DWT based Self-Embedding watermarking

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***Abstract*— Digital watermarking is a technology that hides information in image to provide authentication. Information hiding is done by the tempering content of the image. The embedding process has to be such that the tempering of the media are invisible. The proposed work presents a novel DWT based self-embedding color image watermarking scheme by using cubic interpolation of mean difference matrices of the image and used it as a watermark. Cubic interpolation is used for up-sampling the image.**

Proposed scheme assure the self-embedding of original image and also assure extraction of watermark information with satisfied visual criteria. Two level DWT decomposition of original for embedding watermark information ensure Robustness of proposed scheme. Experimental results show that the proposed scheme is more efficient and robust.

Keywords: Color image: Digital watermark, Discrete Wavelet Transform (DWT) , Cubic interpolation

I. INTRODUCTION

In the past decade various digital multimedia processing tools have made duplication much easy. The availability and easiness to use provide anyone to misuse of intellectual property. A click on the computer can send digital data from one network to a different network. Millions of digital data cross network every day. Copyright protection is a way to give authentication of digital data, which can be a severe issue in today's digital world.

Currently the unauthorized distribution of digital media over the network is a big issue. Watermarking technology protects ownership of multimedia data.

A variety of schemes have been proposed for copyright protection. Digital watermarking has gained a lot of popularity for its efficiency. The human eye is unable to observe the detail. Little bit of modifications in the color values of an image are corrected by the eye, so that the difference is un-noticeable. Digital watermarking makes use of this limitation.

II. RELATED WORKS.

The method proposed by Chun-Shien Lu [1] is checksum based On which checksum of a digital image is calculated and in combination with a seal to produce the watermark information that was responsible for the authentication. Zhao and others also proposed a method that on the basis of discrete wavelet transforms (DWT), a watermarking technique of color image of self-embedding an image into itself [2].

Wang [3] and others proposed a new self-embedding watermarking scheme for both tamper detection in image and image recovery of tempered image. The proposed method embeds watermarks consisting of the authentication information and the recovery data into image blocks. In the temper detection process, instead of independently examining each embedded authentication data, they take all the authentication data embedded in an image into account and utilize a majority-voting technique to determine the legitimacy of image blocks. Mirza Hanane and others [4] proposed a novel color image watermarking scheme. The main idea of this algorithm is to embed a reduced content of the original image to itself, in order to be able to partially recover the deleted features from the watermarked image . Song Qiang and Zhang Hongbin [5] proposed a novel method of self-embedding watermarking technique which is based on Cubic Interpolation for original image. Then they used the discrete wavelet transform (DWT) to embed the watermark image .

However, the current self-embedding algorithms have some problem. One of these is that the recovery quality is not very well, and another is that the watermarked image is not very robust.

The proposed watermarking model presents a novel color image watermarking scheme based on self-embedding method. The basic principle of this scheme is to separate the color image in R, G and B channels and calculate the mean for each channel to compute the mean difference matrices for each channel. Then by using the discrete wavelet transform (DWT) for embedding the watermark image. To verify the effectiveness of the proposed scheme, a series of simulation and experiments are conducted. Experiment results show that the algorithms can self -embed the original image, and extract the watermark information with satisfied image quality. Simulation results show that the proposed scheme is more robust.

The proposed method is organized as follows: Section 3 contains introduce the principle of the Cubic interpolation. Section 4 gives details of the proposed

III. CUBIC INTERPOLATION

The Image Interpolate operation supports various forms of resampling. An interpolation function is a approximating function which generates new data point within the given range. Approximating functions should be such that it must match with the sampled data at the interpolation nodes. Cubic Interpolation determines the pixel value of the weighted average of the 16 closest pixels of the defined input coordinates, and allocates that value to the output coordinates. The one-dimensional interpolation function is applied in both directions for two-dimensional interpolation. In other words, if **g** is the corresponding interpolation function and f is a sampled function, then g(xk) = $f(x_k)$ whenever Xk is an interpolation node.

Many interpolation functions can be written for equally spaced data in the form:

$$g(x) = \sum_k CkU\left(\frac{X - Xk}{h}\right)$$

(1)

Where h represents the increment in samples, *u* is the interpolation kernel, the Xk's are the interpolation nodes, and g is the interpolation function. The C_k's are parameters depending on the sampled data, which satisfy interpolation condition, $g(x_k) = f(x_k)$ [6] [7].

