tick Label	Cover Image	Watermark Image	Ref[5] PSNR	Proposed PSNR
A	Airplane	House	52.1186	65.6785
B	Tulips	Pepper	52.1670	65.7338
C	Pepper	Airplane	52.1812	65.7554
D	Lena	Cameraman	52.0408	65.6013
E	Baboon	Liftingbody	52.1232	65.6880
F	Bridge	Boat	52.2080	65.7827

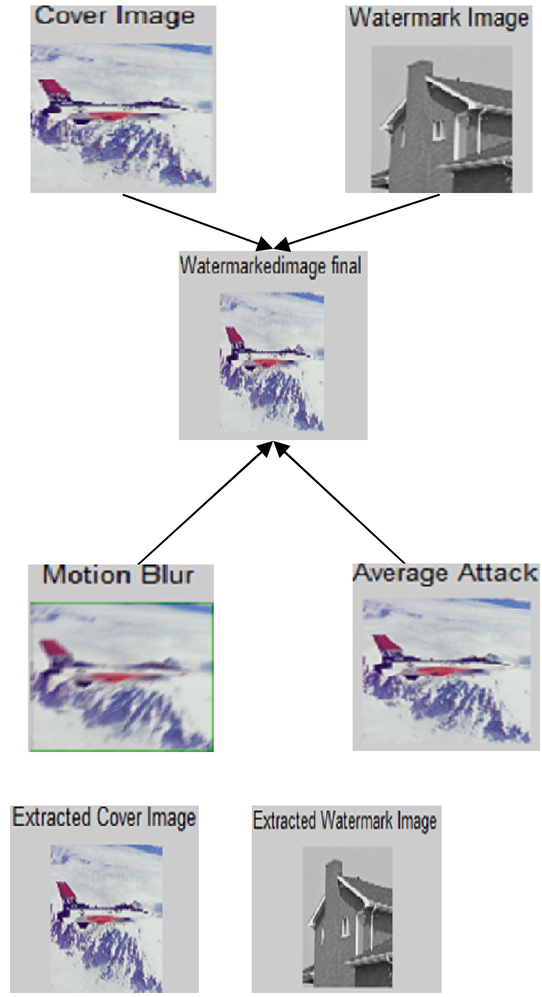

Table-2: psnr comparison between ref[5] and proposed for watermarking.

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E	Baboon	Liftingbody	52.1232	65.6880
F	Bridge	Boat	52.2080	65.7827

Table-3: RMSE after various attacks when Y-channel was used for watermarking.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	45.50	11.18
B	Tulips	Pepper	60.19	24.53
C	Pepper	Airplane	37.86	4.46
D	Lena	Cameraman	38.53	10.82
E	Baboon	Liftingbody	69.67	31.07
F	Bridge	Boat	59.69	33.22

Table-4: RMSE after various attacks when Cb-channel was used for watermarking.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	18.97	3.2371
B	Tulips	Pepper	25.13	2.5540
C	Pepper	Airplane	13.72	2.15
D	Lena	Cameraman	13.98	2.18
E	Baboon	Liftingbody	18.20	2.20
F	Bridge	Boat	21.71	4.81

Table-5: RMSE after various attacks when Cr-channel was used for watermarking.

Tick Label	Cover Image	Watermark Image	Attacks	
			Blur	Avg
A	Airplane	House	15.31	3.2333
B	Tulips	Pepper	33.10	2.5507
C	Pepper	Airplane	18.35	2.11
D	Lena	Cameraman	14.91	2.20
E	Baboon	Liftingbody	17.61	2.22
F	Bridge	Boat	18.04	4.16

Table-6: psnr comparison between ref[5] and proposed for extraction.

Tick Label	Extracted Cover Image	Ref PSNR	Proposed PSNR
A	Airplane	56.4358	57.5769
B	Tulips	43.4780	45.2341
C	Pepper	48.0211	49.5582
D	Lena	53.6118	57.1492
E	Baboon	47.3713	47.8236
F	Bridge	45.5163	47.6387

Table-7: time comparison between ref[5] and proposed for extraction.

Tick Label	Watermarked Image	Ref Embedding Time	Proposed Embedding Time
A	Airplane	0.8413	0.4899
B	Tulips	0.7334	0.3662
C	Pepper	0.6598	0.3716
D	Lena	0.5987	0.3225
E	Baboon	0.6806	0.3033
F	Bridge	0.6450	0.3810

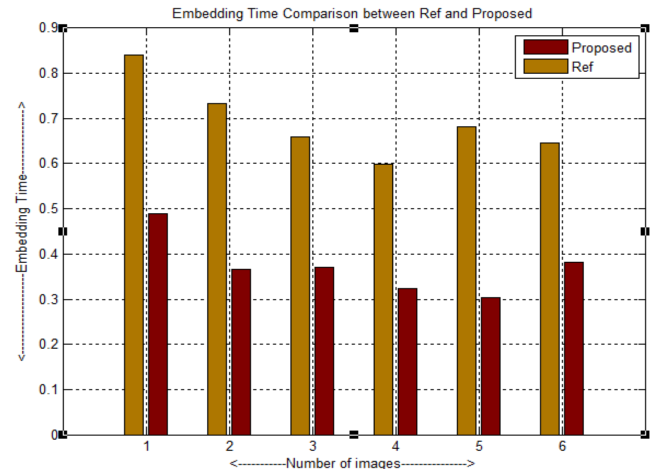

Fig 5 Time Comparison between Ref[5] and Proposed Method

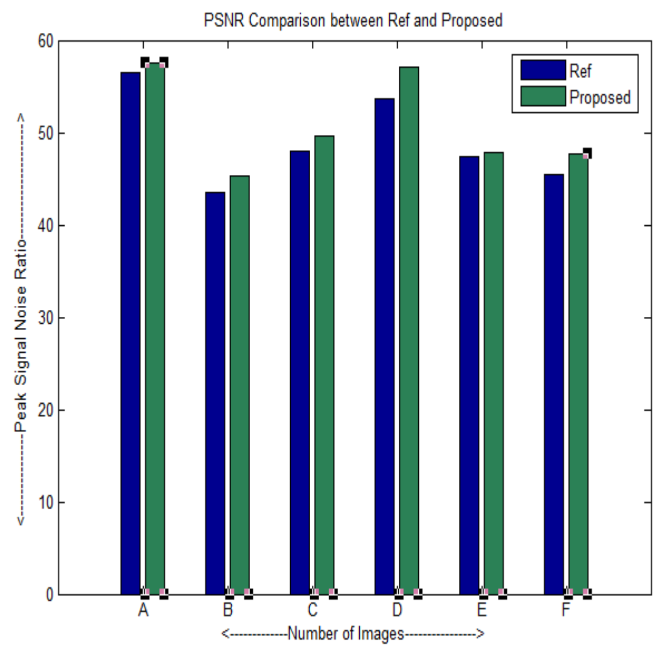

Fig 6 PSNR Comparison between Ref[5] and Proposed Method For Extraction

V. CONCLUSION

In this paper, we proposed a hybrid method of image watermarking in YCbCr color space using three levels LWT–FFT–SVD approach. Improved RMSE values were found for all–channel. Table V and Fig. 4 show the comparison of PSNR between Ref. [5] and the proposed method. The proposed result on RMSE values shown in Table II to IV. The proposed technique shows each a colossal development in imperceptibility and the robustness below attacks. This algorithm could be extended to watermark the images using color images as the watermarks. Experimentation could be done with different color spaces like HSV, CMYK to find the color space with maximum efficiency.

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