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Cancer Cell Detection Using Mathematical Morphology

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Abstract: Medical images edge detection is an important work for object recognition of the human organs and it is an important pre-processing step in medical image segmentation and 3D reconstruction. Conventionally, edge is detected according to some early brought forward algorithms such as gradient-based algorithm and template-based algorithm, but they are not so good for noise medical image edge detection. In this paper, basic mathematical morphological theory and operations are introduced at first, used for detecting the edges as well as the cancer cells of lungs CT and MRI images. Since, salt and pepper noise are more prevalent in medical images the conventional methods are not effective in filtering salt and pepper noise. In this paper, mathematical morphological operations are used to detect the edges and the cancer cells. Morphological erosion is a very good filter of salt and pepper noise. The experimental results show that the proposed algorithm is more efficient for medical image denoising, edge detection and identification than the usually used template-based edge detection algorithms and general morphological edge detection algorithms.

Index Terms- Medical image, edge detection, object detection, mathematical morphology, erosion, dilation, opening, closing.

I.INTRODUCTION

Medical images edge detection is an important work for object recognition of the human organs such as lungs and ribs, and it is an essential pre-processing step in medical image segmentation [1-2]. The work of the edge detection decides the result of the final processed image. Conventionally,edge is detected according to some early brought forward algorithms like Sobel algorithm, Prewitt algorithm and Laplacian of Gaussian operator [3], but in theory they belong to the high pass filtering, which are not fit for noise medical image edge detection because noise and edge belong to the scope of high frequency. In real world applications,medical images contain object boundaries and object shadows and noise. Therefore, they may be difficult to distinguish the exact edge from noise or trivial geometric features.Mathematical morphology is a new mathematical theory which can be used to process and analyze the images [4-9].It provides an alternative approach to image processing based on shape concept stemmed from set theory [10], not on traditional mathematical modeling and analysis. In the mathematical morphology theory, images are treated as sets, and morphological transformations which derived from Minkowski addition and subtraction are defined to extract features in images. As the performance of classic edge detectors degrades with noise, morphological edge detector has been studied [11].In this paper, a novel mathematical morphology edge detection algorithm is proposed to detect lungs CT medical image edge. It is a better method for edge information detecting and noise filtering than differential operation, which is sensitive to noise. And it is a better compromise method between noise smoothing and edge orientation, but the computation is more complex than general morphological edge detection algorithms.

II.BASIC OPERATIONS IN MATHEMATICAL MORPHOLOGY

Mathematical morphology is developed from set theory.It was introduced by Matheron [10] as a technique for analyzing geometric structure of metallic and geologic samples.It was extended to image analysis by Serra [10]. Based on

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set theory, mathematical morphology is a very important theory, whose operation must be defined by set arithmetic. Therefore, the image which will be processed by mathematical morphology theory must been changed into set.

Mathematical morphology uses structuring element, which is characteristic of certain structure and feature, to measure the shape of image and then carry out image processing.Based on set theory, mathematical morphology is the operation which transforms from one set to another. The aim of this transformation is to search the special set structure of original set. The transformed set includes the information of the special set structure and the transformation is realized by special structuring element. Therefore, the result is correlative to some characteristics of structuring element.The basic mathematical morphological operators are dilation and erosion and the other morphological operations are the synthesization of the two basic operations. In the following, we introduce some basic mathematical morphological operators of grey-scale images.

Let $F(x, y)$ denote a grey-scale two dimensional image, B denote structuring element. Dilation of a grey-scale image $F(x, y)$ by a grey-scale structuring element $B(s, t)$ is denoted by,

$$(F \oplus S)(x, y) = \max\{F(x - s, y - t) + B(s, t)\} \qquad (1)$$

Erosion of a grey-scale image $F(x, y)$ by a grey-scale structuring element $B(s, t)$ is denoted by,

$$(F \ominus S)(x, y) = \min\{F(x + s, y + t) - B(s, t)\} \qquad (2)$$

Erosion is a transformation of shrinking, which decreases the grey-scale value of the image, while dilation is a transformation of expanding, which increases the grey-scale value of the image. But both of them are sensitive to the image edge whose grey-scale value changes obviously. Erosion filters the inner image while dilation filters the outer image. Opening is erosion followed by dilation and closing is dilation followed by erosion. Opening generally smoothes the contour of an image, breaks narrow gaps. As opposed to opening, closing tends to fuse narrow breaks, eliminates small holes, and fills gaps in the contours. Therefore, morphological operation is used to detect image edge, and at the same time, denoise the image.

