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DATA HIDING OF BINARY IMAGE USING DISCRETE WAVELET TRANSFORMATION

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Abstract : Watermarking is a technique of hiding information in image including scanned text, figures, and signatures in such a way that it is difficult to intercept. In this paper, we proposed a digital image watermarking algorithm based on wavelet transform. Arnold transform and human visual characteristics is used to scramble the original watermark. In the embedding process two sub-bands which are in the same direction but in different resolution are selected when the carrier image is decomposed by two-layer wavelet transform. In the process of watermark extraction, the watermarks are detected by using the embedded position and scaling parameter *a* after the wavelet decomposition of the watermarked image and the original image.

Keywords: *Digital watermark, discrete wavelet Transform, arnold transform, image processing.*

INTRODUCTION

From the implementing point of view, the digital watermarking algorithm can be divided into two domains, the space domain and the frequency domain [1].LSB and Patchwork are typical algorithms in space domain. Draw backs of space domain are:
1) The capacities of the algorithms are not large enough, especially for small images. For example, a capacity as large as 512 bits is required to incorporate a message authentication code such as SHA-2 (e.g., SHA-512).
2) The existing large capacity algorithm does not have good visual quality of the watermarked image and the computational load is relatively high. Because of this reasons more and more algorithms have transferred to implement in frequency domain. DFT domain, DCT (Discrete Cosine Transform) domain and DWT domain are the familiar three frequency domains. In this paper, an algorithm of digital image watermarking based on discrete wavelet transform (DWT) is proposed.[2]
The paper is organized as follows. Discrete wavelet transform is described in section 2 .In section 3 we will propose an improved algorithm for watermark embedding and detection. In section 4 we are concluding the paper.

DISCRETE WAVELET TRANSFORM

The Discrete Wavelet Transform (DWT) is a mathematical tool that efficiently decomposes an image into multi-resolution sub-bands. It has the characteristics that energy compacts into a few low transform coefficients after the wavelet transform. Figure 1 shows an image that is divided into ten sub-bands through a three-scale wavelet transform.

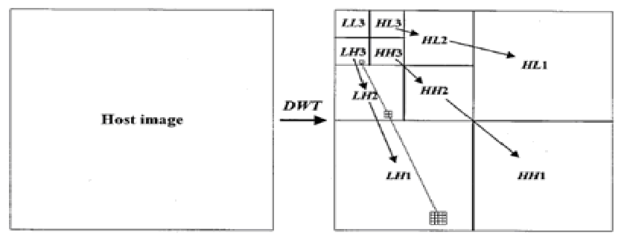

Fig. 1: wavelet decomposition of host image

The image is first decomposed into three high-frequency sub-band in different directions: the level sub-bands HL, vertical sub-bands LH, diagonal sub-bands. Process of decomposition is repeated arbitrary number of times which depends on application in hand in this paper it is decomposed three times or three levels

WATERMARKING ALGORITHM

The watermarking algorithm commonly has three parts watermarking scrambling Embedding algorithm extracting algorithm.

Watermarking Scrambling

Previously pseudo random sequences are used as watermarking messages [7]. Limitations of this method are it can only tell whether the watermark exits while it cannot show what the watermark is. In order to make sure that even if attackers intercepted the watermarking messages, they cannot get the exact secret messages, watermarking messages must be scrambled. That is to say the watermarking image is transformed to a shuffling image so that original secret messages are hidden. Arnold transform is applied to scramble the watermarking image.Given an N*N image, the Arnold transform that is applied to every pixel in the image is given

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 1 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \quad Mod\ N\ x, y \in \{0, 1, 2—N-1\}$$

It means Arnold transform will shift the value of the pixel at position (*x*, *y*) to position (*x*', y'). Characteristics of Arnold transform are it is iterative and is periodic iterative means it is applied to a digital image until the digital image is scrambling. Arnold transform periodic means after some iterative times, an original digital image can be achieved. Its periodicity can be achieved using following algorithm:

Algorithm for Watermark Image Scrambling:

```
START
1. Input : x,y xn,yn,n,N;
2. Initialize x and y to 1 value.
3. for n =1 to ….
      xn=x+y;
      yn=x+2*y;
4. if (xn mod N==1 and yn mod N==1) then
         Break;(get out of for loop).
5. x=xn mod N;
   y=yn mod N;
6. End for
7. Display the value of  n .
STOP
```

Assume size of watermark image is 34*34. Using the above program, periodicity it is executed 18 times. It means we will get original watermark image after implementing Arnold transform 18 times. Fig 2 shows result of applying Arnold transform.

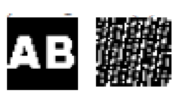

Fig. 2: Watermarked Image and Scrambled Image

Arnold transform pretreatment eliminates spatial correlation and disperses the error bits among all pixels to make watermarking more strongly robust against cropping operation.

Watermark Embedding

To embedded watermark a block DWT-based algorithm is developed. **A** step of wavelet transform decomposes an image into four parts: HH, HL, LH, and LL. The LL band can be decomposed again into four parts. The algorithm to embed a watermark into the host is as follows:

Step1: Let *X is* the original gray-level image with size *p x q,* and *W* is a gray-level image watermark with size *r* x s. First, decompose X into (p/16x q/16) blocks with size 16x16.

Step 2: Processing the watermark *Cy* with Arnold transform we get the confused watermark *w*' with size (r X s).

