DWT-DCT Based copyright Protection In Ycbcr Color Space

Rekha Chaturvedi,Abhay Sharma, Umesh Dwivedi, Sandeep Kumar

Abstract: ***Digital image watermarking is powerful technique which provide ownership protection and copyright protection. In this paper, a novel watermarking technique based on Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) is presented. YCbCr color model is used for watermark embedding and extraction because of its close resemblance to human visual system. Single level DWT is applied to Luma Component of YCbCr color cover image and then DCT coefficients are taken for watermark embedding process. DCT is applied block by block of size*** (4×4)***. Binary watermark is scrambled using Arnold transform with k iterations to achieve robustness. Proposed method has been evaluated by many performance evaluation measures such as Peak Signal to Noise Ratio (PSNR), Normalized Correlation (NC) and Computational time. Various watermark attacks are also applied against proposed method, result shows that superiority over other methods.***

Index Terms: Digital Image Watermarking; DCT middle band coefficient, YCbCr, PSNR, SM and Normalized Correlation.

I. INTRODUCTION

In recent scenario, the Internet users are increasing vigorously and spend a lot of time on it for exchange of digital media or digital content. Due to increase in accessibility in digital content and Multimedia, risks related to information security are also growing up. Copyright protection is one of the most challenging task now days. Various scientist has proposed various techniques for copyright protection [1-5]. Digital watermarking is one of the most suitable method for restricting the illegal copying of data file, image, audio and video. Digital image watermarking is broadly classified in to two type one is Blind and other is Non-blind. In blind watermarking, there is no requirement of original cover image and any other information for extracting watermark whereas non-blind watermarking requires cover image and other information [6]. Blind watermarking is most challenging task because it is very complex to extract watermark without any information like original cover image or watermark. Watermarking method can be implemented using spatial domain or transform domain. Use of spatial domain in watermarking is very easy and efficient but it is less suitable against various watermarking attacks also quality of watermarked image is badly affected because pixel values of digital image are directly modified to hide the watermark bits, Examples are LSB (Least Significant Bit) Substitution [7-8]. Where in transform domain image is firstly converted into transform domain according to frequency of pixels then watermark bits is getting hide. examples of transform domain are DCT, DWT, FFT (Fast Fourier Transform), LWT (Lifting Wavelet Transform) etc.

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II. RELATED WORK

In recent years various researchers has presented their work on digital image watermarking. Some recent works are emphasized here. Singh et.al. proposed blind watermarking scheme using DWT-Singular Value Decomposition (SVD) and DCT [9]. They have blended the transform domain with spatial domain to enhance the robustness. DCT was applied to LSB (Least Significant Bit) and MSB (Most Significant Bit) of watermark image and DWT of cover image is chosen for hiding the watermark bit using SVD, Method was efficient and robust against various watermarking attacks such as filtering and geometric attack. Patwardhan et.al. presented a method based on DWT, SVD and QR code. Watermark was firstly converted into QR code and then hide using DWT and SVD [10]. Results was evaluated for watermarking attacks like additive noise, filtering, cropping and image adjustment. DWT-SVD and Slant Transform based watermarking was proposed and tested for watermarking attack like JPEG Compression, Histogram equalization etc [11]. Principal Component Analysis (PCA) with SVD in YCbCr colour space was implemented to enhance the robustness of the method and fuzzy inference system was used for estimating the scaling factor [12] A novel method was proposed using DCT and Lifting Wavelet Transform (LWT) using splitting, prediction and updating functions [13]. Hosseini et.al. presented their method based on PCA and DWT. first component of PCA is chosen for hiding the watermark. result was satisfactory for various watermarking attacks [14]. Non- Blind watermarking was introduced by Navas in which they used different sub band of DWT for hiding the watermark with SVD as hiding method [6]. A novel method based on LWT and firefly Algorithm was presented by blending the optimization technique to estimate the scale factor for more robustness [15]. Based on the review of above related work we came to know that major factors of watermarking are Robustness, Imperceptibility and Capacity. Robustness concerns with successful extraction of watermark after Appling various watermarking attacks while imperceptibility deals with quality of watermarked image means there should be less difference between original and watermarked image. Amount of information can be hidden in cover image is called the

capacity of watermarking methods.

