Automatic Thresholding For Segmentation In Chest X-Ray Images Based On Green Channel Using Mean And Standard Deviation

V.Thamilarasi, R. Roselin

Abstract: ***Threshold based segmentation plays important role in digital image processing. It is one of the best and generally used methods. Presently medical diagnosis need more support from Computer Aided Diagnosis (CAD), particularly the chest X-ray images for lungs. Segmentation of lung portion from chest X-ray plays an important role in identification of abnormality in lung region. There are lot researches going on, in the segmentation of lung region based on threshold. The universally accepted Thresholding techniques Otsu, Niblack and Sauvola methods are experimented for 247 chest X-ray images from Japan Society of Radiological Technology (JSRT) dataset[1]. The result of these methods however fails to segment lung region with good accuracy. Every image needs proper threshold for segmentation. It is difficult to fix single threshold for all images. The chest X-ray images need absolute threshold for segmentation, within a point difference which results merging of lung portion or leads improper lungs portion. This paper presents efficient Automatic threshold based on mean and standard deviation which works centered on all three channels and suggested that green channel in RGB images works well than other two channels blue and red. Based on this concept the proposed method was developed and experimented on all 247 images. This method is able to segment lung portion in all images except one which is JPCLN044. The accuracy of this method catches with the help of dice coefficient similarity method. The proposed method achieves nearly 79.71% success rate before applying filter and 79.73% after applying filter with the support of dice similarity method.***

Index Terms: Threshold algorithms, Mean, Standard Deviation, Green channel, Segmentation, Automatic Thresholding.

I. INTRODUCTION

Segmentation is basis for all type of experiments in image processing. It gives better vision about the image foreground and background details. It is a basic pillar of image processing. Threshold value plays vital role in segmentation. Threshold based segmentation is essential for maximum image processing techniques. It simply results in binarization which separates background object from foreground in the image. Detection of lung cancer requires segmentation of lung region from all other region in the chest X-ray images. It is a challenging task for radiologist. Setting common threshold for all images is difficult task for researchers. Compared to computer tomographic images, nature of chest X-ray images contains more difficulties to segment lung portion based on proper threshold. There are a lot of binarization algorithms available and gives different result based on selection of image dataset and area. There are many algorithms available for automatic threshold. Based on the importance of segmentation, this paper analyses and apply all available automatic thresholding algorithms in chest X-ray images and proposed method focused experiment in red, green, blue channel based on mean and standard deviation and develop three algorithms for segmentation based on automatic thresholding in chest X-ray images. Segmented portion of lung is compared with ground truth image from JSRT dataset, Dice coefficient similarity method is used to measure the accuracy of segmentation. This paper is organized as follows: Section II summarizes the related work, Section III describes and analyze automatic Threshold algorithms. Section IV predict the methodology used for segmentation, Section V analyses experimental results and Section VII concludes the paper with the direction to future research.

II. RELATED WORKS

There are lot researches in the literature dealing with lung segmentation. Vijay Jumb, Mandar Sohani, Avinash Shrivas develops HSV based segmentation using k-means clustering and used OTSU threshold to get suitable threshold for image. Compared proposed system with 3 algorithms Hill-climbing with K-means (HKM), Region Growing (RG), Fuzzy C-Means clustering (FCM) and results are compared with the help of PSNR and MSE values [2]. Puneet and Naresh Kumar Garg analyses about different Binarization thresholding techniques with gray scale images and recorded result as which images need global threshold method and local threshold methods [3]. Liu Jianzhuang, Li Wenqing. Tian Yupeng developed two-dimentional Otsu method and compared with one dimensional Otsu method and recorded 2-dimentional Otsu method is better than one dimensional Otsu method [4]. Quoc Bao Truong and Byung Ryong Lee developed automatic multilevel threshold by improving otsu method based on evolutionary approach and also developed automatic thresholding algorithms based on Hill Climbing Algorithm and Adaptive Genetic Algorithm and achieves segmentation with reduced time [5]. Yu Liu, developed segmentation based on Otsu algorithm with gray extension [6]. S. Reddi, S. Rudin and H. Keshavan proposed single and multiple thresholds and also implemented with some

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examples [7]. Orlando J. Tobias, Rui Seara developed histogram threshold based on similarity between gray levels and similarity assessed with the help of fuzzy measure [8]. N. Senthilkumaran , S. Vaithegi used local adaptive technique to remove background with the support of local mean and standard deviation. A detailed Comparision study of niblack and sauvola threshold algorithmsare presented for some medical images [9]. Mehmet Sezgin and Bulent Sankur analysed and compared 40 threshold algorithms and documented the performance of algorithms [10]. N.Otsu discuss about various threshold selection method based on gray level histogram [11]. P. K. Sahoo, S. Soltani, A. K. C. Wong, and Y. C. Chen survey about various threshold techniques in image processing [12]. V.Thamilarasi and R.Roselin develop perfect segmentation algorithm for chest X-ray images based on canny with morphology and threshold .These algorithms executed in all 247 images and compare accuracy with the help of Jaccard similarity coefficient method and record threshold based method gives 80% success rate in lung segmentation [13]. J.S.Weszka, A.Rosenfeld evaluates various threshold techniques in digital image processing [14].

