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Research Article

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The research based on the genetic algorithm of wavelet image denoising threshold of medicine

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ABSTRACT

The paper presents a genetic algorithm based on wavelet threshold medical image denoising method. Theoretically analyses the principle of wavelet threshold denoising, the improved threshold function is proposed. Using genetic algorithm combined with clustering histogram of the image information are used to get the optimal threshold, the calculation without a priori information, such as noise variance and improve search efficiency. Experimental results show that with the ordinary wavelet threshold demising method, this method can improve the visual effect of medical image after denoising, improve the peak signal to noise ratio.

Key words: wavelet, genetic, image, biological chemistry, Chemical reagent

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INTRODUCTION

Noise is an important factor that can influence medical image's quality. Medical images are susceptible to noise affect in the process of processing and transmission, cause the loss of image contrast, details blur, when the diseased tissue and normal tissue attenuation coefficient is very small, the doctor will not be able to distinguish the rush of the interested lesions, thus influence the diagnosis. So filtering out the inside of the the signal noise, geting a clear image becoming a doctor's very concerned. In the existing image denoising methods, the wavelet transform has good multi-resolution characteristic, has been very widely used in image processing [1-5]. At present, people on the research of the wavelet threshold denoising method mainly concentrated in two aspects: the determination of threshold functions and threshold. Common denoising methods in determining the threshold value is rarely consider characteristic of the image itself. As a result these methods has a lot limitations, cannot achieve ideal denoising effect [6-9]. Genetic algorithm (based Algorithms, GA) is a simulation of evolutionary biological evolution mechanism of swarm intelligence algorithms. It has strong implicit parallel and global searching ability, in combinatorial optimization, engineering control and pattern recognition, and other fields has been widely used.

In order to improve the quality of image enhancement, this paper puts forward a kind of medical image denoising algorithm based on genetic algorithm. This algorithm improves the traditional threshold functions, the improved threshold function has advantages of soft and hard thresholding function, and to a certain extent, overcomes their defects. Threshold algorithm fully concern the characteristics of the image itself, it can according to the image itself of the histogram feature adaptive adjustment, to obtain ideal denoising effect, so as to achieve the purpose of enhancing image quality. Compared with ordinary wavelet thresholding method, this method can improve the image's visual effect after denoising, improve the peak signal to noise ratio.

THE TRADITIONAL METHOD OF WAVELET THRESHOLD DENOISING

Signal energy in wavelet is concentrated in a limited number of wavelet coefficients, and the energy distribution of noise in the wavelet domain. Assuming that observation signal is as follows:

$$f(k) = s(k) + n(k) \quad k = 0,1,2,\cdots,N-1 \tag{1}$$

Among them, $s(k)$ is the real signal, $n(k)$ is the Gaussian white noise whose variance is σ^2, obedience $N(0,\sigma^2)$, N is the length of the signal. Because the wavelet transform has linear properties, the observation signal after discrete wavelet transform, the wavelet coefficients $w_{j,k}$ is composed of two parts, one part is real signal $s(k)$ corresponding wavelet coefficients $w_s(j,k)$, recorded as $u_{j,k}$, another is noise $n(k)$ corresponding wavelet coefficients $w_n(j,k)$, recorded as $v_{j,k}$ [2].

The wavelet threshold denoising method can be divided into the following three steps:

1) Noisy signal $f(k)$ for discrete wavelet transform to obtain a set of wavelet coefficients $W_{j,k}$;

2) Threshold processing of $w_{j,k}$, and estimate the wavelet coefficients, $\hat{w}_{j,k}$, and make $\left\|\hat{W}_{j,k} - u_{j,k}\right\|$ as small as possible. There are two commonly used threshold function:

Soft threshold:

$$\hat{w}_{j,k} = \begin{cases} sign(w_{j,k})(\left|w_{j,k}\right| - \lambda)\cdots\left|w_{j,k}\right| \geq \lambda \\ 0\cdots\left|w_{j,k}\right| < \lambda \end{cases} \tag{2}$$

Hard threshold:

$$\hat{w}_{j,k} = \begin{cases} w_{j,k}\cdots\left|w_{j,k}\right| \geq \lambda \\ 0\cdots\left|w_{j,k}\right| < \lambda \end{cases} \tag{3}$$

Formula, $W_{j,k}$ is the original of decomposition of the wavelet coefficients, $\hat{w}_{j,k}$ is after processing of the wavelet coefficients, sign is the symbol function, λ is the threshold.

3) Useing the estimated wavelet $\hat{w}_{j,k}$ inverse transformation of wavelet coefficients estimated signal, $\hat{f}(k)$ is the denoising signal after.

In the wavelet threshold denoising method, the most important is the selection of threshold functions and threshold.

