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RESEARCH ARTICLE

MULTI-WAVELET BASED ON NON-VISIBLE WATER MARKING

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Abstract

The paper presents multi-wavelet based on non-visible water marking. In the past, DWT-DCT technique has less copyright protection and content authentication. The proposed method is solved referred problems. In this paper, firstly apply the multi wavelet to improve image resolution at LL sub band. Secondly, embedded the important data (watermark image) into host multimedia, and it can be used in digital right management, authentication and data hiding. The experimental result shows that the watermark scheme has strong robustness, and can embed much more data.

Index terms: *DWT-DCT; multi-wavelet; watermarking*

I. INTRODUCTION

As digital technology pervades our society, a vast amount of medical images now exists in electronic format for storage [1] and transmit. Ubiquitous wired and wireless networks make it possible to access and snatch patient's data from anywhere, to promote high quality care for patients. Current, encryption and access control technologies are difficult to meet the requirements of the medical image's information security [2]. Hence, how to protect the medical image from being pirated has been an urgency problem in information security field [3]. The watermarking technology can be an effective way to solve this problem. This kind of technology put patients' information as a digital watermarking hidden in medical images. Currently the field of digital watermarking for medical research focused on the spatial domain and transform domain (DCT, DFT and DWT), which can be implemented by changing some pixel gray-scale values in the space domain or by changing the values of coefficients in the transform domain to embed watermark. Since both the new Joint Photographic Experts Group 2000 (JPEG2000) and new Moving Picture Experts Group 4 (MPEG-4) use DWT, a watermarking algorithm that uses DWT [4] is compatible with them. In order to protect the medical image's lesion zone, the general approach of the medical watermarking often embeds the watermarking into the Region of Non-Interest (RONI)[5]. The ROI of the medical image refers to the area of lesion that contains the important pathological features. If the embedded

watermarking was placed in these regions, it may cause an erroneous diagnosis. At the same time, people often spend much time and energy on looking for ROI, and it is possible to interface the doctor's diagnosis if the selection is wrong.

II. MULTIWAVELET TRANSFORM

Multi-wavelet transform based watermarking has good space-frequency localization and Low computational cost. Since different wavelet bases have different characteristics, the choice of multi wavelet bases for embedding watermark is important. The core concept of the multi wavelet is multi-resolutions decomposition. The multi wavelet functions must satisfy the two-scale equation:

$$\mathbf{\Psi}(t) = \sqrt{2}\sum_{k} \mathbf{H}_k \mathbf{\Phi}(2t-k)$$

The first level multi-wavelet coefficients $W_{l,k}$ are obtained using high-pass multi-filtering and down-sampling:

$$\mathbf{W}_{1,k} = \sum_{m} \mathbf{H}_{m-2k} \mathbf{V}_{0,m}$$

Full multi-wavelet decomposition of the signal can be found by iterative filtering of the scaling coefficient:

$$\mathbf{V}_{j,k} = \sum_{m} \mathbf{G}_{m-2k} \mathbf{V}_{j-1,m}$$
$$\mathbf{W}_{j,k} = \sum_{m} \mathbf{H}_{m-2k} \mathbf{V}_{j-1,m}$$

A. Multi-wavelet in Comparison with Wavelet

The multi-wavelet idea originates from the generalization of scalar wavelets; Instead of one scaling function and one wavelet, multiple scaling functions and wavelets are used. This leads to more degree of freedom in constructing wavelets. Therefore opposed to scalar wavelets, properties such as compact support, orthogonality, symmetry, vanishing moments and short support can be gathered simultaneously in multi-wavelets, which are fundamental in image processing.

The increase in degree of freedom in multi-wavelets is obtained at the expense of replacing scalars with matrices, scalar functions with vector functions and single matrices with block of matrices. However, pre-filtering is an essential task which should be performed for any use of multi-wavelet in the image processing.

III. PROPOSED METHOD

The watermark embedding procedure is listed as follows:

1. Apply three-level multi-wavelet transform to decompose the cover image into 10 sub-bands as shown in fig.1.

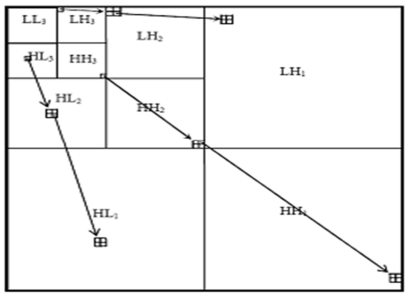

Fig.1. 3-level multi wavelet transforms

2. Divide LL3 into 8x8 blocks. Perform DCT on each block, and determine the embedding coordinates of the watermark in below equation.

$$\{(m,n)\,|\,\frac{1}{64}\sum_{u=0}^{7}\sum_{v=0}^{7}|F(u,v)|^2-|F(m,n)|^2|$$

$$=\min(|\frac{1}{64}\sum_{u=0}^{7}\sum_{v=0}^{7}|F(u,v)|^2-|F(i,j)|^2|)\}$$

Where F(u,v) denotes the DCT magnitude of each block. Then the DFRFT coefficients matrix A of the watermark embedding positions can be arrived. The indexes of (m, n) must be stored as matrix T.