III.K-MEANS CLUSTERING ALGORITHM FOR IMAGE SEGMENTATION

K-Means algorithm is an unsupervised clustering algorithm that classifies the input data points into multiple classes based on their inherent distance from each other. The algorithm assumes that the data features form a vector space and tries to find natural clustering in them. The points are clustered around centroids $\mu_{i\forall}$ i = 1…….k which are obtained by minimizing the objective

$$V = \sum_{i=1}^{k} \sum_{x_{j \in S_j}} \left(x_{j - \mu_j} \right)^2$$

where there are k clusters Si, i = 1,2……., k and μ_i is the centroid or mean point of all the points xj ϵ Si. As a part of this project, an iterative version of the algorithm was implemented. The algorithm
takes a 2 dimensional image as input. Various steps in the algorithm are as follows:

1. Compute the intensity distribution(also called the histogram) of the intensities.
2. Initialize the centroids with k random intensities.
3. Repeat the following steps until the cluster labels of the image does not change =]anymore.
4. Cluster the points based on distance of their intensities from the centroid intensities.

$$c^{(i)} := \arg \min_j ||x^{(i)} - \mu_j||$$

5. Compute the new centroid for each of the clusters.

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$$\mu_{i=\frac{\sum_{i=1}^{m}\{c_{(i)=j}}{\sum_{i=1}^{m}\{c_{(i)=j}\}}}\}x^{(i)}$$

where k is a parameter of the algorithm (the number of clusters to be found), i iterates over the all the intensities, j iterates over all the centroids and μ_i are the centroid intensities.

IV.PROPOSED SYSTEM

Morphological edge detection and object detection algorithm selects appropriate structuring element of the processed image and makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and the synthesization operations of them to get clear image edge. In the process, the synthesized modes of the operations and the feature of structuring element decide the result of the processed image. Detailedly saying, the synthesized mode of the operations reflects the relation between the processed image and origin image, and the selection of structuring element decides the effect and precision and the result. Therefore, the keys of morphological operations can be generalized for the design of morphological filter structure and the selection of structuring element. In medical image edge detection, we must select appropriate structuring element by texture features of the image. And the size, shape and direction of structuring element must been considered roundly. Based on the shape of the cells we choose the structuring element. Cells size varies from 1µm-100µ.

In this paper, a novel mathematical morphology edge detection algorithm is proposed. Opening-closing operation is firstly used as preprocessing to filter noise. Then smooth the image by first closing and then dilation.

The perfect image edge will be got by performing the difference between the processed image by above process and the image before dilation. The following is the novel algorithm:

