Determining the Size of a Solid Tumor

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Abstract – **Determination of the size of tumors plays an important role in diagnosis and treatments of cancer disease. Two proposed methods for the calculation of total area of tumor are based on pixels of image and the division of tumor into many parts with the same distance in this paper. In comparison, simulation results are shown to determine the accurate area of each method.**

Keywords – **Tumor, Measuring, Size of Tumor, Solid Tumor**

I. INTRODUCTION

Cancer is the second most common reason for worldwide death with over 200 kinds of one just identified. Solid tumors account for 85% of human cancers. Every year billions of dollars from both government and private funding resources is spent on Cancer researches. The most important cancer treatment is surgical removal of such tumors. The key leading to a successful cure often involves the efficient delivery of anticancer drugs to the tumor site after a surgery. The size of tumor in these cases need to be determined.

Tumor size helps doctors or medical staffs determine the stage and the appropriate treatment for the patients with tumors. Moreover, in treatment the tumor size was monitored in clinical trials to evaluate the efficacy of the treatment process and determine the next treatment. So, determination the size of a tumor plays a vital role in diagnosis and treatment of cancer disease. There are many different methods to measure the size of tumor. In this paper, the authors proposed two methods: the first one is the calculation of the total area of tumor based on pixels of image; the second is that the division of tumor into many parts with the same distance is applied.

II. MATERIALS AND METHODS

It is very difficult for doctors to determine the area of a tumor based on the original CT image. Although the accuracy of diagnosis depends partly on the qualifications of a doctor, the diagnosis will be more confident if he observed a carefully processed image. Therefore, we implement the following block diagram shown in the Figure 1. This diagram composes of 5 stages. These stages and the output of each one are shown as follow: (1) Reading the input image: The types of input image being able to read are gif, png, jpg, bmp, tiff, and pgm; (2) Pre-processing: more easily observed image; (3) Edge detection: the edge of image; (4) ROI: the edge of region of interest in Biomedical image; (5) Measuring the size of Tumor: The area of solid Tumor in mm^2.

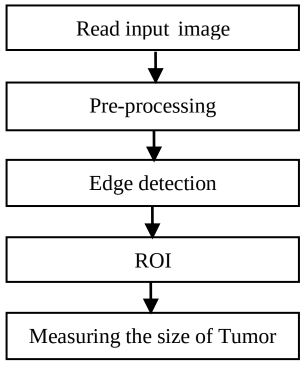
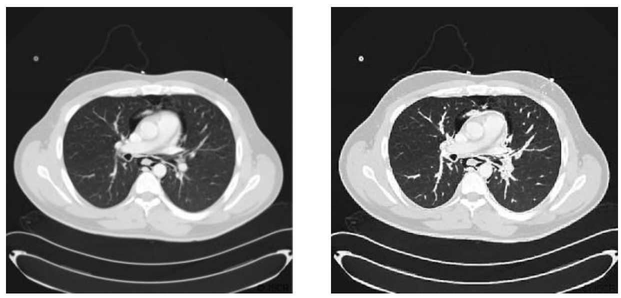


Fig 1. Block diagram of determining the size of Tumor

After being read, the image is then pre-processed from an original image as shown in Fig. 2. At this stage, image will be filtered and enhanced in order to be more evident. The methods of enhancing image include noisy filter, histogram equalization, etc. The result of pre-processing is the better image which helps doctors or physicians determine the location of tumor more accurately.



a) b)

Fig 2. The result of pre-processing image
a) Original image b) Pre-processed image

The second stage is the edge detection using wavelet method. The method used in this step is 2D discrete wavelet transform. The result of this step is the edge of image which is showed in Fig 3.

Fig 3. Detected edge image

Therefore, we determine ROI (region of interest) in the next stage. In this stage, one can directly choose the region on the image by using PC's mouse as shown in figure 4.