IMPROVED ALGORITHM

The improved threshold function

Soft threshold and hard threshold function has been widely used in practice, and achieved good denoising effect, But soft thresholding wavelet coefficients $\hat{w}_{j,k}$ obtained though the estimated overall continuity is good, make the signal does not produce an estimated additional shocks. But when $\left|w_{j,k}\right| \geq \lambda$, $\hat{w}_{j,k}$ and $w_{j,k}$ there is always the fixed deviation, caused certain information loss at high frequency, lead to the edge of the image blur; Hard threshold method in mean square error sense better than the soft threshold method, but because of the hard threshold function in the place of λ discontinuity, the estimated signal will generate additional volatility, on the edge of the rich information of the image will produce many "artificial" noise points, resulting in images appear visual distortion such as ringing, pseudo GibbS effect. In order to overcome the shortcoming of soft threshold and hard threshold method, combining with the advantages of the two kinds of methods, in this paper, the threshold function is improved, the improved threshold function such as type (4):

$$\hat{w}_{j,k} = \begin{cases} 0 \cdots\cdots \left|w_{j,k}\right| < \lambda_1 \\ \dfrac{w_{j,k}}{e-1} \cdot (e^{\frac{\left|w_{j,k}\right|-\lambda_1}{\lambda_2-\lambda_1}} - 1) \cdots\cdots \lambda_1 \le \left|w_{j,k}\right| < \lambda_2 \\ w_{j,k} \cdots\cdots \lambda_2 \le \left|w_{j,k}\right| \end{cases} \tag{4}$$

Improved threshold function type, when, $\left|w_{j,k}\right| < \lambda_1$, $\hat{w}_{j,k} = 0$, when $\left|w_{j,k}\right| \ge \lambda_2$, $\hat{w}_{j,k} = w_{j,k}$, overcome the fixed bias in soft threshold function, when $\lambda_1 \le \left|w_{j,k}\right| < \lambda_2$, the between 0 and $w_{j,k}$, overcome the discontinuity of the hard threshold function. Therefore, the improved threshold function can has better denoising effect than soft threshold function and hard threshold function [3].

Threshold optimization based on genetic algorithm and the information of gray histogram

In the process of image denoising, the threshold selection is very important of using the technology of wavelet denoising threshold, can determine the final image denoising effect. If the threshold value is too large, the filtered noise, also maybe detailed information may be filtered signal, resulting in excessive signal smoothing;and the noise threshold is too small will be kept, reach the purpose of denoising.

In a typical image de-noising algorithm is based on the statistical properties of the wavelet coefficient is simple to estimate wavelet threshold shrinkage and study. Its classical threshold is: the unity of Donoho threshold, $\lambda = \sigma\sqrt{2\ln(N)}$, σ is the gaussian noise intensity. In fact, noise intensity is unknown. The classical threshold is based on a common statistical characteristics, wavelet shrinkage is the best threshold limit, but it is not the best threshold shrinkage.

Genetic algorithm learned from Darwin's theory of evolution and Mendel genetic theory, its essence is a kind of efficient, parallel and global searching method.It automatically acquire and accumulate in the process of search from the knowledge space, and adaptive control for optimal solution search process. Genetic algorithm from a set of randomly generated initial solution (group) began to search the evolving, called genetic. Genetic algorithm is mainly realized through crossover and mutation, selection, calculation. Crossover or mutation operation to generate the next generation of chromosomes, called the offspring. The stand or fall of chromosome measured by fitness. Select a certain number of individuals from the previous generation and future generations in accordance with the size of the fitness, as the next generation of group, and then continue to evolve, so after several generations, algorithms converge to the best chromosome, get the optimal or suboptimal solution of the problem[4].

Genetic algorithm is a global a global contraction algorithms are strong, and clustering algorithm is a local search ability are strong. Combine the two methods, it is bound to get good clustering effect, improve the convergence speed.

Threshold optimization based on genetic clustering algorithm and the general steps can be described as follows[5]:

(1) The input image histogram information operations. Initialize the algorithm to obtain the clustering center of the image, taking the number of clusters.
(2) The initial population size, chromosome binary encoding, crossover rate and mutation rate, the total number of iterations and the number of the current.
(3)Crossover and mutation operations.
(4) According to the function to conduct appropriate assessment.
(5) Select from the result .
(6)To judge whether meet the termination conditions, if satisfied, output the optimal threshold, turn to step (7); If not satisfied, the current iteration number plus 1, turn to step (3).
(7) Proceeds from the optimal threshold for image denoising.
(8)Output the image after denoising.

ANALYSIS OF THE EXPERIMENT RESULT

Based on MATLAB7.0 environment, apply traditional soft and hard threshold function, as well as improved