$$(M \bullet B) \oplus B = M \bullet B . \qquad (3)$$

Where

$$M = (F \bullet B) \circ B . \qquad (4)$$

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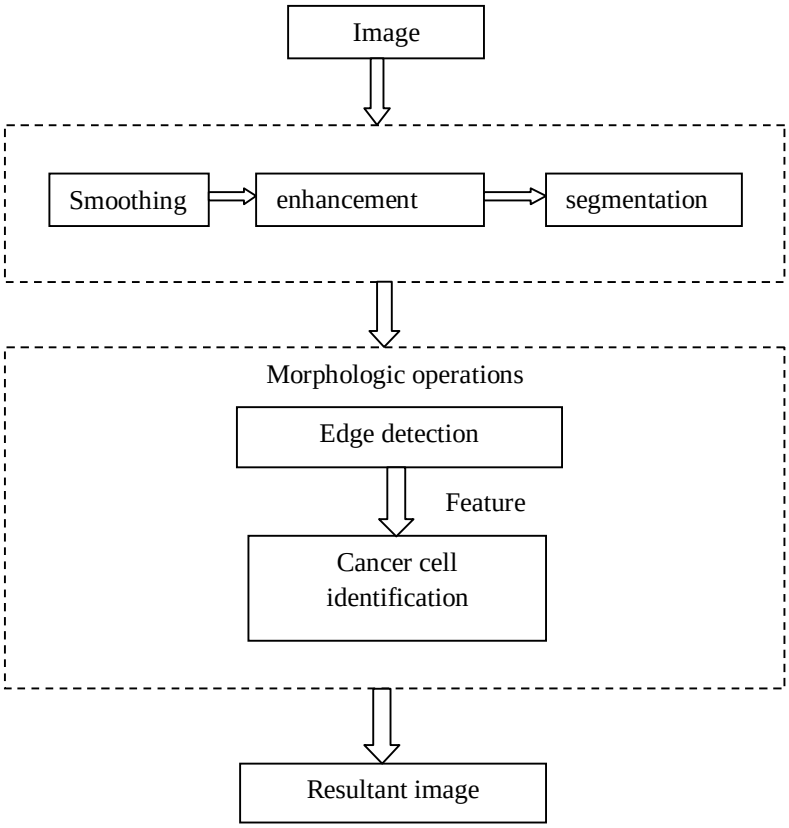

Here, the image is taken from either MRI and CT scan.The image is then filtered using morphological erosion.Therefore the salt and pepper noise are completely eliminated because they are very smaller in size than other parts of the image.Once the images are denoised further processing is done with that filtered image..The morphological operations are applied to the segmented images.Morphological opening and closing are performed on the segmented image.Morphological opening is performed to detect the images in the foreground and morphological closing is performed to detect the background images.Here the technique called binary gradient is used to detect the cell.The process involved here is determining the difference between the dilated image and the original image.From that we can easily identify the edges of the cell. Once, the edges are detected the holes in the image is filled by performing morphological operation called opening.After that, the edges of the cells are smoothened by performing dilation operation.

V.COMPARATIVE STUDY

In this paper a comparative study is done between the residue edge detector,morphological gradient edge detector and the novel morphological edge detector in order to compare the efficiency of each filter.The original medical images are more prevelant with the salt and peper noise.This can be removed easily by morphological operations compared to the conventional detectors.

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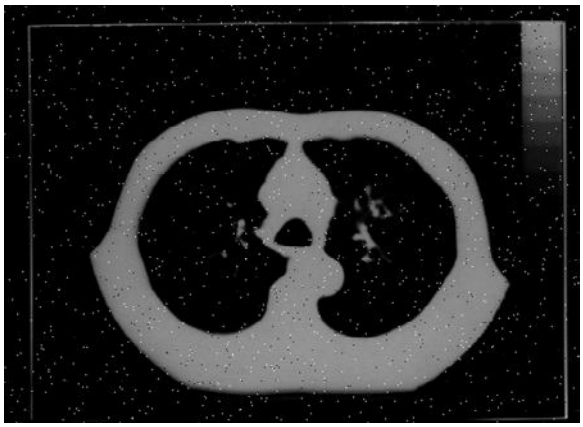

Fig.1. Original lungs CT image with salt-and- pepper noise.

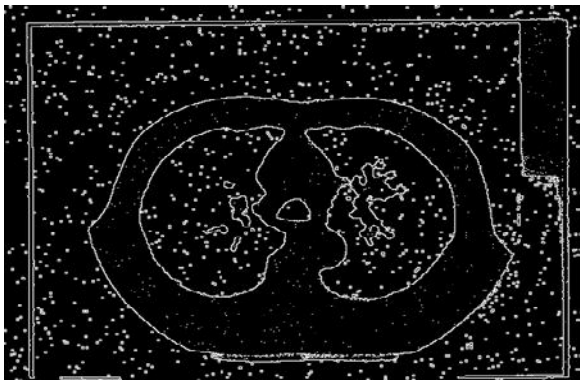

Fig.2. Lungs CT image processed by dilation residue edge detector.

