ISSN 2616-5791 Vol.4, Issue 2: 60-64, DOI: 10.25236/AJMHS.2023.040210

A Method of Chest Film Segmentation Based on Minimum Error Threshold Method

Weiren Wang[1], Xinyu Li[2]

[1]*China Medical University, Shenyang, China, 110000*
[2]*Shanxi Medical University, Taiyuan, China, 030001*

Abstract: *In recent years, due to irregular life schedule and environmental pollution, the incidence rate and mortality of lung cancer have greatly increased. However, early detection and treatment can significantly reduce mortality. In the diagnosis of lung cancer, X-ray plays a key role. With the wide application of artificial intelligence, intelligent analysis of medical images has also ushered in a new breakthrough. In the intelligent analysis of medical images, image segmentation is an extremely critical link. This paper mainly introduces an image segmentation method about minimum error threshold segmentation, which provides an efficient and convenient method for medical image segmentation. This method can effectively extract the target lung region, avoid obvious over-segmentation and interference of stomach air region, and eliminate cavities and noise points, to obtain more accurate lung segmentation effect. Various reasons have led to the rapid rise of the incidence rate and mortality of lung cancer. Lung cancer will become one of the most threatening diseases to mankind in the 21st century. People should pay more attention to lung cancer related issues, realizing the advantages of intelligent analysis of medical images, and pay more attention to this field.*

Keywords: *Minimum Error Threshold Method, Image Segmentation, Medical Image Processing*

1. Introduction

In recent years, due to the influence of people's smoking, irregular diet and environmental pollution, the incidence rate and mortality of lung cancer have risen rapidly. The mortality of lung cancer ranks the highest among most common malignant tumors. The incidence of lung cancer gradually increased in China. Lung cancer will become one of the diseases that pose the greatest threat to human health in the 21st century. Early discovery, early diagnosis and early treatment are the primary means to improve the survival rate of patients [1].In the process of lung cancer diagnosis, chest X-ray examination is one of the basic examinations for clinical diagnosis. With the progress of imaging technology, medical image analysis plays a very important role in the process of early screening and diagnosis of diseases. However, with more and more patients, the limited medical resources are difficult to meet today's social needs[2]. Therefore, with the wide application of artificial intelligence, intelligent analysis of medical images also ushered in a new breakthrough.

The normal X-ray chest radiograph includes the information of several different tissue systems, such as lungs, trachea, heart, bones, stomach, etc., and there are different degrees of overlap between organs. The segmentation of these unrelated areas from the chest radiograph and the segmentation of effective lung tissue are helpful for the qualitative and quantitative analysis of pathological tissues[3]. Therefore, medical image segmentation is a key link in the intelligent analysis of medical images, subsequent imaging diagnosis depends heavily on the accuracy of the segmentation of the lesion area [4].

There are many segmentation algorithms that can be applied to lung X-ray image segmentation, among which the minimum error threshold method is a fast and effective segmentation algorithm. It is achieved by the probability distribution density of background and target pixels in the image. This paper mainly summarizes a simple and efficient medical image segmentation method including image preprocessing, minimum error threshold method segmentation and morphological post-processing.

2. Method Framework

As shown in Figure 1, first read the original image and perform pre-processing, including polygon frame selection of the stomach air area in the original image, unified setting of the brightness of this area,

ISSN 2616-5791 Vol.4, Issue 2: 60-64, DOI: 10.25236/AJMHS.2023.040210

direct binarization of the image, and image enhancement. After that, the minimum error threshold method is used to segment the image. The resulting pictures were processed through morphological postprocessing for filling and denoising of cavities. Finally, Finally, the processed image was extracted with edges drawn onto the original image [5].

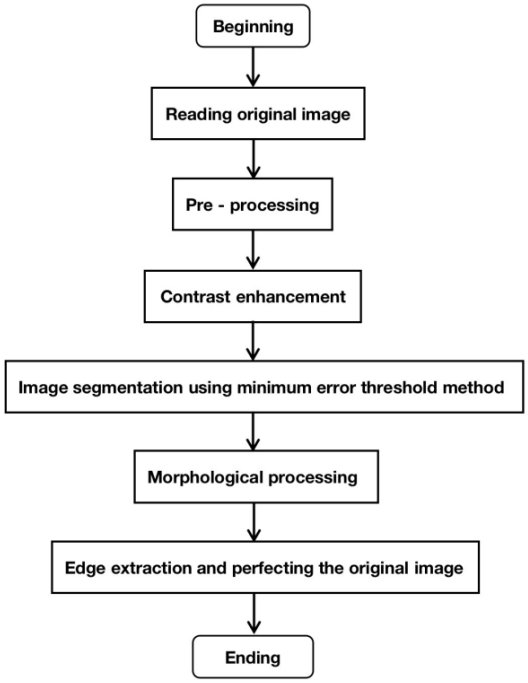


Figure 1: Method Framework

3. Core Theory

3.1 Principle of threshold segmentation

Threshold segmentation is a common image segmentation method and a image segmentation technique based on region. Its main principle is to obtain the corresponding threshold values of different areas by analyzing the pixel gray levels of the image, then compare the obtained threshold values with the specific gray levels of the corresponding pixels of the analyzed image, and finally segment the image pixel points according to the different characteristic thresholds set[6].

