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SEGMENTATION OF CANCER CELL FROM AN IMAGE

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Abstract

Segmentation of an image is the first step to extracting required details from an image. It is a process of separating an image into unique regions containing each pixel with identical attributes. In this paper, an automatic segmentation algorithm is implemented to detect cancer cells from an image and label them in the original image.

Keywords : Image Segmentation, Thresholding, Edge detection, Computed Tomography

I. Introduction

Detection of the cancer cells from an image such as Computed Tomography (CT) image, Magnetic Resonance Image (MRI), digital mammography, etc. [IX] plays a vital role in medical imaging. To diagonalize the cancer cells in the patients, it is important to know the physical size of the cancer cells.

Human measurements from an image may vary from person to person (depends on the operator who computes the measurements). Various image processing techniques such as thresholding, morphological operations, etc. can be used to detect the cancer cells automatically from the above-mentioned images [VIII]. The first step towards the automatic estimation of the size of cancer cells is the segmentation of cancer cells.

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. Segmentation is accomplished by scanning the image pixel by pixel and then after each pixel is labeled, depending on whether the gray level is greater or less than the threshold value. The image segmentation can be classified into two basic types such as local segmentation and global segmentation [XII]. Most of the segmentation algorithms are based on two basic approaches of segmentation i.e. region-based or edge-based approaches.

An image segmentation algorithms are widely used in medical applications such as the quantification of tissue volumes, diagnosis, localization of pathology, treatment planning, computer-integrated surgery, etc. [VI].

An algorithm has been defined in the MATLAB documentation [I] to detect cells using Edge detection and morphology. In this paper, we extended the above-mentioned algorithm to segment the cancer cell from an image. It is implemented in the MATLAB software [III].

II. Segmentation Techniques

An image is defined as a 2D function $F:(x,y)\rightarrow I$ where x and y is spatial coordinates and the amplitude of I at any pair of coordinates (x,y) is called the intensity of the image at that point.

Thresholding methods are the simplest methods for image segmentation. These methods divide the image pixels concerning their intensity level. There are three types of thresholding methods such as global thresholding, variable thresholding, and multiple thresholding [II]. In this paper, we have used global thresholding which is defined as in the following:

Global thresholding is done by using any appropriate threshold value T. This value T will be constant for the whole image. Based on T the output image $q(x,y)$ can be obtained from the original image $p(x,y)$ as:

$$q(x,y)=\begin{cases}0 & if \quad p(x,y)\leq T\\ 1 & if \quad p(x,y)>T\end{cases}$$

There are various methods available in the literature to find the threshold value such as OTSU [IV], Sobel [IX], etc. In this paper, we use the Sobel operator to compute the threshold value for segmentation.

Sobel Operator:

The Sobel operator is mainly used for edge detection, and it is technically a discrete differential operator used to calculate the approximation of the gradient of the image luminance function [VII]. In other words, it is a typical edge detection operator based on the first derivative.

Morphological dilation makes objects more visible and fills in small holes in objects. The dilation $\delta(X)$ of a set (binary image) X by the structuring element S is defined by

$$\delta(X)=\{x+s|x\in X, s\in S\}$$

Morphological erosion removes islands and small objects so that only substantive objects remain. The erosion $\varepsilon(X)$ of a set X by a structuring element S is defined by

$$\varepsilon(X)=\{x|\forall s\in S, x+s\in X\}$$

III. Method to Segment Cancer Cell Using Edge Detection

Step by step procedure to detect cancer cell from an image is defined as in the following:

Step 1: Convert RGB color image to Grayscale image

Step 2: Contrast the difference between the object to be segmented and the background image is high. Variation in contrast can be identified by operators that compute the gradient of an image. Calculate the gradient image and apply a threshold to create a binary mask containing the segmented cell. The value for the threshold is calculated using the Sobel operator.

Step 3: The above computed binary gradient mask image may have lines of high contrast in the image. These lines do not indicate the exact position of the boundary of the object. There may be gaps in the lines surrounding the object in the gradient image. The morphological dilation with proper structuring elements can be applied to connect the gaps in the gradient image.

Step 4: The gradient mask image after dilation will have a better outline of the cell, still there may be holes in the interior of the cell. The “infill” function in MATLAB may be used to fill these holes.

Step 5: The resulted image will contain segmented cells, also, that there may be noise around the boundary. The “imclearborder” function in MATLAB can be used to remove these noises that are connected to the border of the image.

Step 6: The morphological erosion with a diamond-shaped structuring element is applied to smooth the segmented image.

Step 7: The “label overlay” function in MATLAB is used to visualize the segmented object in the original image.