III. PLIMINARIES

A. Discrete Cosine Transform (DCT)

DCT is a very powerful tool for various image processing application, watermarking is one of them. As it has resilient Energy constricting characteristics which states that essential information is collected in a very small Coefficients of the DCT image. DCT is very popular in signal processing as it is less affected by compression [7].

$$F(u,v) = \frac{2C(v)C(u)}{\sqrt{MN}} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \cos\frac{(2i+1)u\pi}{2M} \cos\frac{(2j+1)v\pi}{2N} . f(i,j) \quad (1)$$

$$f(i,j) = \frac{2C(v)C(u)}{\sqrt{MN}} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \cos\frac{(2i+1)u\pi}{2M} \cos\frac{(2j+1)v\pi}{2N} . F(i,j) \quad (2)$$

Where $u = 0,1, \ldots\ldots, M-1, v = 0,1,2 \ldots\ldots N-1,$

$$C(\varphi) = \begin{cases} \frac{\sqrt{2}}{2} & if\ \varphi = 0 \\ 1 & otherwise \end{cases}$$

F(u,v) is called DCT coefficients for function f (i, j).

B. Discrete Wavelet Transform (DWT)

DWT has been applied successfully in the field of image classification and watermarking. Because of extraordinary space and frequency compaction property. DWT is responsible for customizing the image into four distinguished sub bands name are HH, HL, LH and LL. LL component denotes the lower resolution approximation which is achieved by low pass filtering, another spatial component are HL, LH, HH are called horizontal, Vertical and Diagonal spatial component [9]. HH sub band is achieved by high pass filter in both direction where LH and HL are achieved by filtering low pass and high pass filter in horizontal and vertical direction respectively.

C. YCbCr Color Space

There are numbers of color spaces for color image such as RGB, YCbCr, YIQ, HIS, HSV etc. YCbCr is one of the most popular color space in the area of digital photography because it is very much resemblance with human visual system [10]. In YCbCr space Y defines Luma component and Cb and Cr as Chroma components which are basically the blue-differences and red-differences Chroma respectively.

$$[Y\ Cb\ Cr] = [R\ G\ B] \begin{bmatrix} 0.299 & -0.168935 & 0.499813 \\ 0.587 & -0.331665 & -0.418531 \\ 0.114 & 0.50059 & -0.081282 \end{bmatrix} \quad (3)$$

$$[R\ G\ B] = [Y\ Cb\ Cr] \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & -0.344 & 1.77 \\ 1.403 & -0.714 & 0.0 \end{bmatrix} \quad (4)$$

IV. PROPOSED SCHEME

In this Section, we have proposed a novel robust watermarking scheme based on DWT-DCT. Single level DWT is applied to cover image and four sub bands are obtained. LL sub band are chosen for hiding watermark. DCT coefficients of LL sub band are taken block by block of size (4×4) and arranged in ascending order according to standard deviation of each block. watermark image is firstly scrambled with Arnold transform with k iterations for enhancing robustness. Watermark bits are then hide using DCT coefficients. Watermark embedding and extraction process is showing in figure 1 and figure 2 respectively.

A. Watermark Embedding:

Watermark embedding steps:

1. Input colour image I_{RGB} of size 1024*1024 as Cover image in RGB.
2. Convert Cover image in to YCbCr colour spaces I_{YCbCr}.
3. Select Luma component L and apply Single level DWT on I_Y .
4. Select LL sub band for watermark hiding, Apply DCT block by block of LL sub band of I_{Y-LL}.
5. Arrange all the blocks according to standard deviation of block in ascending order (order is recorded in position vector PV).
6. Watermark is Scrambled using Arnold Transform with k iterations and Convert the binary watermark into vector W_m.
7. Calculate Median of each block B_{m_i} and apply according to watermark bit
   a. If watermark bit$W_m = 1$ then B_i=B_{m_i}+ T
   b. Otherwise B_i=B_{m_i}- T

   Here T is strength factor B_i is DCT coefficients of blocks.
8. Place the Blocks in respective positions according to position vector and Apply IDCT to each block to form LL component.

Join another Sub band and Apply IDWT to Obtain watermarked image in I'_{YCbCr} and converting from YCbCr to RGB watermarked image I'_{RGB}.

B. Watermark Extraction:

Watermark Extraction steps:

1. Input Color Watermarked image I'_{RGB} and convert it into YCbCr space from RGB I'_{YCbCr}.
2. Extract luma Component and apply Single level DWT and obtain LL sub band I'_{Y-LL}.
3. Apply DCT to I'_{Y-LL} and arrange all the block according to standard deviation of blocks.

4. Calculate the median of all block and form B_{m_i}
5. For each block calculate Watermark bits as follows
   i. If (B_i>B_{m_i})
      watermark bit is 1
   ii. otherwise
      watermark bit is 0.
6. Form watermark W_m by combining all bits.
7. Scramble the bits using Arnold transform and obtain original watermark.