3.2 Principle of Minimum Error Threshold Method

The minimum error threshold segmentation method is implemented according to the probability distribution density of the background and target pixels in the image. The idea is to find a threshold and divide it according to the threshold, calculate the probability that the target point is wrongly divided into the background and the probability that the background point is wrongly divided into the target point, and obtain the total error division probability. When the total error partition probability is the smallest, the required optimal threshold is obtained.

Use $f(x,y)$to represent the pixel gray value of a pair of images with size $M \times N$ at coordinate (x,y), $f(x,y) \in G = [0,1 \cdots, L-1]$. The probability distribution of image gray level is represented by one-dimensional histogram *h (x).* Let the gray level of the target point of interest in the image also be normal distribution, the density is $f1(x)$), the mean and variance are $\overline{x_1}$ respectively and $\overline{s_1}$;The gray level of the image background points is also normal distribution, the density is $f2(x)$, and the mean and variance are respectively $\overline{x_2}$ and $\overline{s_2}$.Therefore, the entire density function can be seen as a mixture of two unimodal density functions, namely, bimodal density functions. According to Kittler and IIIingworth scholars combined with the minimum error correlation theory and calculation method, the following formula [7]is obtained.

$$J(t) = 1 + 2[P_1(t)\ln\sigma_1(t) + P_2(t)\ln\sigma_2(t)] - 2[P_1(t)\ln P_1(t) + P_2(t)\ln P_2(t)] \quad \rightarrow (1)$$

ISSN 2616-5791 Vol.4, Issue 2: 60-64, DOI: 10.25236/AJMHS.2023.040210

$$P_1(t) = \sum_{x-0}^{t} h(x), P_2(T) = \sum_{x-t+1}^{L-1} h(x) \quad \rightarrow (2)$$

$$\mu_1(t) = \sum_{x-0}^{t} \frac{h(x)x}{P_1(t)}, \mu_{21}(T) = \sum_{x-t+1}^{L-1} \frac{h(x)x}{P_2(t)} \quad \rightarrow (3)$$

$$\sigma_1^2 = \left[\sum_{x-0}^{t} x - \mu_1(t)^2 h(x)\right] \Big/ P_1(t) \quad \rightarrow (4)$$

$$\sigma_2^2 = \left[\sum_{x-t+1}^{L-1} x - \mu_2(t)^2 h(x)\right] \Big/ P_2(t) \quad \rightarrow (5)$$

When $J(t)$ is the smallest, the best threshold can be obtained as $t = \text{Arg} \min_{0<t<L-1} J(t)$

4. The experiment processes

4.1 The experimental equipment

This experiment uses a MacBook Pro (13 inch, 2019, Two Thunderbolt 3 ports) computer with a 1.4 GHz quad core Intel Core i5 processor and MATLAB R2022a (9.12.0.1884302) software. The source of the experimental image is TCIA: The Cancer Imaging Archive.

4.2 Specific experimental process

4.2.1 Image preprocessing

First, image preprocessing is carried out, including the selection of stomach air area, image enhancement and direct binary segmentation. The selection of stomach air area is mainly to solve the over segmentation problem between the enhanced stomach air area and the lung. The main method is to frame the stomach air area and set the brightness of this area to 255. In the subsequent operation process, this part will automatically correspond to the white area, It will not affect lung segmentation, as shown in Figure 2.