3. Perform JPEG attack.

4. After the DCT embedding process, apply inverse DFRFT to each 8x8 block of the matrix.

5. Apply inverse DWT to get the watermarked image.

6. To extract the watermark image by the following non-blind extraction process:

1. Use three-level multi-wavelet to partition the watermarked image c into 10 sub-bands.

2. Divide LL3 into 8x8 blocks.

3. Perform DCT on each block. Then by matrix T , we can collect the extracted DCT coefficients matrix A of the watermark embedding positions.

3. Apply jpeg attack to get the watermarking image.

IV. SELFRECOVER AUTHENTICATION ALGORITHM

Watermark can authentication the reality and integrity, but also can recover the original host image after using the recovery information. Generally, the embedded information has two parts: authentication information and recovery information watermark's extraction. Firstly, the authentication information is extracted to validate the reality and integrity. When the cover image is tampered, the recovery information is extracted to recover the tampered images. However, the procedure of these algorithms is often as following: firstly, divided the protected image into blocks with same size, and then extract the feature of blocks to generate the authentication information and recovery information. The embedding position, also named position mapping,

is decided by some mechanism like chaotic system, and so on. So, the recovery information is often embedded into the mapping block. If these two blocks are tampered at the same time, the recovery information is lost, and we can never recover the protected image into original one. How to solve this problem in the case is the focus in this area. Meanwhile, authentication information and recovery information should embed two times, which will degrade the image's quality. Whether can we use one information to complete the authentication and recovery worth considering.

V. MEASUREMENT ANALYSIS

To assess the performance of the proposed filters for removal of noise and to evaluate their comparative performance, different standard performance indices have been used in the thesis. These are defined as follows:

Peak Signal to Noise Ratio (PSNR): It is measured in decibel (dB) and for gray scale image it is defined as:

$$\text{PSNR (dB)} = 10\log_{10}\left[\frac{\sum_i\sum_j 255^2}{\sum_i\sum_j \left(S_{i,j} - \hat{S}_{i,j}\right)^2}\right] \quad (8)$$

$S_{i,j}$ and $\hat{S}_{i,j}$are the input and reconstruction images. The higher the PSNR in the restored image, the better is its quality.

Where mean square error (MSE) is defined as:

$$\text{MSE} = \frac{\sum_{ij}\left|c'_{ij} - c_{ij}\right|}{N * \text{N}}$$

Where c_{ij} and c'_{ij} represent the pixel values in the cover image and the embedded image, respectively,

V. RESULTS

The robustness and security of the proposed algorithm are performed. A 512x512 8bit gray-scale image “Lena” and a 32x32 watermark binary image are chosen to demonstrate the performance. As we know, there is a tradeoff between imperceptibility and robustness.

In this experiment, the embedding factor $\alpha = 0.1$. The cover and watermarked image are show in Fig.1. As we can see, the difference between the watermarked image and the cover image is unperceivable. We test the watermarked image against JPEG attack.

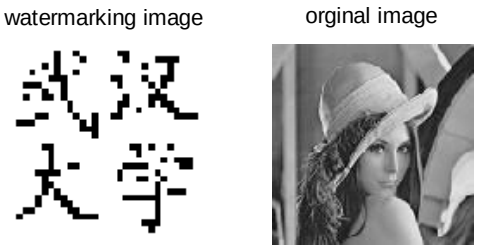

Fig.2. (a) Watermark image; (v) Cover image;

Fig.3. Watermarked image "Lena"(PSNR=65.52dB)

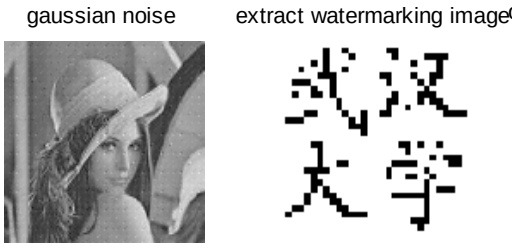

Fig.4. (a) JPEG compression with Gaussian noise with 0.003 variance b) Watermarked image

VI. CONCLUSION

A watermarking approach based on MULTI-WAVELET transformation is proposed. The proposed method embeds watermark into the cover image by modifying the DCT of it. In addition it improves the robustness and security. Experimental results demonstrate that the quality of the watermarked image is good both visually and in terms of PSNR. Finally, the proposed watermarking method is robust to typical image processing attacks.

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