Research on Laser Image Segmentation Algorithm Based on Improved Neural Network

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Keywords: Laser Image; Improved Neural Network; Image Segmentation

Abstract: Aiming at the problems of laser image segmentation, this paper proposes an improved neural network laser image segmentation algorithm. The traditional BP neural network algorithm is improved. The paper discusses the principle of this method and also focuses on the specific process. In order to verify the correctness and effectiveness of the method, a series of comparative tests were conducted. The test results show that compared with the traditional laser image segmentation method, the method used in the paper has been greatly improved in both segmentation accuracy and segmentation efficiency.

1. Introduction

With the rapid development of laser technology, laser technology is widely used in image segmentation. The acquisition of the laser image is greatly affected by the surrounding environment, so the captured image cannot be used normally. Thus, it is necessary to segment and find the areas and information needed. [1] At present, many scholars have conducted in-depth research on the problem of laser image segmentation and have achieved corresponding results. The most widely used method is the threshold segmentation method. This method mainly determines the threshold according to the different characteristics of the gray values in different regions, and finally realizes separating the target region from the background region. However, in practice, it is found that this method will lead to blurs in the edge of each region, which is unclear. This requires optimization of this segmentation method. The particle swarm algorithm and the artificial bee colony algorithm are used for improvement, but the effect is not good. [2] Using BP neural network to optimize this method can improve the segmentation accuracy of laser image to some extent, but this method also has a problem, that is, BP neural network parameters cannot be reasonably optimized. [3]

In order to solve these problems, the paper proposes a laser image segmentation method based on improved neural network. This method mainly uses the particle swarm optimization algorithm to optimize the parameters reasonably, which not only can greatly speed up the learning speed, but also can greatly provide high efficiency. [4]

2. The Process of Segmenting Improved BP Neural Network Laser Image

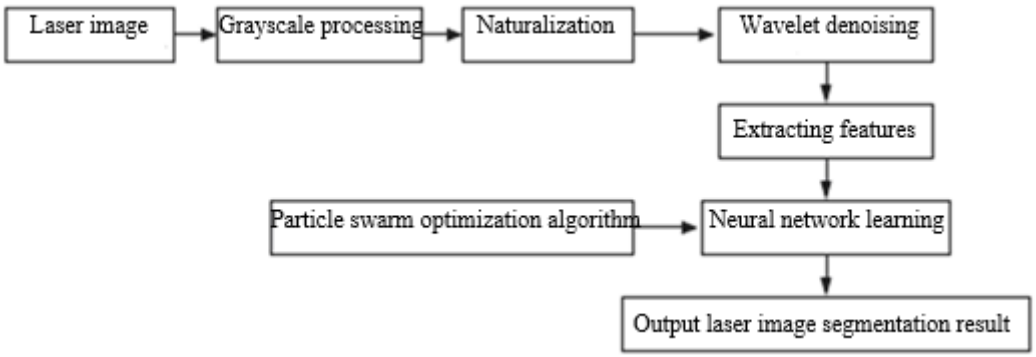


Figure 1 The Process of Segmenting a Laser Image

  DOI: 10.25236/iccse.18.029

The process of laser image segmentation is shown in Figure 1. The process of segmentation is mainly carried out in 7 steps.

It can be seen from Figure 1 that the process of segmentation is mainly carried out in seven steps.

3. Denoising of Laser Images

3.1 Wavelet Analysis

In practice, it is found that there are many kinds of noise in the laser image, and these noises are mixed together, so noise reduction is necessary and complicated. [5] The effect of wavelet analysis on noise reduction is very obvious, and the noise in the laser image can be largely eliminated. Suppose $f(x) \in L^2(R)$ is a function, and its associated wavelet transform can be expressed as:

$$W_f = \frac{1}{\sqrt{|a|}} \int_{-\infty}^{\infty} f(x)\psi^*\left(\frac{x-b}{a}\right)dx = \left\langle f(x), \psi_{a,b}(x) \right\rangle \tag{1}$$

In formula (1), a refers to the scale parameter, b refers to the location parameter, $\psi(x)$ is a wavelet master function, the specific definition can be expressed as:

$$\psi_{a,b}(x) = \frac{1}{\sqrt{|a|}} \psi\left(\frac{x-b}{a}\right) \tag{2}$$

Therefore, in the frequency domain of wavelet analysis:

$$\psi_{a,b}(\omega) = \sqrt{a} e^{-i\omega} \psi^*(a\omega) \tag{3}$$

It can be seen from equation (3) that if |a| and the time domain width relationship are linearly increasing, then the relationship with the frequency domain width is just the reverse. [6]