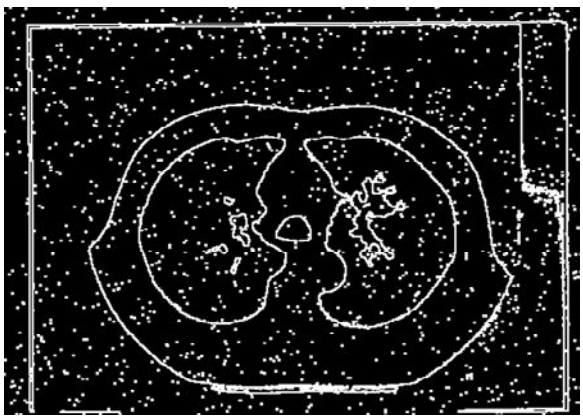

Fig.3. Lungs CT image processed by morphological gradient operation.

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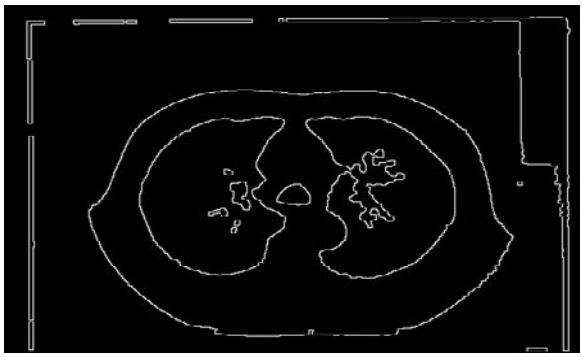
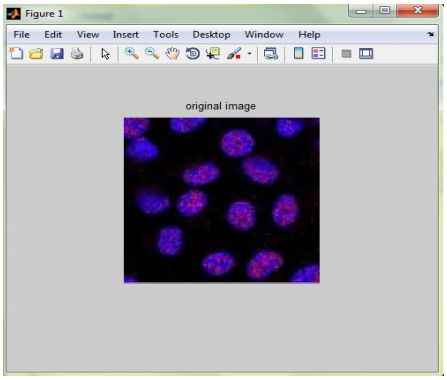


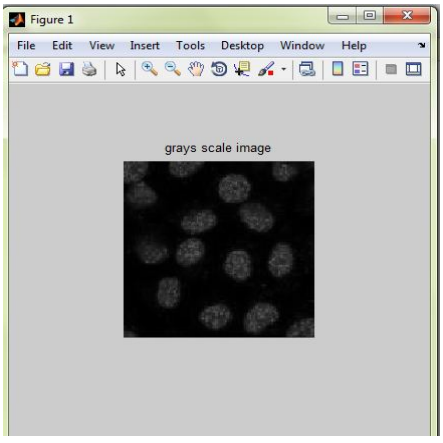
Fig.4. Lungs CT image processed by the novel morphological edge detector

6.IMPLEMENTATION

i)Original image:



ii)Gray Scale Image:



