Implementation of ContourLet Transform For Copyright Protection of Color Images

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Abstract—
In this paper, a watermarking algorithm that uses the wavelet transform with image secret sharing and binary watermarking concepts is introduced. Also, the paper investigates the role of Contourlet Transform (CT) versus Wavelet Transform (WT) in providing robust image watermarking. The comparison between the wavelet-based and the contourlet-based methods; Peak Signal to Noise Ratio (PSNR). Experimental results reveal that the introduced algorithm is robust against different attacks and has good results compared to the wavelet-based algorithm.
Keywords: PSNR, Wavelet Transform, Counterlet

1. Introduction

Now a days, copyright protection of digital information became essential due to the vast growth of the digital media access and editing over networks. Usually, the ownership is digitally protected by embedding copyright information, called watermark, on digital data. In general, a digital watermarking technique should be transparent (or perceptually invisible for image data) and resistant to attacks that may remove it or replace it with another watermark. This means that the watermark should be robust to common signal processing operations, such as, filtering, compression, rotation, and others. Recent image watermarking algorithms utilize image transforms such as Discrete Cosine Transform (DCT) [1], Discrete Wavelet Transform (DWT) [2 and 3], and Discrete Contourlet Transform (CT) [4, 5, and 6]. Transform domain watermarking schemes tend to amend the transform coefficients based on the bits of watermark image. Latest watermarking algorithms are based on the Discrete Contourlet Transform (CT) which is capable of capturing the directional edges of the image at different scales [7] better than the popular DWT. However, the later is still having some properties and superiority over the CT. In this paper, a DWT-based watermarking technique is introduced and compared to the CT-based algorithm. The rest of the paper is organized as follows: section 2 gives the literature review. The Proposed Method is explained in section 3. Section 4 covers the comparison of results and section 5 concludes the proposal.

2. Literature Review

This is a copyright protection scheme for color images using secret sharing and wavelet transform. The scheme contains two phases: the share image generation phase and the watermark retrieval phase. In the generation phase, the proposed scheme first converts the image into the YCbCr color space and creates a special sampling plane from the color space. Next, the scheme extracts the features from the sampling plane using the discrete wavelet transform. Then, the scheme employs the features and the watermark to generate a principal share image. In the retrieval phase, an expanded watermark is first reconstructed using the features of the suspect image and the principal share image. Next, the scheme reduces the additional noise to obtain the recovered watermark, which is then verified against the original watermark to examine the copyright.

3. Counterlet Transformation Model

This model contains two phases:

Watermark embedding phase
Watermark extracting phase.
It also contains five major parts

1. Watermark Scrambling and Unscrambling
2. YCbCr Feature Extraction
3. ISS Encoding and Decoding
4. Correction
5. Watermark reduction.

The algorithms used for Watermark embedding are Share Image Generation Algorithm and Principal Share Embedding Algorithm. The algorithms used for Watermark Extraction are Principal Share Extracting Algorithm and Watermark Retrieval Algorithm. The experimental results are examined in section 4. Image Processing operations such as Cropping etc., are summarized in this chapter. We use Accuracy Rate (AR) as a metric to find the accuracy i.e., to measure the difference between the original Watermark and the recovered one.. Finally, the Conclusion and Future work are discussed in section 5

3.1 DWT VERSUS CT

A. Discrete Wavelet Transform (DWT)

The DWT is a powerful and a popular transform familiar to image processing community. In two dimensional applications, the DWT decomposes a given mage into four sub bands (i.e. LL1, HL1, LH1, and HH1). The sub band (LL1) represents the low frequency part where most energy is concentrated, while the other sub bands represent the high frequency content in the horizontal, vertical and diagonal directions. To obtain the next wavelet level, the sub band (LL1) is further decomposed into another four sub bands. This process can be repeated several times until the required decomposition level is reached.