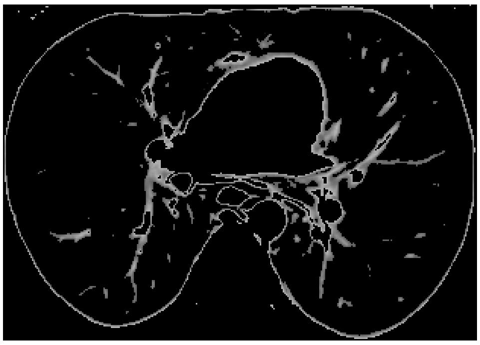


Fig 4. Selected ROI image

The last stage is to measure the size of solid tumor. Depending on the particular image, two methods are proposed to implement this task.

The first one is the employment of the calculation of total area based on pixel of a tumor image, in which the area of the tumor is equal to the sum of all area of pixels inside it. The formula of the tumor *a* is described as follows:

$$S = \sum_{j=1}^{col}\sum_{i=1}^{row} a(i,j) * S_p \qquad (1)$$

where S is the size of the tumor; S_p is the area of one pixel, with i=1,2,…,*row* and j=1,2,…,*col*.

This method has two solutions: (a) checking pixels in all rows and columns; (b) masking directly on tumor image and then counting all pixels of each line.

In the first solution, we check all pixels in rows and columns from the top to the bottom of the image, the left to the right of one and reversely. Whenever checking in row and column, if we detect bit 0, it is considered as the edge of tumor by transforming all bits inside the edge into 1. Therefore, with this ROI, an edge is shown in Fig.5.

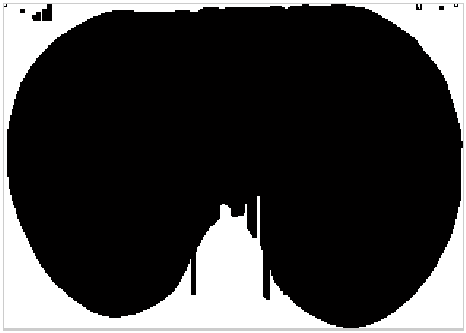
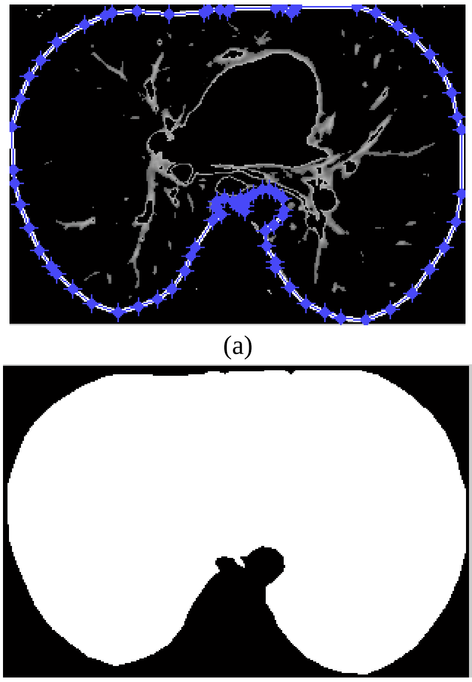


Fig 5. The image after transforming all bits inside the edge into 1

After transforming all pixels in the edge into 1, we can count the area of all 1 pixels in the image with the size of one pixel is $S_p = 0.26 \times 0.35$ (mm^2). Based on the formula (1), one can get the area of the solid tumor.

In the second solution, doctors can directly mask the edge on a tumor image. After masking, all pixels in the masked image will be turned into 0. Therefore, the area of all 0 pixels in the image is calculated. The result is that the area of a solid tumor is obtained as shown in figure 6.



(a)

(b)

Fig 6. Processing before measuring the size of Tumor
a) Masked image
b) The image after transforming all bits inside the edge into 0

The second method is that the tumor is divided into many discrete parts with the same distance. The size of each part is measured and then summed to produce the size of the tumor by using the following formula:

$$S = \sum_{i=1}^{n} S_i = \sum_{i=1}^{n} l_i * d \qquad (2)$$

where n is the number of slices; d is the thickness of a slice; l_i is the length of the i^{th} slice.

