Image Denoising Based on Mean Filter and Wavelet Transform

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Abstract—The traditional mean filter in the processing of the image noise reduction can make the image edge information lose, the image is obscure. The wavelet transformation in the image processing can not only suppresses image noise but also has the strong ability of image enhancement. So I combine two filtering methods for image noise reduction processing. The experiments and the test in this paper show that the denoising effect by combining of wavelet transform and mean filter is superior to simple denoising method and the existing combination of the denoising method no matter from visual aspect and in terms of signal-to-noise ratio and root mean square error.

key words-Image denoising;Average filtering;Wavelet transform ;Threshold

I. INTRODUCTION

Image is one of the important medium of human information [1], but the image in the process of generation and transmission inevitably will be affected by a variety of noise interference, it will damage to the image quality will be, will affect subsequent higher levels of image processing, so the effective image denoising method is particularly important.

Image denoising methods can be divided into two categories: [2], the denoising in the spatial domain and transform domain denoising, the main method of spatial domain denoising with average filtering and median filtering, wiener filtering, etc., the typical denoising method of transform domain have image denoising based on Fourier transform and [3] based on the wavelet transform of image denoising, because wavelet transform has low entropy, multi-resolution willfulness, correlation, selected base flexibility etc get [4] in the aspect of image denoising, a wide range of applications, but single denoising method has its own shortcomings can not meet the requirement of the high denoising effect, therefore the typical spatial domain and transform domain denoising method combining [5] to deal with the noise of image, and through the experimental validation of this method is simple and practical, good denoising effect .

II. MEDIAN FILTER AND WAVELET TRANSFORM DENOISING

The combination of wavelet transform and median filter method for noise image denoising processing is used, and the specific steps are as follows:

1) *Firstly, db4 wavelet base to decompose image into two layers, the noise image will be made as wavelet coefficient threshold quantization.*

2) *Wavelet coefficient is restricted from the second to the first floor to get image signal, get the first layer of the all details of image reconstruction.*

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3) *The low frequency approximation of sub-image is unchanged, different filter templates are respectively adopted to horizontal sub-image details, vertical and diagonal image detail sub-image median filter.*

4) *Finally the low-frequency approximate image will be restricted and I combine the average filtering of level detail child image details, vertical and diagonal image detail to get the sub-image superposition after denoising image.*

III. THE SELECTION OF SEVERAL IMPORTANT PARAMETERS IN IMAGE DENOISING ALGORITHM

A. The selection of threshold function

Wavelet threshold denoising threshold function shows different treatment strategies and different mathematical estimation methods over and below the threshold of wavelet. Thehard threshold function and soft threshold function are widely used in the current threshold function.

Although hard threshold and soft threshold method in image denoising have achieved good results, these two methods have their own defects. The hard threshold method in reconstruction images could be ringing, such as pseudo gibbs visual distortion. Using a soft threshold method of reconstruction image denoising effect is relatively smooth, but it still appears obscure images. Some scholars proposed the improved threshold functions[6] to overcome defects, however most of these improved threshold functions have uncertain parameters, and the denoising effect is affected. in order to overcome uncertain parameters on the denoising effect does not contain not so used to set the parameter in order to improve the denoising threshold function effect and stability[7]. the threshold function is used in this paper:

$$\widetilde{w_{j,k}} = \begin{cases} sgn(w_{j,k})\left(|w_{j,k}|^{2j-1} - \lambda^{2j-1}\right) & ,|w_{j,k}| > \lambda \\ 0 & ,|w_{j,k}| \le \lambda \end{cases} \quad (1)$$

the value function in the continuous lambda, overcomes the defect of the hard threshold function, its changes as the decomposition layers j, adaptive, function is uncertainty parameters, the denoising of the final effect is not affected by uncertain parameters, denoising performance is stable.

B. Threshold selection

Wavelet threshold denoising is also important in addition to the selection of threshold function. If the threshold selection is too large in the image, important information will be filtered. This will cause deviation. If denoising threshold selection is too small, noise will still exist in the image.

So selection of threshold value is:

$$\lambda_j = \delta\sqrt{2log\ (N)}/\sqrt{log_2^{j+1}} \quad (2)$$

J shows decomposition layers, lambda λ_j shows the first j threshold of decomposition layers.

C. *Selection of average filtering templates*

From the perspective of signal energy, noise energy is evenly distributed. And the image detail information is distributed in the high frequency area. To avoid obscure image after the average filtering, appropriate filter template is chosen. In this paper, we choose the filter template. It is shown below:

$$\frac{1}{9}\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix} \qquad \frac{1}{9}\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix} \qquad \frac{1}{25}\begin{bmatrix}1 & 0 & 0 & 0 & 1\\ 0 & 1 & 0 & 1 & 0\\ 0 & 0 & 1 & 0 & 0\\ 0 & 1 & 0 & 1 & 0\\ 1 & 0 & 0 & 0 & 1\end{bmatrix}$$

Fig.1template of average filtering

IV. THE EXPERIMENTAL RESULTS AND ANALYSIS

In order to verify the effectiveness of the method in the selected test, MATALAB with its own 256 x 256 Lena image as input is adopted, and the gaussian noise of 0.01 is added. They are compared with soft and hard threshold denoising methods and mean filtering denoising method respectively.

Fig.2 The original image

Fig.3 noise image

Fig.4 Hard threshold for de-noising

Fig.5 Hard threshold for soft

Fig.6 Average filtering de-noising

Fig.7 methods used in this paper

From the effect of fused denoising is better than other single denoising effect. In order to further verify the denoising effect, as a standard, a peak signal-to-noise ratio and root mean square error is used for objective verify its definition.

$$\text{RSNR}=10+\log\left[\frac{255^2}{\text{MSE}}\right] \tag{3}$$

$$\text{RMSE}=\sqrt{\frac{1}{N}\sum_{I=1}^{N}(S_i-\hat{S}_i)^2} \tag{4}$$

MSE is the mean square error and S_i is the original signal, $\hat{S}_i$ is the signal after denoising.

Tab 1 comparison of denoising methods between PSNR and RMSE values

Denoising method	PSNR/dB	RMSE
Noise image	18.3792	825.7936
Soft threshold	25.2140	178.2310
Hard threshold	26.6312	148.2077
Average filtering	25.7362	154.1526
methods used in this paper	26.6476	107.1782

Seen from the table 1, the combination of the average filtering with wavelet transform denoising method is to improve signal-to-noise ratio. And the root mean square error is reduced.

V. CONCLUSIONS

Based on the existing fusing denoising, image denoising is selected on the basis of image denoising and median filter. In the process of wavelet transform, a new threshold function is chosen. the simulation results show that based on wavelet transform and median filter, the combining effect of denoising is superior to the soft and hard threshold function and median filter in the visual sense. The signal-to-noise ratio and root mean square error is superior to the simple noise reduction method and the combination of the existing noise reduction method from the error aspects of SNR(signal to noise ration) and root-mean-square.

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