III. ANALYSIS OF EXISTING THRESHOLDING ALGORITHMS

First automatic thresholding for chest X-ray images for lungs are tried with the support of available algorithms like Otsu threshold, Niblack threshold, Sauvola threshold. Many modifications are done in the above algorithms to fit chest X-ray images and improved portion of these algorithms does not produce desired result in automatic thresholding.

A. Otsu threshold

Otsu method gives best output for most of the images. It works on the concept of shape of histogram. First the chest X-ray image converted into 2D gray image and changes made in the portion of effective measure and threshold calculation. it gives result as effective measure(em) and threshold(th). However these results cannot produce suitable threshold for all images and difficult to get segmented portion of lungs. Following Figure.1 shows few of the existing automatic threshold algorithms.

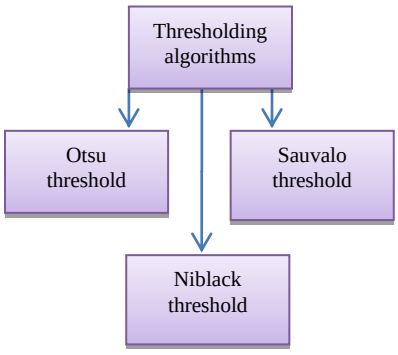


Figure 1 : Automatic Thresholding Algorithms

B. Niblack threshold

It calculates threshold based on the concept of local mean and standard deviation of image. HSV part of the image is extracted first and enhanced with imadjust. Mean and standard deviations are used to fix threshold using the formula $T_{Niblack} = m - k*S$, where k is taken as .3. The author gives the k value as .2. The result of this method gives good result for only few images.

C. Savola threshold

It is the extended version of niblack threshold algorithm and the changes made in the following portion

$T_{Sauvola} = m*(1+.2*((s / 180) - 1))$ to change k value and it gives good segmentation than Niblack but lungs portion is not extracted in a well-defined manner for all images.

IV. PROPOSED SYSTEM

The overall methodology adapted in the proposed method for lung segmentation is given in Figure 2. It has image acquisition, image preprocessing (median filter, histogram equalization), Automatic threshold segmentation based on mean and standard deviation in RGB channels, Dice coefficient Similarity method.

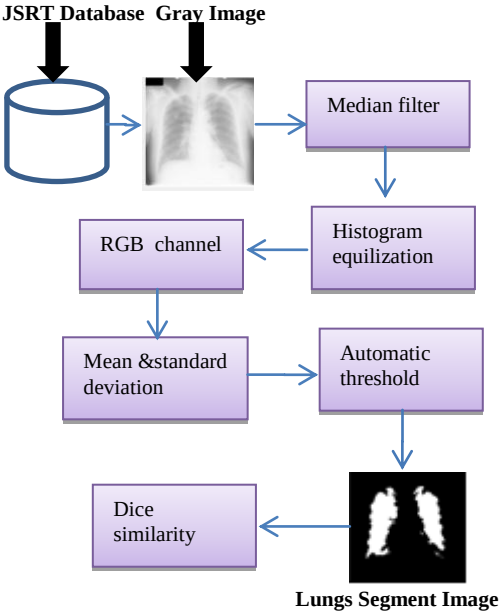


Figure 2 : Outline of proposed system

A. Segmentation by Automatic Thresholding

Segmentation is important step in image processing and it is difficult to find suitable method for images and it takes more time. Basically segmentation divides the image into number of sections based on similar features of image like shape, texture, color etc. Threshold is one of the twinborn methods of segmentation. The gray level images easily produced binary images by a simple selection of threshold value (T) and it results in good segmentation as foreground and background of image. This process makes below T value becomes Black and above this threshold value becomes White. Simply it results good and easy segmentation.

Initially manual thresholding is set for all 247 chest X-ray lung images and it takes more time and it creates eye panic To simplify the task automatic thresholding is needed . To minimize such complexity readly available automatic threshold methods executed with little modifications to suite chest X-ray images. However it does not produce expected result in segmentation of lungs.

Finally three automatic threshold algorithms developed for chest X-ray images. This experiment take three channels red green, blue and image is converted into grayimage by taking green channel. The algorithm developed based on mean and standard deviation of intensity values.