3.2 Laser Image Denoising Based on Wavelet Analysis

The process of denoising is very complicated. In principle, it is actually a filtering process. If $p_j f \in V_j$ is a laser image signal to be denoised, then:

$$P_j f = P_{j-n} f + \sum_{j=j-n}^{j-1} Q_j f \tag{4}$$

Denoising is mainly carried out in three steps:

The first step is to select the wavelet and calculate the hierarchical M analysis of the wavelet decomposition. [7] In this way, the M layer decomposition can be completed on the image y(t).

In the second step, the correct threshold is determined, and the high-frequency coefficients of each layer need to be analyzed. This paper selects the soft threshold function, which can be expressed as:

$$= T_h(\gamma, t) = \begin{cases} \text{sgn}(\gamma)\ (|\gamma| - t) & (|\gamma| \geq t) \\ 0 & (|\gamma| < t) \end{cases} \tag{5}$$

In formula (5), $\hat{X}$ refers to processed wavelet coefficients, t refers to the threshold, and γ refers to the variance.

The third step is to perform wavelet reconstruction on the high frequency coefficients of each layer, so that denoising can be achieved well.

4. Laser Image Segmentation based on Improved Neural Network

Suppose k is a random sample, the output is expressed with $\{x^k\}$, the input is expressed with $\{t^k\}$, and the input of the hidden layer of the BP neural network can be expressed as:

$$Z_j^k = \sum_{j=1}^{n} w_{pj} o_j^k = \sum_{j=1}^{n} w_{pj} x_j^k - \theta_p (j = 1,2,\cdots,q) \quad (6)$$

In formula (6), w_{pj} refers to the connection weight, θ_p refers to the threshold of the hidden layer.s The output can be expressed as:

$$Y_j^k = f(Z_j^k) \quad (j = 1,2,\cdots,q) \quad (7)$$

The output node error can be expressed as:

$$J(X_k) = \frac{1}{2}\sum_{j=1}^{L}(t_p^k - o_p^k)^2 \quad (8)$$

Assuming that the sample is not trained, the total training error can be expressed as:

$$J(X) = \sum_{k=1}^{M} J(X_P) = \frac{1}{2M}\sum_{k=1}^{M}\sum_{j=1}^{L}(t_p^k - o_p^k)^2 \quad (9)$$

The total training error of the BP neural network output node can be expressed as:

$$\delta_j^k = o_j^k(1 - o_j^k)(t_j^k - o_j^k) \quad (10)$$

In formula (10), o_j^k is the expected value.

The training error of the hidden layer can be expressed as:

$$\delta_j^k = o_j^k(1 - o_j^k)\sum_n \delta_n^k w_{jp} \quad (11)$$

The weight and threshold correction can be expressed as:

$$w_{nj} = (t+1) = w_{nj} + \eta(k)\delta_j^k o_j^k + \lambda(k)[w_{nj}(t) - w_{nj}(t-1)] \quad (12)$$

$$\theta(t+1) = \theta_j(t) + \eta(k)\delta_j^k + \lambda(k)[\theta_j(t) - \theta_j(t-1)] \quad (13)$$

$$= \begin{cases} 0.7\eta(k-1) & J(k-1) > J(k) \\ 1.15\eta(k-1) & J(k-1) \le J(k) \end{cases} \quad (14)$$

In formula (14), $\eta(k)$ refers to the learning speed.

$$\lambda(k) = \lambda(k-1) + \Delta\lambda \quad (15)$$

In formula (15), $\lambda(k)$ refers to momentum factor.

The specific segmentation is performed in seven steps:

In the first step, the laser image is collected by the acquisition device and then converted into a grayscale image. [8] In order to further improve the image conversion rate, the image needs to be normalized.

In the second step, the image is denoised by wavelet analysis, the purpose is to remove the useless information and retain useful information.

The third step is to initialize the parameters of the neural network.

In the fourth step, the characteristics of the laser image are extracted at this step, and the settings are also normalized.

In the fifth step, the BP neural network is the learning environment, and the training samples of the laser image need to be set into this environment. At the same time, it needs to be optimized by particle swarm optimization.

In the sixth step, the realization of the optimal neural network for laser image segmentation must meet a condition that the accuracy of the laser image segmentation model must meet the requirements.