The interpolation kernel must be symmetric coupled with the previous condition, The one-dimensional cubic convolution interpolation kernel is:

$$u(s) = \begin{cases} 3/2|s|3 - 5/2|s|2 + 1 & 0 <= |s| < 1 \\ -1/2|s|3 + 5/2|s|2 - 4|s| + 2 & 1 <= |s| < 2 \\ 0 & 2 < |s| \end{cases} \quad (2)$$

Where s is the distance between the interpolating point and the grid point being considered. The one-dimensional interpolation function is applied in both directions for two-dimensional interpolation. It is a disjoint extension of the one-dimensional interpolation function. For interpolating a point (x, y), where $x_k < x < x_{k+1}$ and $y_k < y < y_{k+1}$, the two-dimensional cubic interpolation function is:

$$g(x,y) = \sum_{I=-1}^{2} \sum_{M=-1}^{2} C(J+I, K+M) U(distanceX) U(distanceY)$$

in equation 2, u() is the interpolation function, and $distance_x$ is the X distance from the four grid point and $distance_y$ is the Y distances from the four grid points in each direction. For non-boundary points, the interpolation coefficients, c_{jk}'s are given by

$$c_{jk} = f(x_j, y_k).$$

IV. PROPOSED SCHEME

The proposed authentication technique is based on the self- embedding watermarking technique of image. The details are described in the following subsections.

A. Self- embedding steps are as follow:

1) Firstly separate the original I (N×N×3) to three color RGB planes.

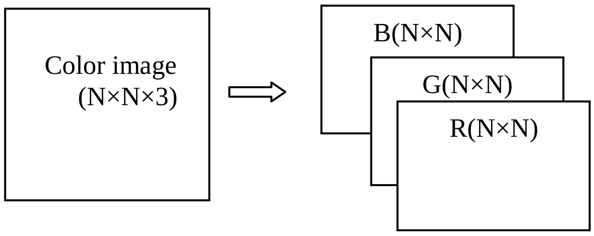

Figure 1. Separating image planes

2) For every plane of the original image, decompose it with discrete wavelet transform (DWT), in this paper we use the 2-level DWT.Fig.2 illustrate the indexing of sub-bands in two-level wavelet decomposition.

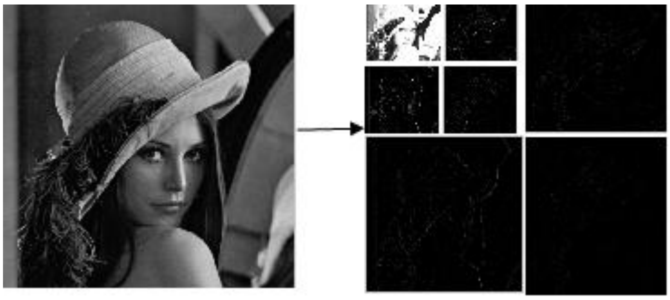

Figure 2. The indexing of sub-bands in two-level wavelet decomposition

3) For the watermark image, we calculated mean of R, G and B channels individually, then we found out mean difference matrices for each channel. We use Cubic interpolation to scale these matrices and used it as a watermark. The size of scaling which is determined by certain rules from the watermarking information. In order to ensure image quality, we will choose an appropriate rate, this rate is 0.25.

Suppose we have an image of size N×N×3. Separate its R, G and B planes and compute mean for each plane M_R, M_G and M_B . Now calculate the mean difference matrices of each plane for each cell i.e. X_{ij}- M_R, Y_{ij}- M_G, Z_{ij}- M_B.

Figure 3 illustrating mean difference matrices for R plane with value X_{ij}- M_R. Same process will be

X_{11}	X_{12}	X_{13}	X_{14}	…
X_{21}	X_{22}	X_{23}	X_{24}	…
X_{31}	X_{32}	X_{33}	X_{34}	…
X_{41}	X_{42}	X_{43}	X_{44}	…
…	…	…	…	…

X_{ij}- $M_{R.}$ ↓

X'_{11}	X'_{12}	X'_{13}	X'_{14}	…
X'_{21}	X'_{22}	X'_{23}	X'_{24}	…
X'_{31}	X'_{32}	X'_{33}	X'_{34}	…
X'_{41}	X'_{42}	X'_{43}	X'_{44}	…
…	…	…	…	…

Figure 3. Image matrix plane and mean difference matrix

Followed for G and B plane respectively. Apply cubic interpolation on mean difference matrices with scaling factor 0.25. This is our watermark information.

4) Embed the respective watermark information into the 2-level discrete wavelet transform (DWT) of original image planes.

5) Reconstruct the processed image, use the inverse discrete wavelet transform (IDWT). Generate watermarked image W (N×N×3) by appending the three planes.

