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Detection of the Tumor Cell in CT Images

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Abstract

Nowadays, lung cancer has become the common cause of death among people throughout the world. Therefore, an attempt to detect lung cancer at an early stage is required, so that it may increase the chances of survival among cancer patients. Image processing plays a major role in biomedical applications in order to detect many diseases which affects human. It detects the tumor cell in lung Computed Tomography (CT) images which affects the digestive system and the lungs. Image processing made it possible to detect, locate, provides the prestate analysis of cancer and its stages. The algorithm is proposed to identify the tumor cell edge clearly and continuously. To detect tumor we propose quad tree concept and sharpness based method and various filter technique for removing the noise. Quad tree works by splitting an inhomogeneous image into four images until the entire block is considered as high sharp block.

Keywords: Computed Tomography, Tumor Detection, Edge Detection, Connected components, Quad tree, Sharpness.

1. Introduction

Lung cancer is a disease of abnormal cells multiplying and growing into a tumor. The most common cancer that occurs for men and women is lung cancer. The report submitted by the American Cancer Society in 2003 indicates that lung cancer is the cause for about 13% of all cancer diagnoses and 28% for all cancer deaths [1]. The survival rate for lung cancer analyzed in five years is just 15 %. If the disease is identified while it is still localized, this rate increases to 49%. However, only 15% of diagnosed lung cancers are at this early stage. Hence, it becomes necessary to detect the lung nodules in earlier stage using chest Computer Tomography (CT) images. This project proposes a technique to find the tumor cell in lung cancer CT (Computed Tomography) images using quad tree and sharpness based method. The results achieved normally to identify the lung tumor by using several edge detection methods are not up to the required standards. Those conventional methods don't exhibit the continuity and clarity of Lungs tumors. This algorithm is thus proposed to define Lungs edges clearly and continuously. The proposed edge detection algorithm identifies the Lungs tumor and removes the irrelevant edges. The Input image is converted into the gray scale image, then the grayscale image is divided into four equal parts using quad tree concept. Finally we check all the blocks classified as a high sharp block or not, if all the blocks are sharp block we stop the further divide and classified it the image contain tumor else the image is considered as no tumor. The results are compared with other conventional methods such as average filter, median filter, canny, sobel, sharpened image. We used filtering in order to make the image smoother as a preparation for images splitting step. Filtering step helps us to have a clear image from splitting and reduce noise [2].

2. RELATED WORK

Several computer aided diagnosis systems are reported in the literature for lung cancer detection. Disha Sharma et al [3] have used the basic image processing techniques such as Erosion, Median Filter, Dilation, Outlining, and Lung Border Extraction are applied to the CT scan image in order to detect the lung region. Then the segmentation algorithm is applied in order to detect the cancer nodules from the extracted lung image. After segmentation, rule based technique is applied to classify the cancer nodules. Finally, a set of diagnosis rules are generated from the extracted features. Here it works for certain cases with constraints such as tumor size, tumor shape etc but in the proposed method we have considered different shape and size cases also. Penedo et al.[4] put forth a computer-aided diagnosis scheme that depends on two-level artificial neural network (ANN) architecture. The initial artificial neural network performs the identification of suspicious regions in a low-resolution image. The input provided to the second artificial neural network is the curvature peaks calculated for all pixels in each suspicious region. This is to find out from the reality that small tumors possess and identifiable signature in curvature-peak feature space, where curvature is the local curvature of the image data when sighted as a relief map. The outcome of this network is threshold at a particular level of importance to provide a positive identification. pulmonary blood vessel regions are extracted and examine the features of these regions with the help of image processing methods. In the diagnosis stage, diagnosis rules are determined according these features, and identify the tumor regions using these diagnosis rules. M.N. Mughal and W. Ikram in August 2015 [5], is proposed by "Early lung cancer detection by classifying chest CT images: a survey" In this paper investigates computer aided diagnosis (CAD) techniques that allow detection of lung cancer through analysis of chest computed tomography (CT) images. In CAD two main problems have to be solved successfully in order to make the clinical acceptance of CAD systems a reality.. The paper aims at describing the overall structure for such a CAD system along with the review of different techniques, presented in recent years, for analyzing lung