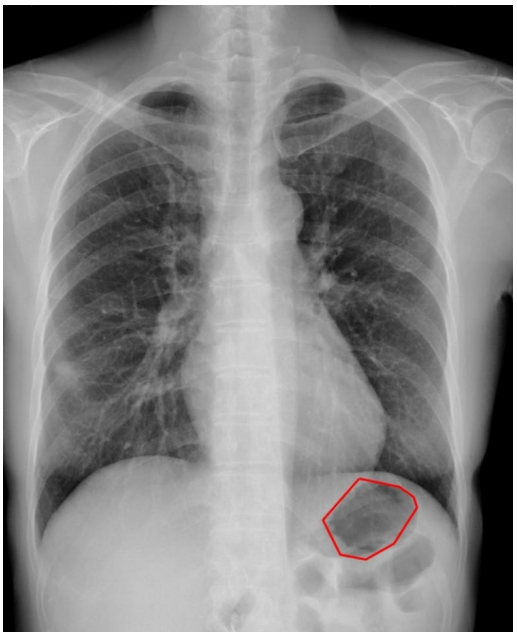
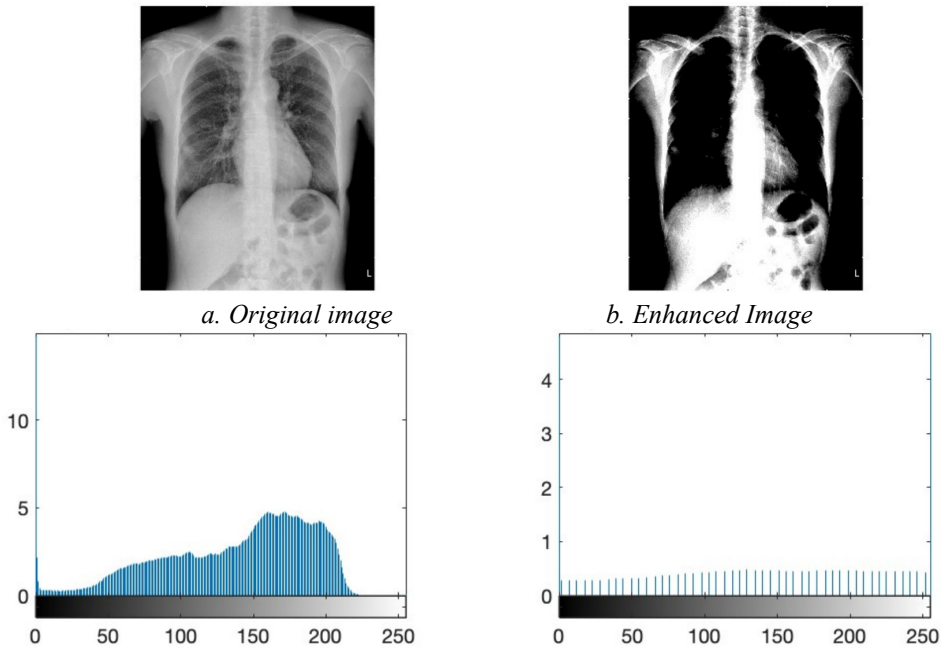


Figure 2: Selection of air area in stomach

In medical images, histogram analysis is the statistics of the distribution of gray scales in the histogram and the occurrence frequency of pixels corresponding to each gray scale. It is a statistical method that can reflect image intensity. Adjusting or changing the shape of the histogram will have a

ISSN 2616-5791 Vol.4, Issue 2: 60-64, DOI: 10.25236/AJMHS.2023.040210

great impact on the corresponding image display effect. As shown in Figure 3(a,b,c,d), the contrast of the lung image after contrast enhancement is performed.



a. Original image *b. Enhanced Image*

c. Histogram of the original image *d. Histogram of the enhanced image*

Figure 3: (a,b,c,d). Histogram contrast of lung images after contrast enhancement

4.2.2 Minimum error threshold segmentation

The minimum error threshold segmentation method is to obtain the minimum error target function by calculating the mean value, variance and other parameters of the target and background, and select the value of the smallest target as the best threshold value, and then segment the image into a binary image according to this threshold value, as shown in Figure 4, which is the result of segmentation by this method.

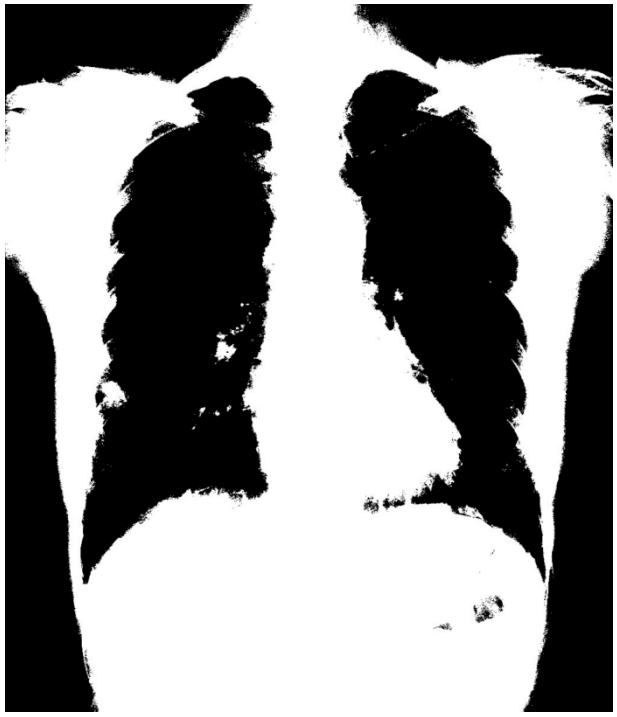


Figure 4: Effect of minimum error threshold segmentation

The segmentation result of the minimum error threshold method shows that the algorithm can effectively locate the target lung region without obvious over segmentation effect, but the result still