The overview of the watermark generation and embedding process is illustrated in Fig.4.

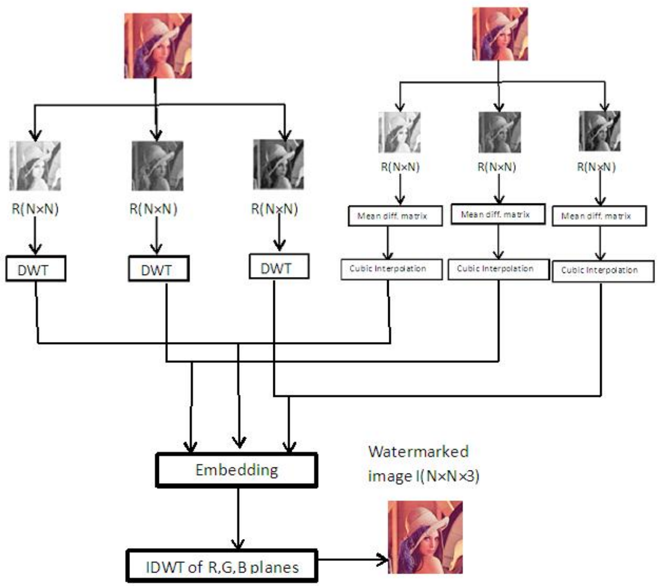

Figure 4. Embedding process of color image

B. Extraction process:

Watermark extraction is the inverse process of embedding. We follow the following steps for extraction process.

1) The watermarked image (N×N×3) is separated into three color planes, R (N×N) ,G (N×N),B (N×N).

2) Decomposed every layer into DWT.

3) Reconstruct the processed image using cubic interpolation and summing the mean values for every plane.

4) Append three plane to generate original image I(N×N×3).

For cubic interpolation rate used is 0.25, and for embedding watermark information different coefficients are used. To achieve satisfied visual quality, we experimented our algorithm with different coefficient. In our algorithm we choose the R, G, and B coefficient as 0.01, 0.12, and 0.02. for different values of these coefficients watermarked image will be of different visual quality. So these coefficient values are same as the secret key. For extraction of the watermark we should obtain these coefficients.

V. SIMULATION RESULT

This section presents the simulation and experiment results of the proposed scheme.

For better understanding and quantitative evaluation, PSNR (Peak Signal to Noise Ratio) is introduced to evaluate the performance of proposed scheme and image quality. PSNR is defined as:

The PSNR block calculates the peak signal-to-noise ratio between two images in decibels. PSNR is used as a quality measurement between the original and a watermarked image. The lower the PSNR, the degradation in the quality of the reconstructed image.

The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two methods used to compute the alteration in original image and watermarked image. The MSE represents the cumulative squared error between the watermarked and the original image, whereas PSNR represents a measure of the peak error. The higher the value of MSE, the higher the error.

Mean-squared error is calculated by the following equation:

$$\text{MSE}= \sum_{M,N} \frac{(I(m,n) - W(m,n))\hat{}2}{M \times N}$$

Peak Signal to Noise Ratio (PSNR) is calculated by the following equation

$$PSNR = 10 * \log10 \left(\frac{(255*255)}{MSE} \right) Db$$

Where M×N is the image size, I (m, n) and W (m, n) are the corresponding pixel values of the two images.

The proposed scheme is experimented with four different color images of size 512×512. To show the effectiveness of proposed scheme we have used images of different texture and contrast. Fig. 5 show the original images, watermarked images side by.

Figure 5. Experiment Results (Original & Watermarked image)

From figure 5 and TABLE 1 we can conclude that our proposed algorithm assures the better quality of watermark image. Watermarked images are more near to the original images.

TABEL 1 PSNR between Original & Watermarked Image

Image	PSNR	NC
Image (a)	25.0210	.9321
Image (b)	28.1830	.91s10
Image (c)	24.0974	.8935
Image (d)	29.9346	.9020

V. CONCLUSION RESULT

Proposed model, a new color image watermarking algorithm based on the self- embedding techniques. The main contribution of this paper is to assure that it is quite efficient and easy to embed the content of image in itself as a watermark. We used cubic interpolation to scale the watermark information. We also used DWT to embed image. Experimental results of the proposed scheme show that self–embedding method can effectively withstand attacks with satisfying adequate visual quality.

We can also use different watermark information derived from an image. Future work of this scheme is concentrating on the other scheme based on other watermark information and processing of the original image.

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