CT images for early detection of cancer. Lin et al.[5] Provided a neural fuzzy model to formulate the diagnosis rules for identifying the pulmonary nodules. Initially, series of image processing methods like thresholding, morphology closing, and labeling to segment the lung area and obtain the region of interest are used. Next, three main features such as circularity, size of area, and mean brightness are obtained from region of interest and the nodules are detected with diagnosis rules that are formed with the help of neural fuzzy model. F. Keissarian in April 2010 [6], is proposed by A New Quad-tree-based Image Compression Technique using Pattern Matching Algorithm In this paper, a new image compression technique is proposed in which variable block size technique is adopted, using quad-tree decomposition, for coding images at low bit rates. The proposed algorithm decomposes the host image into blocks of variable sizes according to histogram analysis of the block residuals. Variable block sizes are then encoded at different rates based on their visual activity levels. To preserve edge integrity, a high-detail block is coded by a set of parameters associated with the pattern appearing inside the block. The use of these parameters at the receiver together with the quad-tree code reduces the cost of reconstruction significantly and exploits the efficiency of the proposed technique. Ada et al.[7] here Firstly, they have used some techniques that are essential to the task of medical image mining, Lung Field Segmentation, Data Processing, Feature Extraction, Classification using neural network and SVMs. The methods used in this paper work states to classify digital X-ray chest films into two categories: normal and abnormal. Different learning experiments were performed on two different data sets, created by means of feature selection and SVMs trained with different parameters.

In summary, it is observed from the literature review that most of the methods or systems use classifier and pixel level features to identify tumor cell. It is true that classifier dependent method requires large number of samples for training and it restrict ability to work on different datasets. In the same way, pixel based methods are sensitive to noise and distortions. Therefore, In this paper, we propose a new method quad tree and sharpness based method. Identifying tumor cells by exploring sharpness features at components level with minimal supervision.

3. PROPOSED METHODOLOGY

In the proposed method we identify the tumor in the CT image. Several image processing techniques are used to find the tumor in an image. The input image is RGB image it is converted into gray image. Based on the quad tree segmentation (region splitting) dividing the gray image into four equal parts ie upper-left, upper-right, lower-left, lower-right, then we apply the average filter and median filter to the four parts respectively. Then we apply the canny and sobel edge detection for resultant average filter and median filter image. Then subtract from median filter by average filter, the resultant image we get sharpened image. Then apply the canny and sobel edge detection for sharpened image[8]. Based on their condition difference image is greater than Median filter image and Median filter is greater than Sharpened image the image classified as high Sharp block, then check there condition difference image is less then Median filter and Median filter is greater than sharpened image then it is classified as low sharp block, then using the above condition, upper left and lower left blocks classified as high sharp blocks other wise low sharp block, then we consider high sharp blocks again divide the high sharp block into four blocks as we did for first level, then check which block is classified has high sharp block and low sharp block, continues the procedure until 64*64 sized block is obtained. If all the blocks classified as high sharp block then we stop and classify it as tumor image else the image is considered as no tumor image. In this procedure our work is identify the tumor in a CT image. The algorithm for the proposed method as follows.

Algorithm:

1. Convert color image in to gray image.
2. Divide the gray image into four equal divisions (Sub-blocks) using quad tree.
   i. Input: Sub-blocks.
   ii. For each sub-block, apply average filter (mean filter which is also called smoothing), say, Avg-F.
   iii. For each sub-block, apply median filter, say Med-F.
   iv. Subtract Avg-F from Med-F, and say, Diff- F.
   v. Apply Canny and Sobel on Diff-F.
   vi. Count the number of edges in Canny and Sobel of Diff-F, N-Canny and N-Sobel.
   vii. Get N-Canny and N-Sobel for all four blocks.

3. In the same way, subtract diff block by average block. This gives sharp block. Then get N-Canny and N-Sobel for sharp block.

Let be Avg-Block and Med_Block the mean and median filter outputs.

4. If (Diff-Block = Med-Block - Avg-Block) or
   (Sharp_Block = Avg-Block - Diff_Block)

5. Find canny and sobel for Diff, median filter block, sharp block. Then count number of edge components. (with this information, we derive rule to divide further or leave block).

6. If (Diff-F > Median-F) and (Median-F > Sharp-F) then it should be classified as high sharp block.
Otherwise If (Diff-F < Median-F) and (Median-F > Sharp-F) then it should be classified as low sharp block.
Using this information, Upper Left and Lower Left blocks classified as high sharp blocks, other two blocks classified as low sharp block.

7. Next, consider high sharp blocks then divide further into four blocks as we did for first level (Step 2 to 6). Check which block is classified as high sharp block and low sharp blocks. Continue until 64 X 64 sized blocks.

8. If all the blocks classified as high sharp block then we stop and classify it as tumor image else the image is considered as no tumor image.