IV. Results

The aforementioned algorithm is implemented to detect the cancer cell from the image given in Fig. 1. The grayscale image of the input image is shown in Fig. 2. The boundary of the cancer cells with disconnected lines are obtained and displayed in Fig. 3. Fig. 4 is obtained by applying morphological dilation to this image to connect all the disconnected boundaries. Holes filling algorithm is used to fill the holes in the dilated image and the result is shown in Fig. 5. Morphological erosion is carried out to remove noise from the image. Cancer cells are segmented and given in Fig. 6. And these cells are labeled in the original image Fig. 7.

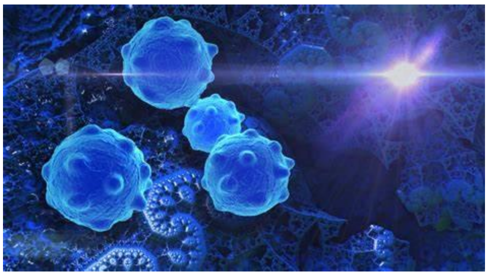

Fig. 1: Image with cancer cell

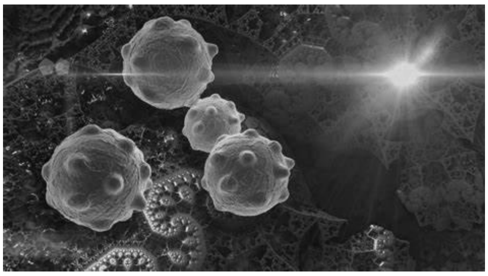

Fig. 2: Grayscale image

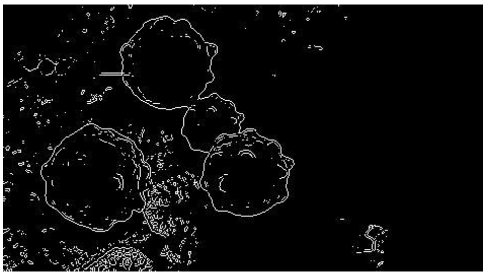

Fig. 3: Binary Gradient Mask

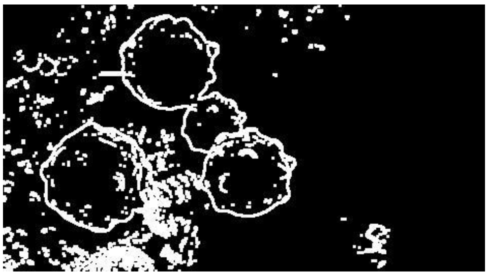

Fig. 4: Dilated Gradient Mask

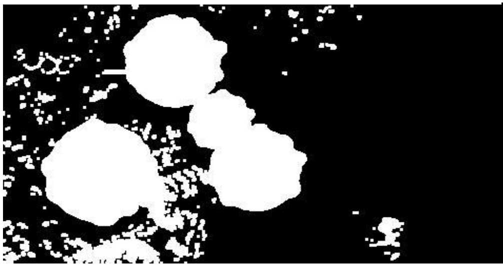

Fig. 5: Binary Image with Filled Holes

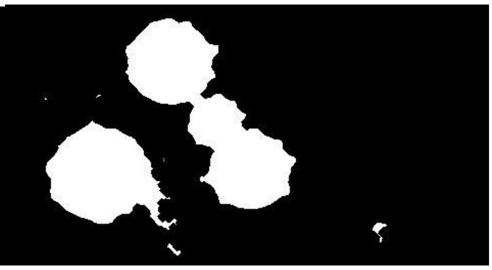

Fig. 6: Segmented image

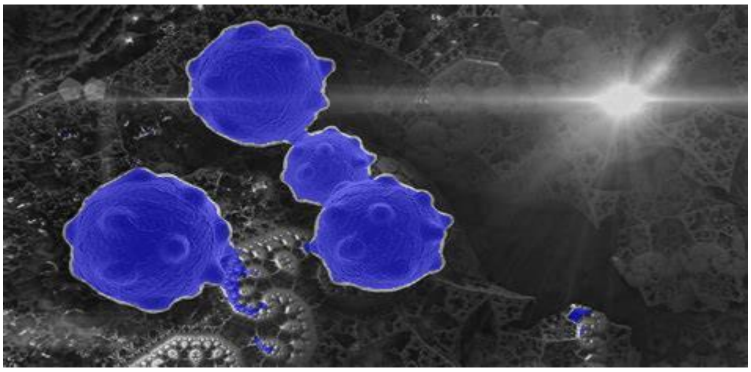

Fig. 7: Segmented cancer cells labl1ed in the original image

V. Conclusion

Various techniques for image segmentation were described. A combination of global thresholding and morphological operations were applied in this paper to segment cancer cells from an image. Finally, segmented cancer cells were marked in the original image. Furthermore, this approach can be applied to segment various objects in medical images such as kidney stones, bones, etc.

Conflict of Interest:

There was no relevant conflict of interest regarding this article.

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