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Digital Image Watermarking using wavelet packet and hybrid Filter

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Abstract. In this paper, a new digital image watermark algorithm using wavelet packet transform and hybrid filter is proposed for right protection. The proposed watermark algorithm applies watermark to the overall subband that include the lowest frequency band and uses hybrid filter to remove the noise that was added to the watermarked image. The hybrid filter consists of median filter and wiener filter. Simulation analyzes PSNR and similarity of the watermarked image to test the quality and robustness of the watermarked images. From the simulation results, the proposed algorithm shows better invisibility and robustness performance compare with conventional wavelet transform based watermarking methods.

Keywords: watermark, wavelet packet transform, wavelet transform

1 Introduction

In the wavelet transform based watermark technique, the watermark is embedded in the subbands except the lowest frequency band. However, because the image compression is usually lossy compression that eliminates all the high frequency components, the techniques that the watermark is embedded in the lowest frequency band have studied for high image compression. But this elastic change by the watermark embedding in the lowest frequency band causes damages of the original image.

Because the high altitude images such as an aerial photograph and a satellite photograph are mainly composed by high frequency components, a new watermark algorithm, inserts watermark into all subband that include the lowest frequency band, is needed for robustness and invisibility [1]. To resolve this problem, wavelet packet based digital watermark algorithm is suggested in this research. So wavelet packet transform analyze adaptively signal of each frequency band contrary to wavelet transform which is recursively decomposed in the low frequency band, it is more suitable for non-stationary signal analysis such as texture image that is easily recognized in the remote sensing images. The wavelet packet transform shows better performance than the conventional wavelet transform in texture images. Because the large coeffcients are abstracted from the lowest frequency band as well as high frequency bands after the wavelet packet transform, watermark can be embedded in the overall band without any quality loss of image and keep its robustness against

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lossy image compression. In this paper, a new watermark that based on wavelet packet transform is proposed for satellite photograph or other images, which include many high frequency components.

2 Proposed watermarking method

Early watermarks are embedded in the insignificant coefficient for preventing recognition of their existence. But these watermarks are easily damaged or eliminated by image compressions or other image processing techniques. On that account, watermark has to be embedded in the perceptually significant coefficient region. In the proposed algorithm in this research, watermark embedding process is composed as following sequences; the wavelet packet transform of original image, selecting the perceptually significant coefficients, watermark embedding and inverse wavelet packet transform.

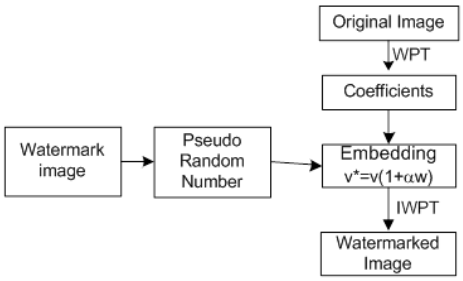

Fig. 1. Watermark embedding

First of all, input image is decomposed into wavelet packet using 9-7 tap biorthogonal filter and first-order entropy [2]. Watermark is embedded to wavelet packet coefficient. That is, in case of large wavelet packet coefficients, a large α value is embedded and in case of small wavelet packet coefficient, a small α value is embedded. The reason for this watermark embedding, generally, large value is insensible to quantity of addition compare with the small value. v is a selected coefficient to embedding watermark, w is a watermark and α is an embedding weight. The embedding weight for coefficient of the lowest frequency band, α, is set 0.04 and coefficient of other band is started form 0.01 and doubled. As a next stage, after watermark embedded coefficient is transformed by inverse wavelet packet transform, watermark embedded image is accomplished. Contrary to in the dyadic wavelet transform, the significant coefficients locate in each subband including high frequency band, so embedding this coefficients prevents the quality of the original image from degrading and brings a robust watermarking.

To detect the watermark is a reverse process of embedding process. That is, after wavelet packet transforms the watermark embedded image, watermark information is analyzed and abstracts watermark by pseudo-random sequence. We use hybrid filter

to extract the noise distortion that was added to the image in watermark embedding stage. This hybrid filter consists of the median filter and the wiener filter to reduce white Gaussian noise and impulse noise respectively. It efficiently removes Gaussian and impulse noise from digital images while preserving thin lines and edges in the original image [3] [4].

3 Simulation Results

The proposed method has been tested with different gray-scale images, standard natural images and satellite photograph images. Two-dimensional separable length 9-7 biorthonormal wavelet filters are used for wavelet packet decomposition. Wavelet packet coefficients are selected for watermark embedding. Invisibility and robustness of watermark is used for measurement of performance in this research. Other watermark algorithms, such as Xia [1] and Cox [6] are also used for comparing performance at the same condition with proposed algorithm.

Fig. 5 is watermark embedded images using the proposed algorithm. As shown in the two figures, it is impossible to distinguish in perceptually whether watermark is embedded in these images. After embedding watermark to original images, PSNR are calculated for observing image distortion as shown in Table 1. JPEG is applied to proposed watermark-embedded image for robustness check against image compression. The criterion of detection is defined by comparing similarity between pre-abstract watermark and post-abstract watermark. Simulation result of robustness is shown in Table 2. As shown in Table 2, over 90% of watermark image is survived from high image compression.

Fig. 5. Watermark embedded images

Table 1. The PSNR(dB) of watermark embedded image

	boat	carolina
Cox	40.01	38.78
Xia	41.33	38.97
Proposed method	43.16	42.65

Table 2. The similarity of JPEG lossy compression

JPEG	boat	carolina
25%	0.974293	0.961222
50%	0.993020	0.981180
75%	1.000000	0.996113

4 Conclusions

In this paper, a new watermarking algorithm is proposed using wavelet packet transform and hybrid filter. The proposed watermark algorithm is used in high frequency component of image and apply watermark to the overall subband that include the lowest frequency band. And the watermark is embedded on original image and hybrid filtering has been adopted to remove the noise.

From the simulation result, the proposed algorithm shows better invisibility and robustness performance with comparing with conventional watermark methods. Especially, it demonstrates better robustness for high image compression in the remote sensing images such as aerial photos.

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