Step 3: For each blocks of X, it is decomposed into three levels with ten sub bands of a pyramid structure by DWT. Sub bands (LH3, LH2) are selected to be cast. Select the element LH3 (i, j) *€ LH3* with the maximum summation of the absolute value of its sons' coefficient in LH3.

Summation = |*LH2 (2*i-1,2*j-1*|
+|*LH2(2*i-1,2*j*|+|*LH2(2*I ,2*j-1*|
+|*LH2(2*i ,2*j*|

And select LH2(k,l) € LH2 with the maximum absolute value in *LH3*(i, j) 'S sons. Put LH3(i, j)into the vector VecLH3, and put LH(k,l) into the vector VecLH2.

Step 4: In the casting stage, watermarks are redundantly embedded into subbands of LH3 and *LH2* for robustness. Watermarks W*'* are embedded as follows:

For i = 1 to r x s
VecLH3(i)= VecLH3(i)+α X W'(i/s+1, i mod s +1)
VecLH2(i)= VecLH3(i)+α X W'(i/s+1, i mod s +1)
End For

Step 5: Take the two-dimensional Inverse DWT (IDWT) of the modified DWT coefficients and the unchanged DWT coefficients to form watermarked image.

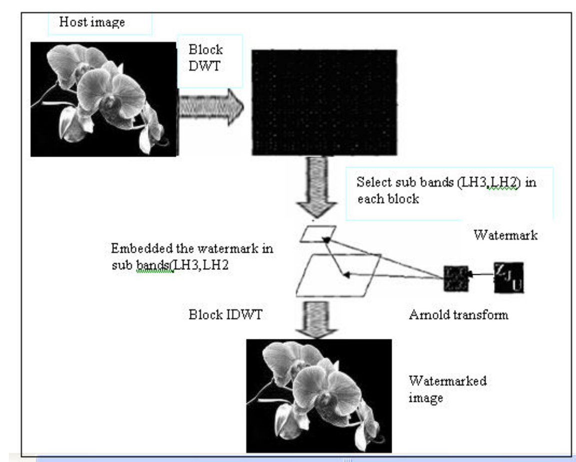

Fig. 3: Watermark Embedding

Fig. 3 shows watermark embedding process for a flower image .it will apply block DWT to image to get decomposed image of three levels and ten sub bands .LH3 and LH2 are selected for embedding .At the same time watermarked Gray level image is scrambled by Arnold transform .in the casting stage watermark is redundantly embedded in each block at DWT coefficients .recursively apply Inverse DWT (IDWT) get watermarked image which is ready for transmission

Watermark Extracting Method

In this method, the watermarks are detected by using the embedded position and scaling parameter ***a*** after the wavelet decomposition of the watermarked image and the original image as shown in fig 4.

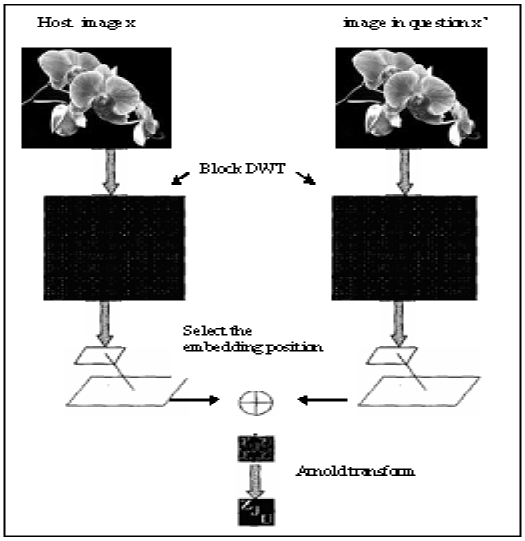

Fig 4: Watermark Extraction

Step 1: First, we decompose a watermarked image ***X'*** and the original image ***X*** into (p/16xq/16) blocks, and then decompose each block with DWT into three levels of ten subbands respectively.

Step 2: Using the algorithm in the embedding method, we can get the vector VecLH3 and VecLH2 from the subbands (LH3, LH2) of the original image blocks. Then we correspondingly get VecLH3' and VecLH2' from the watermarked image.

Step 3: Average and scaling down the watermarks

for i=1 to r x s
W''_3 *(i/s +1, I mod s+1) = VecLH3'(i)-VecLH3(i)*
W''_2 *(i/s +1, I mod s+1) = VecLH2'(i)-VecLH2(i)*
W" = (W"3+w"2)/(2x α)
End for

Step 4: Processing *W"* with Arnold transform, we get the extracted watermarks *W'*.

Step 5: Measure the similarity of original watermarks and extracted watermarks by the standard correlation coefficient as

$$\frac{\Sigma(x-x')(y-y')}{\sqrt{\Sigma(x-x')^2}\ \sqrt{\Sigma(y-y')^2}}$$

At receiver side this algorithm will decompose original image and watermarked image using DWT, applying watermark embedding algorithm to get W" which is scrambled watermark, applying Arnold transform to get original watermark and using correlation to compare images. The watermarks are detected by using the embedded position and scaling parameter ***a*** after the wavelet decomposition of the watermarked image and the original image.

CONCLUSION

Watermarking was done in wavelet domain. Conventional watermarking attacks were not possible. The resolution of tamper localization was achieved at pixel level. The watermarked image's quality was still maintained while providing pixel-level tampering accuracy.

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