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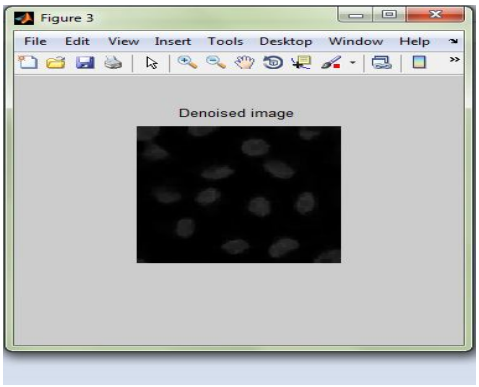
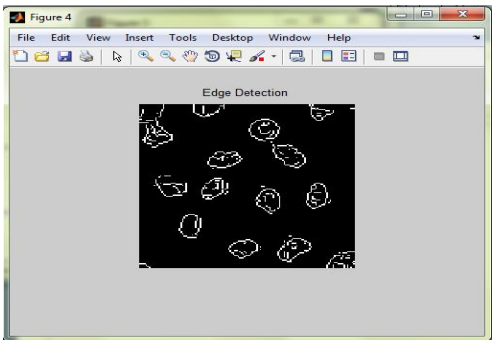
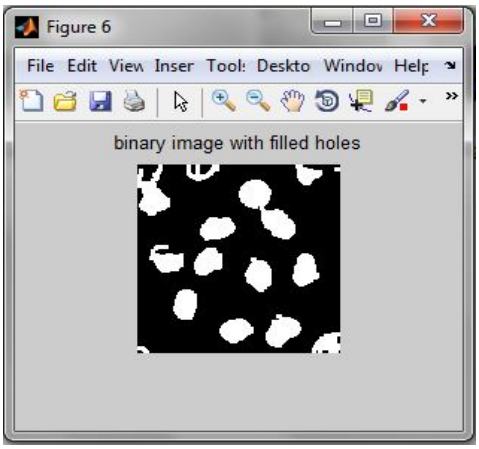
iii)Denoised Image:



iv)Detection of Edges:



v)Filling the holes in the image:



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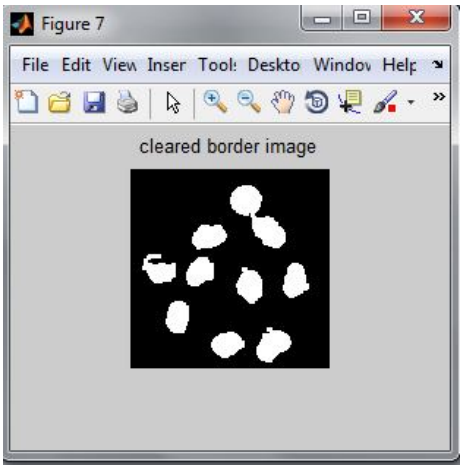
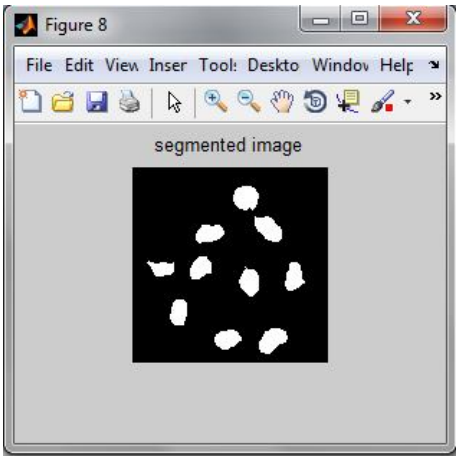
vi)Clearing the border of the image:



vii)Segmented Image:



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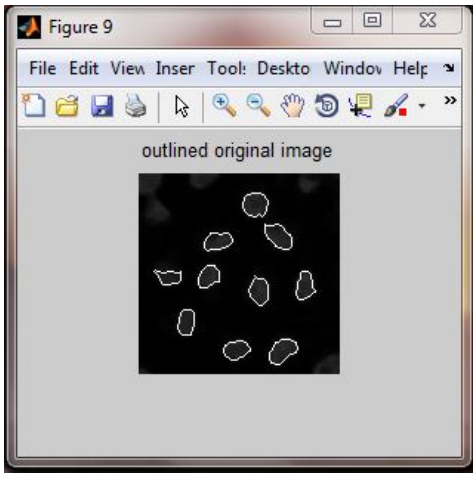
viii)Outlined Image:



VII.CONCLUSION

In this paper, a novel mathematic morphological algorithm is proposed to detect edges of the lungs and the cancer cells in CT and MRI medical image. The experimental results show that the algorithm is more efficient for medical image denoising and edge detecting than the usually used template-based edge detection algorithms such as Laplacian of Gaussian operator and Sobel edge detector, and general morphological edge detection algorithm such as morphological gradient operation and dilation residue edge detector.

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