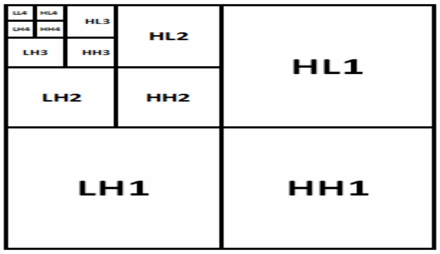


Fig. 1 Two level wave let

Figure 1 shows an example of two level wavelet decomposition sub bands.t

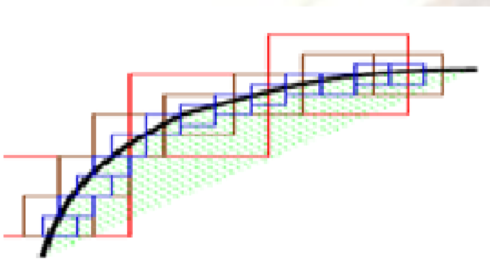


Fig. 2 wavelet discontinuity

This representation shows image to be successively approximated, from coarse to fine resolutions

B. Contourlet Transform **(CT)**

The Contourlet Transform (CT) is a new image decomposition scheme introduced by Do and Vetterli [7]. CT is more effective in representing smooth contours in different directions of an image than the Discrete Wavelet Transform. The CT can be divided into two main steps: Laplacian Pyramid (LP) decomposition and Directional Filter Banks (DFB) decomposition. An image is first decomposed into low pass image and band pass image by LP decomposition. Each band pass image is further decomposed by DFB step. A DFB is designed to capture the high frequency content like smooth contours and directional edges. Multi-resolution and multi-direction decomposition can be obtained by repeating the same steps mentioned above for the low pass image. In Contourlet, the number of directional sub bands at each level is set to 2 n where n is a positive integer number. For example, if we choose to decompose an image into four levels using n= (1, 2, 3, 4) then we get 2, 4, 8, and 16 sub bands as shown inFigure 3

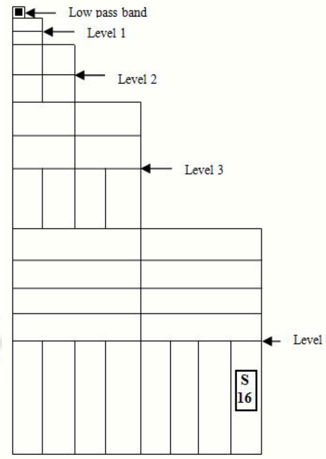


Fig. 3 Two level Contourlet Transform

Figure 3.shows the directional decomposition is computed with the detailed image, by that, if we made more pyramidal decompositions we generate at least a half more information of the above level as redundancies.

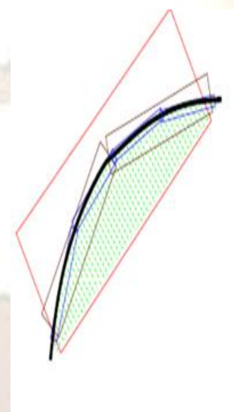


Fig. 4 continuity of contourlet

A DFB is designed to capture the high frequency content like smooth contours and directional edges. Multi-resolution and multi-direction decomposition can be obtained by repeating the same steps mentioned above for the low pass image shown in the above fig.4

3.2 THE WATERMARK EMBEDDING PHASE

Principal share embedding stage:

The share image generation stage: First, the color host image is transformed to the YCbCr color space. Next, the watermark is scrambled using the ran dam function. Then the scrambled watermark and the host image features, extracted from the YCbCr color space, are used to generate the principal share image during the ISS generation.