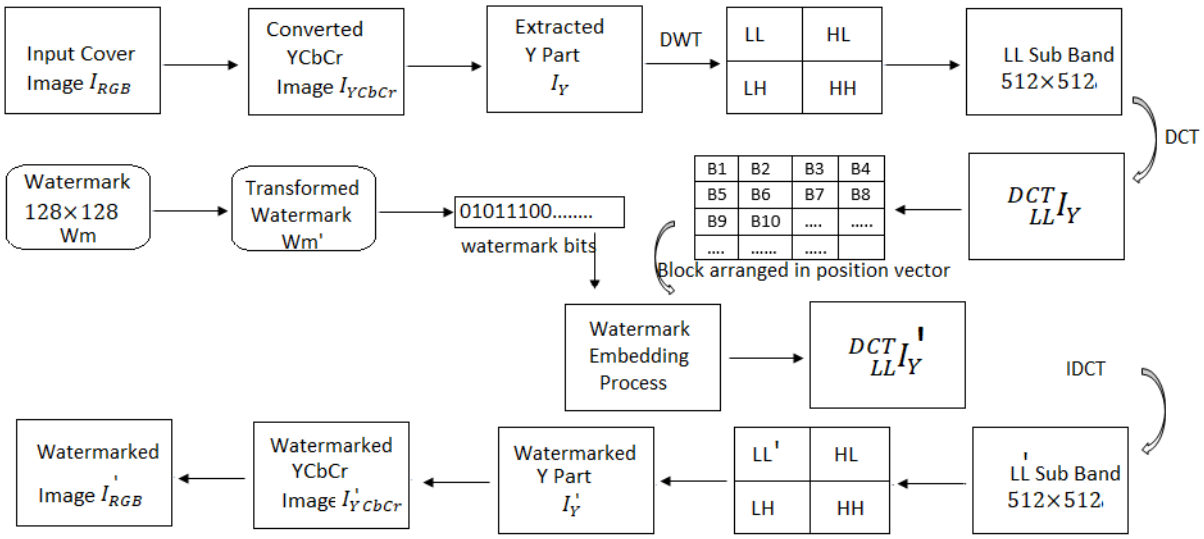


Figure 1Watermark Embedding Process

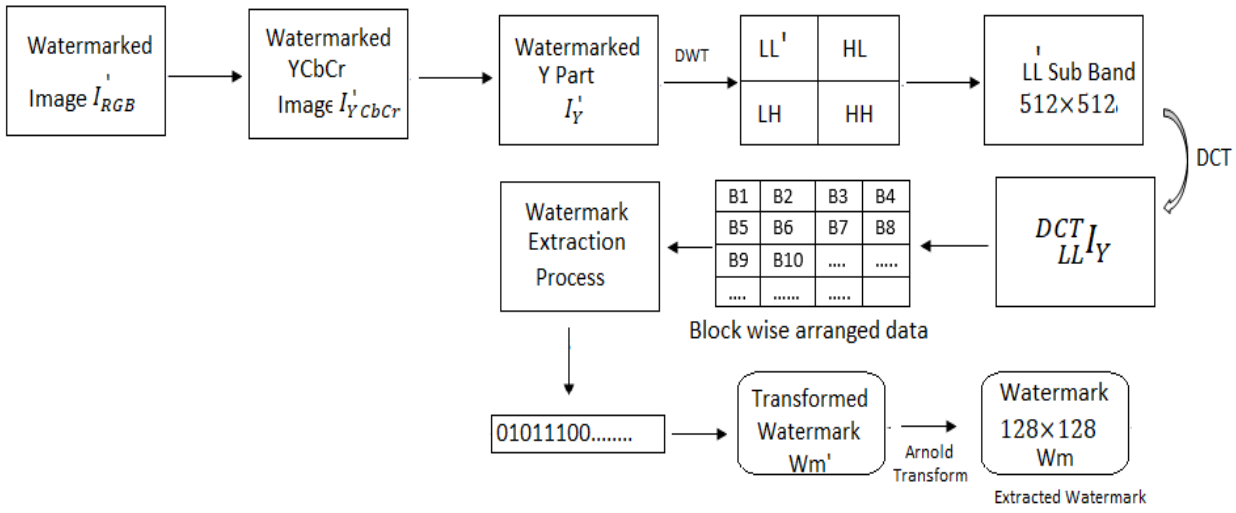
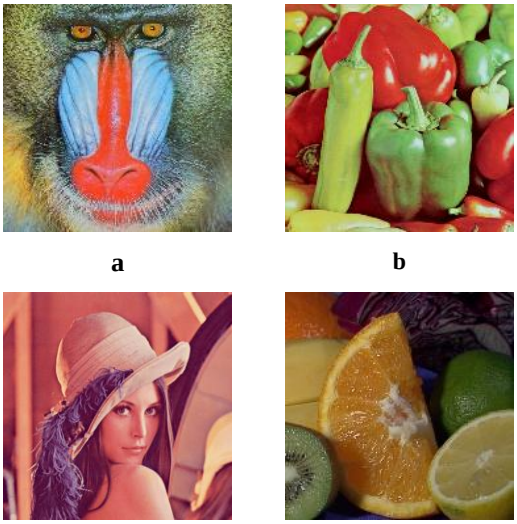


Figure 2Watermark Extraction Process

V. SIMULATION RESULTS

Proposed method is implemented on MATLAB 2009 with Core i5 processor, 2.30Ghz and 4GB RAM. Some benchmark color images are chosen from "Berkley datasets and benchmarks" such as "Mandrill", "Lena", "Pepper", "Fruit" with size of (1024×1024) Showing in Fig4 and amity logo has been chosen as a watermark of size (128×128) showing in Figure 3. We have used binary watermark for embedding process.