B. Image aquisition

The Japanese Society of Radiological Technology (JSRT) combined with Japanese Radiological Society (JRS) in1998 and provide standard dataset in chest X-ray images for both nodule and non nodule lung images. It has been used all over the world for various researches like picture archieving and communication system (PACS), computer aided diagnosis (CAD) and image processing. It contains 247 images which includes 154 nodule images and 93 non nodule images were at a size of 2048 × 2048. These images are obtained with the help of ImageJ tool which available in JSRT dataset. In this paper 1024×1024 resized images are used for experimental analysis.

C. Median Filter

Enhancement is used to improve the visualization of image properties clearly. The enhancement depends on type of process like extract or restore of image information. Domain of application decides the type of enhancement technique. Basically filters used to remove noise from images and present image as sketchy manner. There is lot of filters available, here median filter used to reduce the noise. It is better than mean filter in preserving high frequency details in the image. median filter based on numerical values , mid value is fixed as median m, and there is a two range below m and greater than m. At every pixel location median filter need ordering neighbourhood values. First the lungs segment without being used median filter. To enhance image details median filter again used. The difference between the performances is measured in terms of dice similarity method before and after application of median filter in Table 2.

Figure.3 shows the lung segmentation before and after application of median filter

Figure 3 : Before and After Application of Median Filter

D. Histogram Equalization

It is one of the best method for preprocessing and it is well suited for chest X-ray images. It works based on the concept of frequent intensity values and it simply enhance low contrast image into high contrast one. The chest X-ray images were taken from different lighting effect and surroundings. Common enhancement of this method gives expected result in images.

E. RGB Channel

In grayimage the three channels RGB are identical. Here the experiment done in all three channels seperatly based on mean and standard deviation of gray images of all 247 and found green channel gives excellent result than others. The segmented image is compared with ground truth segmentation with the help of dice coefficient similarity measure.

F. Mean and Standard Deviation

Mean and standard deviation of all three channels calculated separately .Green channel with mean and standard deviation gives good automatic threshold segmentation. Three different algorithms developed for mean and standard deviation.

Method 1:

1. Green channel is alone taken first.
2. Median filter is applied to remove the noise.
3.Contrast enhancement by histogram equalization .
4. Mean value of the intensity value is calculated.
5.Square root of standard deviation is computed.
6. Threshold is obtained by subtracting mean from standard deviation.
7. Binarization done with the help of the threshold.
8. Finally segmented portion of lungs is produced.

This algorithm gives best result for 123 nodule images and 80 nonnudule images. Deficiency in the segmentation is again processed by the following algorithm.

Method 2:

1. Green channel is alone taken first.
2. Median filter is applied to remove the noise.
3. Contrast enhancement by histogram equalization ..
4. Mean value of the intensity value is calculated.
5. Standard deviation of intensity value is calculated.
6. Threshold obtained by subtract mean with standard deviation.
7. Binarization done with the help of the threshold.
8. Finally segmented portion of lungs produced.

This algorithm gives result for nodule images 3, 4, 5, 9, 10, 11, 12, 17, 25, 27, 36, 41, 42, 43, 55, 59, 60, 61, 67, 74, 85, 95, 96, 97, 99, 100, 117, 127, 131, 132, 135, 154 and nonnudule images 3, 7, 24, 29, 30, 31, 49, 60, 66, 77, 80, 83, 88, 90, 91 which is not produced by method 1 algorithm.

Method 3:

1. Green channel is alone taken first.
2. Median filter is applied to remove the noise.
3. Contrast enhancement by histogram equalization.
4. Mean value of the intensity value is calculated.
5. Standard deviation of intensity value is calculated
6. Threshold obtained by subtract mean with standard deviation and multiply it with standard deviation.
7. Binarization done with the help of the threshold.
8. Finally segmented portion of lungs produced.

This algorithm also produced good result in segmented images but it works well than algorithm2.

All the above three algorithms applied for all the images until suitable threshold obtained.These algorithms repeteadly used for remaining two channels red and blue but they only give result for selective images. Compared all three channels, green channel gives best result than others. Along with all 247 images only one image JPCLN044 does not give result and confirmed these algorithms achieved 79.93% perfect automatic threshold segmentation with the support of Dice similarity method..

F.Dice Coefficient

Dice Coefficient used to compare segmented result with ground truth result to

observe the accuracy of implemented method.The function used to compute the Dice Coefficient for similarity is Dice(bw1,bw2). Bw1 indicate ground truth image bw2 indicate segmented image.

V. RESULT AND DISCUSSION

The following Table 1 reports the dice similarity measure of images for only ten images of both nodule and nonnodule before and after application median filter.