The principal share embedding stage: before feature extraction, the host image must be converted to the Y Cb Cr color space next a sampling plane is generated from Y Cb Cr planes then sampling plane is divided into non overlapping blocks of size 8x8 and the elements of each block are transformed to DWT coefficients after applying two level DWT there will be four coefficients in the LL2 sub band of each block

Let M be the average of four coefficients then M should satisfy the following

a. Only one coefficient is smaller than *M*

b. Two coefficients are smaller than *M*

c. Only one coefficient is greater than *M*

Table-1 XOR RULE

Feature Type n	Mean Value Location	The watermark pixel is white		P-Share XOR-C-Share	The watermark pixel is black		P-Share XOR C-Share
		P-Share	C-Share		P-Share	C-Share	
1	a<M< b,c,d						
	b<M< a,c,d						
	c<M< a,b,d						
	d<M< a,b,c						
2	a,b≤M<c,d						
	c,d≤M<a,b						
	a,d≤M<b,c						
	b,c≤M<a,d						
	a,c≤M<b,d						
	b,d≤M<a,c						
3	b,c,d≤M<a						
	a,c,d ≤M<b						
	a,b,d≤M<c						
	a,b,c≤M<d						
4	M=a=b=c=d						
a b / c d	The four coefficients of the LL2 subband (a is at the top left, b is at the top right, c is at the bottom left, and d is at the bottom right position)						
P-Share: Principal share; C-Share: Complementary share							

d. All of the four coefficients are the same and therefore all equal to *M*

The feature type of each block is thus obtained from the above rule. Let *n* be the feature type, which represents the corresponding number of the above conditions

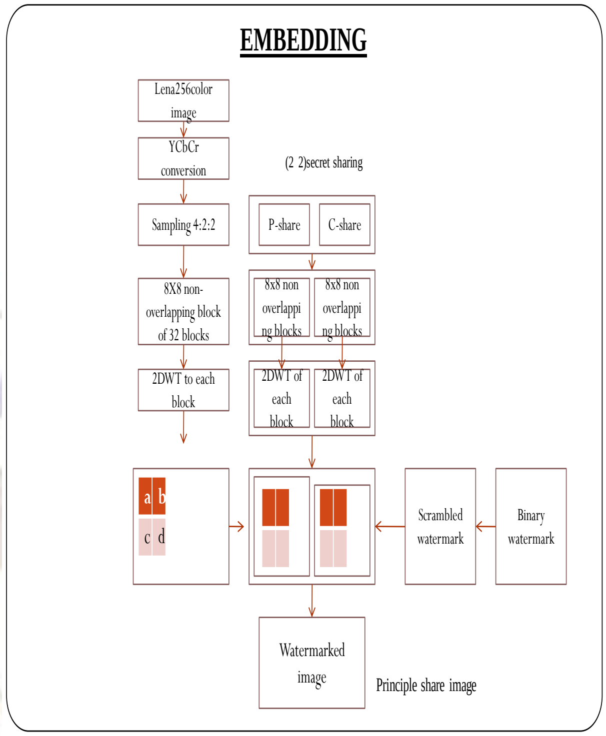


Fig 5 watermark embedding

- n=1, if M satisfy the condition (a)
- n=2, if M satisfy the condition (b)
- n=3, if M satisfy the condition (c)
- n=4, if M satisfy the condition (d)

One of the following condition by using the table I scrambled watermark image will be embedded into sampled blocks . from DWT create share image and complementary share image now embed the watermark by using table-1 the resultant is principle share image number of attacks are applied on principle share image after attacks watermark image will be retrieved from principle share image at the retrieval phase