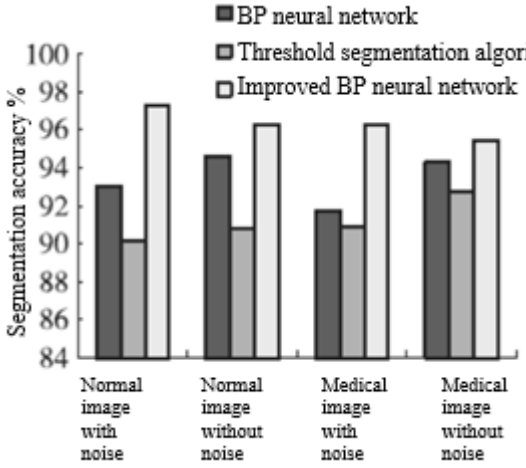
In the seventh step, the sample of the laser image is experimentally obtained through the

obtained optimal neural network, and the final result is obtained.

5. Test Result and Conclusion

5.1 Test Results

In order to verify the correctness of the method, the article compares the two aspects with the traditional methods, one is the segmentation precision, and the other is the segmentation time. The results of the test are shown in Figures 2 and 3.



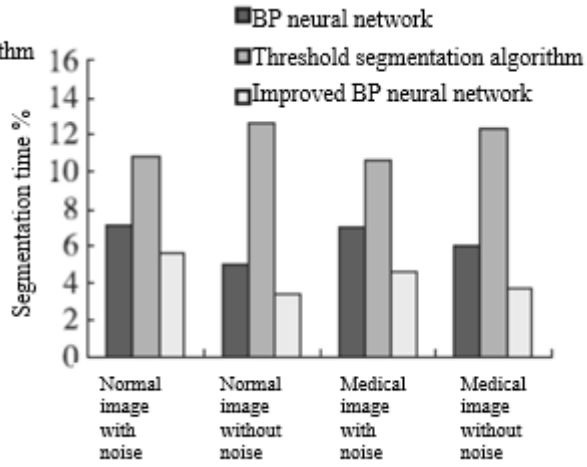


Figure 2 Segmentation accuracy comparison test result Figure3 Split time comparison test result

It can be seen from Figure 2 that regardless of the presence or absence of noise in the image, the method discussed in this paper has the highest accuracy.

It can be seen from Figure 3 that no matter whether there is noise in the image, the method described in this paper takes the shortest time and the highest efficiency compared with the traditional method.

5.2 Conclusion

In the field of image segmentation, laser image segmentation is very complicated, and conventional laser image segmentation methods also have such problems. This paper proposes an improved neural network laser image segmentation algorithm for such problems. The paper discusses the principles and processes of this method and conducts scientific comparative tests. It can be seen from the test results that the segmentation method not only has high cutting precision, but also requires a short cutting time, and the efficiency is greatly improved compared with the conventional method.

References

[1] Wang Hongzhi,Nie Shengdong, Wang Baohua.Methods for brain-structure auto segmentation using MR image[J],Biomedical Engineering foreign Medical Sciences,2005，28(5):302-306.

[2] Chai Hua，Yang Mingqiang. Brain image segmentation based on wavelet packets and region growing[J].Computer Engineering and Applications，2011，47(7)：215-217

[3] She Lihuang，Zhong Hua，Zhang Shi. Fuzzy C-means clustering algorithm combined with markovrandom field for brain MR image segmentation[J].Journal of Image and Graphics,2012，45(12):9-13

[4] Ma Yide, Dai Ruolan, Li Lian. Automated image segmentation using pulse coupled neural networks and images entropy[J],Journal of china instttute of communications，2012，7(1):98-110.

[5] Niu Y, Fang L, Sun S, et al. The Design of Book Sorter Base on Radio Frequency Identification

[J]. Journal of Applied Science and Engineering Innovation, 2018, 5(1): 18-21.

[6] Li R, Yu R, Wang X. Information Resources Sharing Security in Cloud Computing[J]. Journal of Applied Science and Engineering Innovation, 2018, 5(3): 65-68.

[7] P. Xu, Research and application of near-infrared spectroscopy in rapid detection of water pollution, Desalination and Water Treatment, 122(2018)1-4.

[8] Hu L, Tang L, Wen P, et al. Research on Fault Location Algorithm with Traveling Wave Based on Determinant of Matrix A[J]. Journal of Applied Science and Engineering Innovation, 2018, 5(3): 73-79.