ISSN 2616-5791 Vol.4, Issue 2: 60-64, DOI: 10.25236/AJMHS.2023.040210

contains some holes and noise interference. Therefore, further morphological post-processing was carried out.

4.2.3 Morphological processing

In the process of medical image segmentation, there are frequent interfering conditions like holes and noise, which will cause certain interference to the segmentation of lung target area. Therefore, morphological post-processing can be selected to eliminate holes and noise points, and further improve the accuracy of image segmentation. Finally, the obtained image is edge extracted and drawn into the original image, as shown in Figure 5.

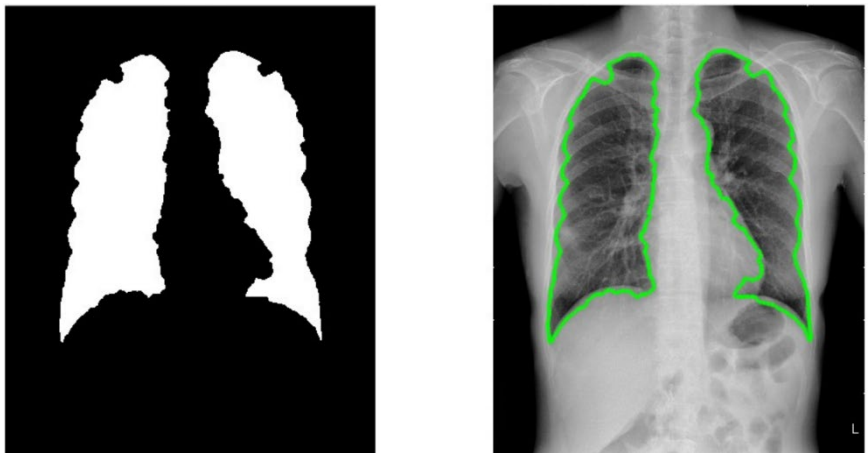


Figure 5: Result after segmentation

This effect shows that the method of minimum error threshold can effectively extract the target lung region, avoiding obvious over-segmentation, and eliminate cavities and noise points to obtain more accurate lung segmentation effect.

5. Conclusion

This paper mainly introduces a method of chest film segmentation based on minimum error threshold method. The minimum error threshold method has been widely used in image segmentation because of its advantages such as convenience and high accuracy. This experiment further summarized the processes including region selection, image enhancement, minimum error threshold method and morphological post-processing, and improved the segmentation effect and image segmentation accuracy again, which also has certain reference value for other medical image processing.

References

[1] Feng Longfeng, Chen Ying, Zhou Taohui, Hu Fei, Yi Zhen. Overview of segmentation methods for lung and lung lesions in CT images [J]. Chinese Journal of Image Graphics,2022,27(03):722-749.
[2] Wu Yi, Zhang Xiaoqin. Research progress and prospect of artificial intelligence in medical image processing [J]. Journal of the Third Military Medical University,2021,43(18): 1707-1712.DOI: 10. 16016/j.1000-5404.202106194.
[3] Liu Rongfei. Lung CT imaging research based on deep learning and image omics [D]. Chongqing University, 2021. DOI: 10.27670/d.cnki.gcqdu.2021.000112.
[4] Chen Guanze, Fu Chengzhou. Research on application of image segmentation algorithm in X-ray chest film analysis [J]. Computer and information technology,2022,30(01): 17-20.DOI: 10.19414/j. cnki. 1005-1228.2022.01.015.
[5] Liu Yanqi, Zhan Fuyu. MATLAB Computer Vision and Deep Learning Practice [M]. China Industry and Information Publishing Group, 2017.
[6] MATLAB Scientific Research Center. Research on specific medical image segmentation algorithm based on minimum error threshold method [Online]Available: https://blog.csdn.net/m0_70745318/ article/details/127991615(2022/11/22)
[7] Light of Poseidon Minimum Error Chest Film Segmentation System Based on GUI of MATLAB [Online]Available: https://blog.csdn.net/TIQCmatlab/article/details/118278522(2021/06/27)