3.3 THE WATERMARK EXTRACTING PHASE

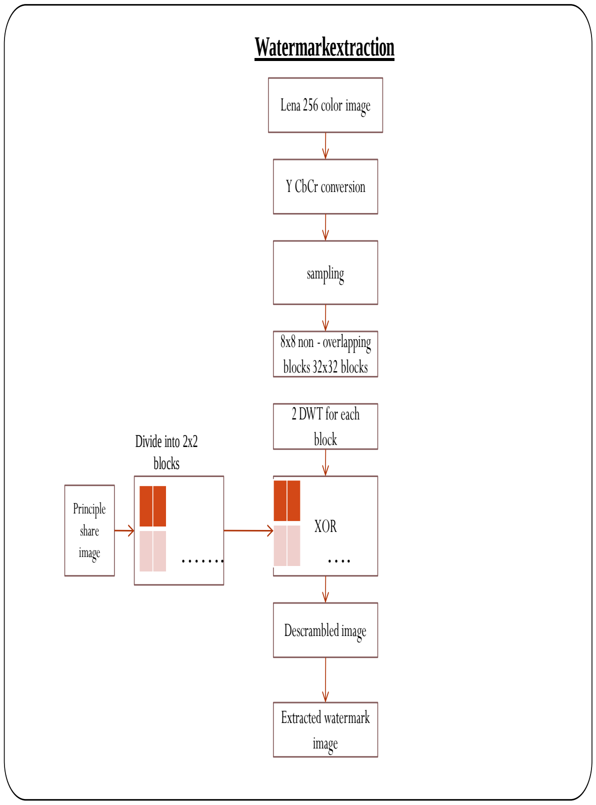


fig 6 watermark extraction

Watermark retrieval stage

The *principal share extracting* stage: First the R,G and B bands of the suspect color image will be transformed to the frequency domain by two-level DWT respectively. Next, the frequency coefficients of the principal share image are extracted from the suspect image. Then, the extract frequency coefficient is transformed to the principal share image in the spatial domain by one-level inverse DWT.

The *watermark retrieval* stage: First, the suspect color image is transformed to the YCbCr color space. It is reverse process to extract the watermarking Next, the scrambled watermark can be retrieved by decoding the features of the YCbCr color space and the principal share image. Then, by rearranging the scrambled watermark, the unscrambled watermark is obtained. Afterward, correction is applied on the unscrambled watermark to produce the corrected watermark, which is then reduced to a reduced watermark. Finally, the reduced watermark is used to verify the copyright.

Attacks like Gaussian noise, rotation and sharpening, whereas the second stage is made robust to local attacks (like JPEG compression) by the quantization of the low pass image coefficients. Therefore, the algorithm is robust to both global and local attacks. Embedding the watermark in the high frequency sub bands of CT and WT which contains edges improves the perceptibility of the watermarked image since the human visual system is less sensitive to edges [4]. Two quality measures are used to investigate the robustness of the proposed algorithm. The first measure is the Peak Signal to Noise Ratio (PSNR) which is used to evaluate the quality of the watermarked image. Let the host image of size NxN is f(i,j) and the watermarked counterpart is f'(i, j).

4. Experimental Results

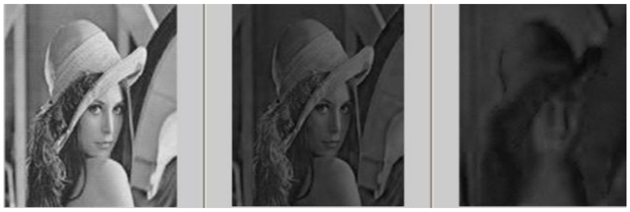
In order to easily compare with other watermarking techniques in the literature, a standard 256x256 Lena color image is used as the host image. The watermark image is made from a binary loge image having the picture 'JNTU logo of size 32x32 pixels.. In contourlet decomposition, both LP decomposition and DFB decomposition with 'pkva' filters [10] are used. The first four pyramidal levels are chosen and the number of directional sub bands for each level is set to 2, 4, 8, and 16 respectively. In wavelet decomposition, 'haar' filters are used because of their high efficiency. The decomposition tree is done for four levels. Similarly wavelet transformation is used compared performance of both transformations. In counterlet transformations PSNR values are more comparatively wavelet transformation as shown in table2

The accuracy rate (AR) is used to measure the difference between the original watermark and the retrieved one. AR is defined as follows:

$$AR = CP/ NP$$

Where NP in the number of pixels in the original watermark and CP is the correct pixels obtained by comparing the pixels of the original watermark with those of the retrieved water. The more closely AR approaches to 1, the more closely the retrieved watermark resembles the original one.