Figure 3:Original color Watermark and Binary watermark of size128×128.



a b c d

Figure 4: Benchmark RGB color images of size 1024×1024(a) Mandrill (b) Pepper (c) Lena (d) fruit

Table 1: PSNR value and NC value of images for different strength factor

Image Name	Strength	PSNR	NC
MANDRILL	5	48.3473	0.9983
	7	48.1092	0.9984
	9	47.8321	0.9942
PEPPERS	5	49.8293	0.9942
	7	49.6102	0.9984
	9	49.0017	0.9943
LENA	5	49.8372	0.9974
	7	49.7387	0.9972
	9	49.1892	0.9984
FRUIT	5	48.9283	0.9975
	7	48.4782	0.9972
	9	48.0012	0.9939

Table 2*:*Normalized correlation against image processing attack

Attacks on images	Normalized Correlation			
	Mandrill	Peppers	Lena	Fruits
S & P noise (0.01)	0.8764	0.9112	0.9474	0.9037
S & P noise (0.02)	0.8263	0.8792	0.9182	0.8734
S & P noise (0.03)	0.7128	0.8682	0.8416	0.8276
Speckle noise (0.001)	0.9343	0.9938	0.9945	0.9827
Speckle noise (0.005)	0.8823	0.9835	0.9683	0.9783
Speckle noise (0.009)	0.8087	0.9412	0.9081	0.9503
Gaussian noise (0.001)	0.9012	0.9758	0.9836	0.9829
Gaussian noise (0.005)	0.7744	0.8509	0.8838	0.8793
Gaussian noise (0.009)	0.6532	0.7418	0.6976	0.7397
Cropping (Top – left)	0.9883	0.9989	0.9492	0.9863
Cropping (Center)	0.8329	0.9511	0.9919	0.9549
Cropping (Bottom – Right)	0.9173	0.9791	0.9912	0.9793
Rotation (10°)	0.9193	0.9341	0.9383	0.8973
Rotation (20°)	0.6398	0.7391	0.5692	0.5493
Scaling (1:2)	1	1	1	1
Scaling (2:1)	0.9723	1	1	0.9827
Gamma correction (0.9)	0.9854	1	1	1
Gamma correction (0.6)	0.9549	1	1	1
JPG compression (Q = 80)	0.99	1	1	0.9912
JPG compression (Q = 75)	0.9684	0.9952	0.9963	0.9552
JPG compression (Q = 50)	0.9264	0.9497	0.9720	0.9257
Gaussian filter (3 × 3)	0.9732	1	1	1
Gaussian filter (5 × 5)	0.9634	1	1	1
Average filter (3 × 3)	0.9692	0.9923	0.997	0.9873
Wiener filter (3 × 3)	0.8740	1	0.9939	0.9864
Median filter (3 × 3)	0.9248	0.9902	0.9943	0.9902
Histogram equalization	0.9593	1	1	0.9483
Sharpening filter	0.9893	1	1	0.9763

Proposed method was evaluated with respect to image imperceptibility and robustness. These performance measuring parameters are PSNR, Normalized correlation. PSNR is used to check the similarity between original cover image and watermarked image.Table 1 displays the PSNR value and NC value of the watermarked images for different strength factor (T=5,7,9). All the values are greater than 30db which is acceptable in image watermarking.
Various watermarking attacks are also applied against the method and results are displayed using table 2. Types of attack are first additive noise like S & P Noise (salt and pepper), Speckle and Gaussian second Filtering attack like median, Gaussian, average and wiener third JPEG compression attack fourth geometric attack like cropping, scaling and rotation. Results shows that proposed method provides high level of robustness as most of the time the value of NC is very good after so many watermarking attacks.

VI. CONCLUSION

This paper focus on a novel blind watermarking technique using DWT, DCT. We have utilized the both transform domain in effective manner and YCbCr color space is used for watermarking. Arnold transform is used for scrambling the watermark so the scheme will be more robust. We have also tested our method against various watermarking attack like additive noise, filtering, JPEG compression and geometric attack and results shows that method is robust against all watermarking attacks

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