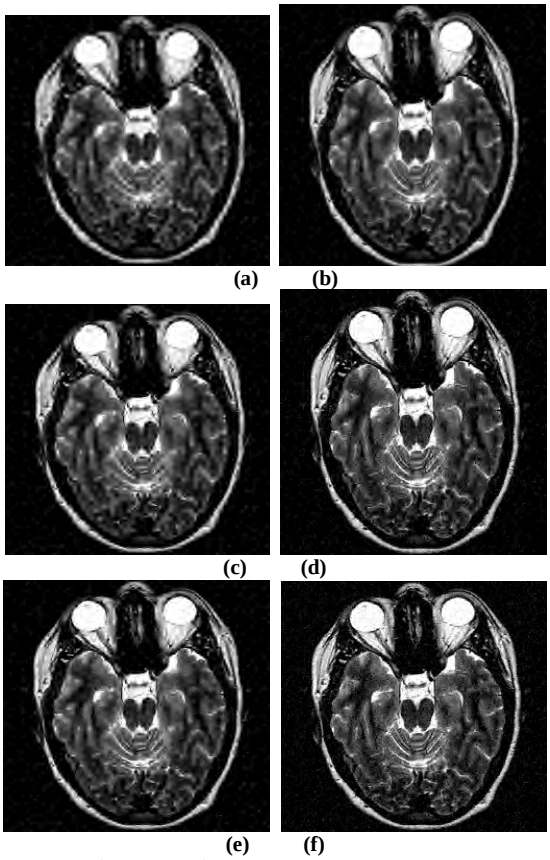
threshold function to do denoising experiments respectively with a brain mri image of size 256*256. The Selected threshold is the unified Donoho threshold and the optimal threshold. Table 1 is the comparison of denoising results of PSNR between the improved threshold function and the original soft and hard threshold function with different noise variance. Table 2 and figure 2 is the comparison of denoising results between the unified Donoho threshold and the optimal threshold with the same noise variance .

Table 1. Improved threshold function compared with soft and hard thresholding function PSNR (unit: dB)

Noise variance	Soft threshold function	Hard threshold function	Improved threshold function
16	20.52	21.63	23.20
18	18.89	20.66	22.30
20	19.31	20.08	21.41
24	18.30	18.89	20.04

Table 2. Uniform threshold and optimum threshold denoising results of PSNR (unit: dB)

Noise variance	Soft threshold function	Hard threshold function	Improved threshold function
Donoho threshold	19.31	20.08	21.41
Optimum threshold	19.99	21.10	23.24



(a) Soft threshold function Donoho threshold
(b) Soft threshold function optimization threshold
(c) Hard threshold function Donoho threshold
(d) Hard threshold function optimization threshold
(e) Improved threshold function Donoho threshold
(f) Improved threshold function optimization threshold

Figure 2. various threshold denoising effect and threshold function

Through the data in table 1, it can be seen denoising PSNRof the improved threshold functions is obviously enhanced compared with the original soft and hard threshold function. The lower the variance of noise is, the more obvious the effect of the improved algorithm. Through the data in table 2, it can be seen that using the optimized threshold of genetic algorithm and histogram information, signal to noise ratio is higher compared with traditional

unified Donoho threshold denoising. Furthermore, it can be seen from figure 2, the denoising visual effect of improved threshold functions and threshold has obviously good denoising performance compared with traditional wavelet threshold, as nuclear magnetic image with gaussian white noise can be clearly restored to the original image, the details of fuzzy in soft threshold function denoising and edge information Gibbs phenomenon of hard threshold function has improvement of different degrees. Visible, the improvement of threshold functions and threshold in this paper can get satisfactory effect, it is an effective method for estimating wavelet coefficients, conforming to the requirements of the reality of denoising.

CONCLUSION

Due to the better time-frequency characteristic of wavelet and the frequency distribution characteristics of noise and useful signals, wavelet has good advantage in image denoising. According to the basic principle of wavelet threshold denoising, the traditional threshold functions are improved in this paper, the improved threshold functions have both advantages of soft and hard threshold function, furthermore the respective defects of soft and hard threshold function are made up to a certain extent by the new improved function. Using genetic algorithm combined with clustering histogram of the image information, the optimal threshold is gained without a priori knowledge about the noise variance, also the search efficiency is enhanced. It can be seen from the results of simulation experiment, the method applied in this pater is better than the traditional wavelet and denoising method, as visual effect and signal to noise ratio are superior after image denoising, meantime it shows that the improved threshold functions and threshold has validity and superiority in medical image denoising as well as a good application prospect.

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REFERENCES

[1] JIA Di, YANG Jin-zhu, CAO Peng. *Journal of Chinese Computer Systems*, **2011**, 32(10), 2064-2065.
[2] YANG Jin-yun, LI Hao. *Computer*, **2009**, 25(7), 277-278.
[3] LIU Yan-xia, L DONG Bei-bei, IU Yu. *Ideo Technology*, **2012**, 36(19), 183-184.
[4] ZHANG Lin, WANG Sheng-qian, XIE Zh-i hua, GAN L-i xin, SHU Zheng-hua. *LASER & INFRARED*, **2008**, l 38(2), 187-188.
[5] LIANG Yun, XU Dongfeng, WANG Dong. *Computer Engineering and Applications*, **2011**, 47(16), 194-197.
[6] Zhang B.; Zhang S.; Lu G.. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 256-262.
[7] Zhang B.; *International Journal of Applied Mathematics and Statistics*, **2013**, 44(14), 422-430.
[8] Zhang B.; Yue H.. *International Journal of Applied Mathematics and Statistics*, **2013**, 40(10), 469-476.
[9] Zhang B.; Feng Y.. *International Journal of Applied Mathematics and Statistics*, **2013**, 40(10), 136-143.