Fig7 Original Lina Image



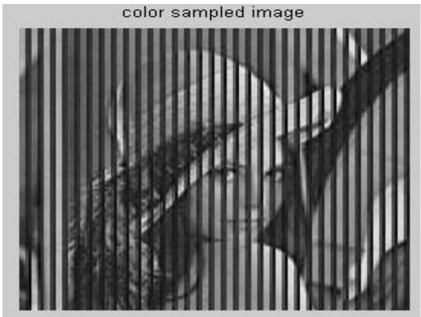


fig.9 Sampled Image

Firstly color image is converted into YCbCr color space and sampled as conventional 4:2:2 sampling method as shown in the figures 7,8,9.

fig 10 Principle share image

Attacks are applied to the principal share image and water mark image is retrieved from that imageas shown in the fig 11

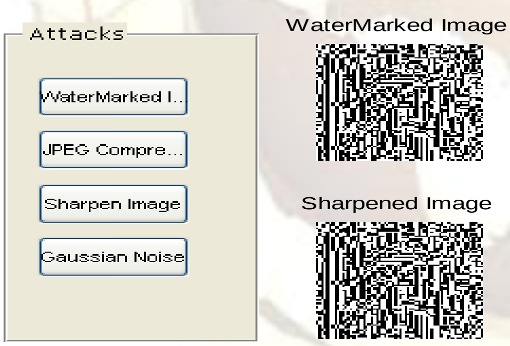


fig 11Attacks

Fig 12 Extraction of Watermarking

Table-2

	wavelet		counterlet	
Type of attack	MSE	PSNR	MSE	PSNR
Jpeg Compression	309.3600	23.2260	310.3003	23.2130
Sharpening	2.5145e+005	5.8737	3.010e+005	6.6557
Rotating	1.5617e+003	16.1949	1.7610e+003	15.6732
cropping	2.5044e+004	4.1439	2.5132e+004	4.1285
salt & Pepper Noise	746.1365	19.4026	587.3840	20.2130
Gausian Noise	312.9363	23.0762	340.8712	23.1978
After Extraction	49. 4651		49. 4651	

The table-2 gives PSNR values that are obtained for wavelet and contourlet transformations.from the table it is clear that PSNR values of contourlet are better than wavelet transformation

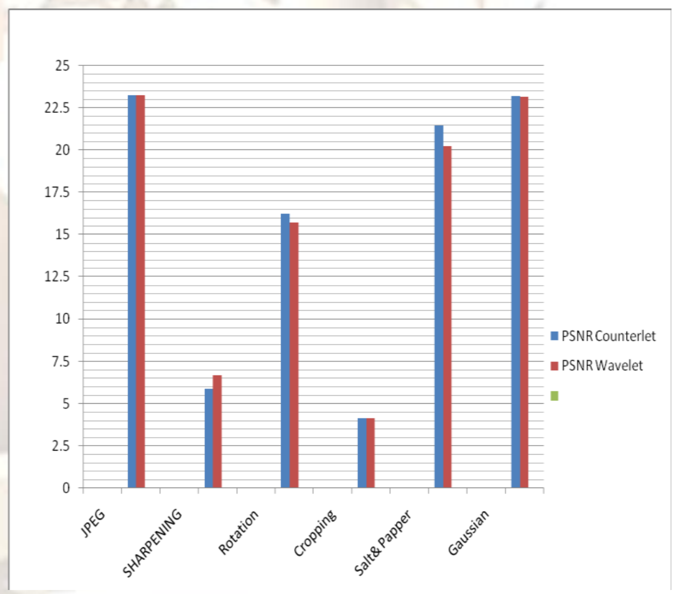


Fig-13 PSNR comparison

The fig- 13 gives the comparison between PSNR values of contour let and wavelet transformations

5. Conclusions

This paper proposes a wavelet-based watermarking technique and compares it to a contourlet-based watermarking which improves the perceptibility of the watermarked image. The results of the presented algorithm show highly robustness against different image attacks. The counterlet-based algorithm demonstrates better performance than the wavelet-based algorithm in most attacks while retiring smooth adages algorithm. Both algorithms use multiple descriptions coding of host image of low pass image. Furthermore, the step size used in the quantization process is reduced

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