After masking on the ROI image, we converse all pixels inside the mask into the value 0. For re-building the edge of a tumor, one can obtain the edge which is shown in figure 7.

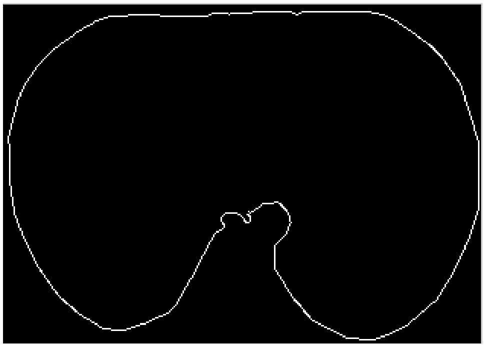


Fig 7. Rebuilt the edge after masking

For dividing the tumor in the vertical, we have many slices with the same distance. The size of tumor is the sum of all areas of slides using formula (2). In addition, one can adjust the width of slides. This parameter affects the size error of a tumor. The smaller is parameter, the higher is the accuracy of calculating the tumor size. However, the processing speed is decreased.

III. Results

This paper provides the block diagram of measurement the size of tumor. The algorithm of its determination is implemented on two methods and the simulation of this algorithm is run on MATLAB. The results of this simulation are the determination the size of a solid tumor, the demonstration of feasibility using the supposed methods and the comparison of each solution using the different methods.

Authors process biomedical images on MATLAB and gain some results. Firstly, the original image will be pre-processed to get the better observation. This task is shown in figure 2. Secondly, the edge of the output image is then detected by using Wavelet transform. ROI is chosen by PC's mouse. The task is demonstrated in Fig 4. Figures 5-7 show the algorithm in three methods. Finally, the numeric results were calculated using two proposed methods as shown in Fig. 8. In that figure, S1 and S2 are the two results of the first method using checking pixels and mask and S3 is the result of the second method using dividing a tumor into many different parts.

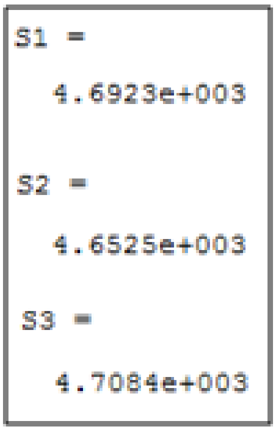


Fig 8. Numeric results of three solutions

IV. Discussion

The comparison between the two methods with three solutions shows that the results of S1 and S3 are nearly the same. The first one is that S1 is more accurate if ROI is independent from both other parts in the image and the shape of the solid tumor. The second one is that S2 using the masking method produces a little bit different result. Because of pixel 0 in ROI, this method is considered as the edge of tumor which is shown in Fig 5. Moreover, the shape of Tumor affects the result of the calculation of its size as shown in Fig 8.

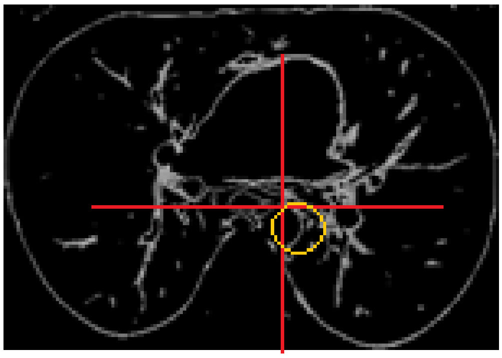


Fig 9. The error of first method

In these three solutions, S2 and S3 can be applied to all shapes. The error depends on the operation of doctors and medical staffs in the second solution. The error of S3 in the third solution depends on the quality of tumor edge and the parameter which is adjusted to change the width of slides. In this paper, the width parameter of slide is chosen to be 1 for calculation.

Based on each specific case, doctors or physicians can choose the method to measure the size of tumor to give the accurate result.

V. CONCLUSION

This paper shows two methods such as the edge detection, the division of an image into parts for calculating the size of a tumor. Many shapes based on the features of image are also determined. The results show that these methods could be used effectively for measuring the size of tumor.

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