Table 1: Performance Evolution

Images	Before Median Filter	After Median Filter
JPCLN038	0.8757	0.8759
JPCLN048	0.8595	0.8594
JPCLN073	0.8496	0.8497
JPCLN104	0.8666	0.8670
JPCLN106	0.8851	0.8851
JPCLN147	0.8677	0.8678
JPCLN149	0.8664	0.8666
JPCLNN022	0.8738	0.8739
JPCLNN035	0.8751	0.8753
JPCLNN040	0.8871	0.8871
JPCLNN047	0.8904	0.8905

Figure 4 shows the graphical representation of filter effect in segmentation.

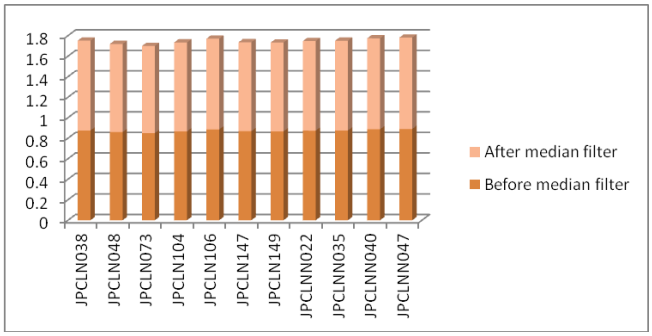


Figure 4 : Graphical Representation of Filter Effect

Table 2 reports dice similarity of automatic threshold algorithms.

Table 2 : Dice Similarity Measure

Images	Otsu	Niblak	Sauvola	Proposed
JPCLN022	0.7217	0.2352	0.7531	0.8751
JPCLN040	0.7803	0.6754	0.7654	0.8851
JPCLN035	0.8664	0.7445	0.7945	0.8595
JPCLN047	0.7110	0.7630	0.7630	0.7438
JPCLNN038	0.6650	0.5764	0.7781	0.8677
JPCLNN048	0.8486	0.7918	0.7918	0.8871
JPCLNN073	0.7246	0.6141	0.6541	0.8904
JPCLN104	0.7991	0.7001	0.7050	0.8670
JPCLN106	0.4843	0.7429	0.7429	0.8851
JPCLN147	0.6567	0.8026	0.8026	0.8768

The following Figure 5 shows the graphical representation of dice similarity in automatic threshold algorithms.

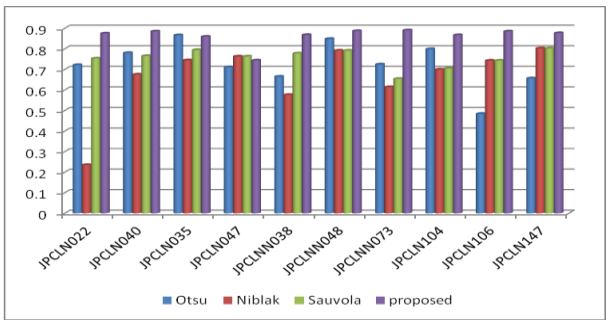


Figure 5 : Graphical Representation of Dice Similarity

Figure 6 shows the result of every steps in Automatic segmentation.

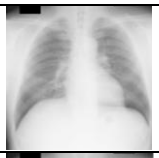
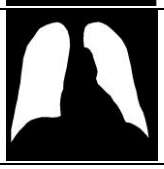
STEPS	RESULT
Gray Image	
Median filter	
Histogram Equalization	
Segmented X-ray	
Segmented Lungs	
Ground Truth	
Dice Similarity	0.8851

Figure 6 : Results of Various Steps in Segmentation

VI. CONCLUSION

In this paper selected automatic threshold algorithms are modified to segment the chest X-ray images and implemented and tested for all 247 images in JSRT database. The algorithms OTSU, Niblack and Sauvola does not achieve high accuracy in segmentation of lungs in chest X-ray images and some of these cannot produce proper lung segmentation. So proposed method of automatic segmentation based on threshold takes mean and standard deviation of green channel and segment lung portion for all 246 images which includes both nodule and non-nodule images out of 247 images. The image JPCLN044.jpg

does not respond in both old and proposed algorithms. All these segmentations are compared with the support of Dice similarity method. This proposed method results shows that the green channel based on mean and standard deviation is suitable algorithm for automatic threshold segmentation of lungs in chest X-ray images than remaining red and blue channel methods. Median filter application reasonably increases the accuracy of lung segmentation. It gives best support for this medical chest X-ray images and results in feasible solution for threshold selection using automatic threshold and thereby reduce the complexity in segmentation based on threshold. It builds strong foundation for further process after segmentation. This proposed method successively achieves the expected result and reduce processing time and cost than manual Thresholding for segmentation. Further research can be carried out to improve the accuracy in segmentation of lung region.

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