3.1. Classification of Lung Components

For each input gray image, the method obtains canny edge and sobel edge image as shown in figure 2(a) and (b) the edges separates each object from the other. Sobel operator help us to find the edges in an image; it does so by finding the image gradient. Image gradient is the change in the intensity of the image. The intensity of the image will be of maximum value where there is a separation of two regions. The image gradient will be greater where the intensity value is very large. Sobel operator uses this greatest value to find edges in an image. Sobel operator uses two 3X3 kernels and filters the image to estimate the value of each pixel by convolving with the original image [9]. Sharpening is one of the most impressive transformations, the canny edge detector is susceptible to noise present in raw unprocessed image data [10]

(a) Canny image (b) Sobel image (c) Sharpened image

Figure 1 Classification of lung components

In the proposed method we use the new concept quad tree, a quad tree is a tree data structure in which each internal node as exactly four children. Quad trees are most often used to partition a two-dimensional space by recursively subdividing it into four quadrants or regions. The regions may be square or rectangular, or may have arbitrary shape. The data structure was named a quad tree by Raphael Finkel and J, L. Bentley in 1974. A similar partition in is also known as a Q-tree. All forms of Quad trees share some common features:

- They decompose space into adaptable cells
- Each cell (or bucket) has a maximum capacity. When maximum capacity is reached, the bucket splits
- The tree directory follows the spatial decomposition of the quad tree.

The region quad tree represents a partition of space in two dimensions by decomposing the region into four equal quadrants, sub quadrants and so on with each leaf node containing data corresponding to a specific sub region. Each node in the tree either has exactly four children, or has no children (a leaf node). The region quad tree is a type of tree. A region quad tree with a depth of n may be used to represent an image consisting of $2^n * 2^n$ pixels, where each pixel value 0 or 1. The root node represents the entire image region. If the pixel in any region is not entirely 0s or 1s, it is subdivided. In this application, each leaf node represents a block of pixels that are all 1s. Region quad trees may also be used as a variable resolution representation of a data field. For example, the temperatures in an area may be stored as quad tree, with each leaf node storing the average temperature over the sub region it represents. If a region quad tree is used to represent a set of point data (such as the latitude and longitude of a set of cities), region are subdivided until each leaf contains at most a single point [11].

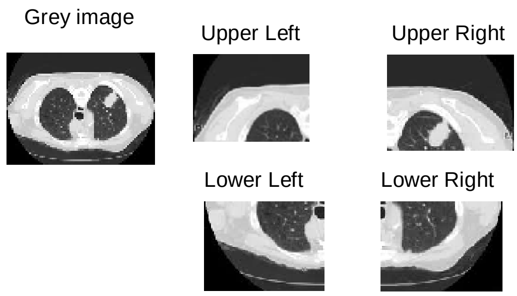


Figure 2 Illustrating the quad tree concept

3.3. Illustrating the quad tree to identifying the tumor

In this proposed method based on the quad tree and edge component of sharpened, we are going to declare weather the tumor is present or not. After applying the quad tree, which is divides the input image as four equal parts. The process is continuous until all the blocks are high sharp figure 3.

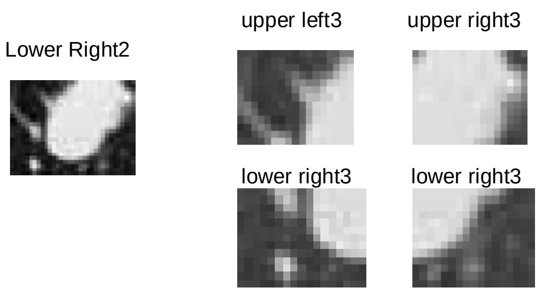


Figure 3 Illustrating the quad tree in which all blocks called high sharp.

Based on quad tree and apply the filter such as average, and median filter and find the number of connected compound of respected filter. Then find out difference (DiffF) = MedF-AvgF. Sharpened=DiffF-AvgF and also find connected compound for difference and sharpened image. According to high sharp value we can decide which block contain tumor. Then again we apply the quad tree for high sharp block until all the blocks contain sharp block.

4. EXPERIMENTAL RESULTS

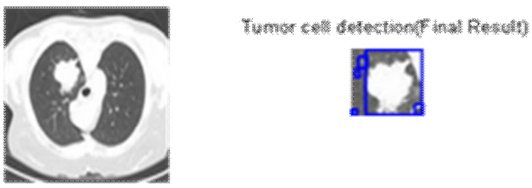
We have experimented on 50 different CT images containg tumor cells. The method consists of two major steps that are classfication of lung components and identification of tumor cell in the lung components. We evalute both the steps using detection rate for the segmetnation of lung components from the given input image and classification rate for the identificaiton of tumor cells in the lung components.

4.1. Experiments on Detection of Lung Components

The proposed method is tested on 50 CT images to evaluate the method in terms of detection of tumor cell. The method successfully detects 40 CT image tumor cell out of 50 CT image and hence it gives 80% detection rate. This result is promising and encouraging. The main reason to get good detction rate is used by number of edge component of sharpend image [12] .

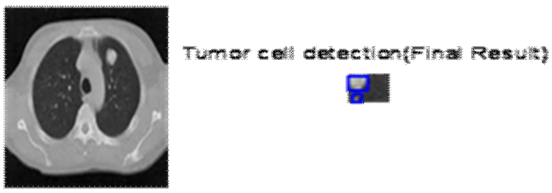
4.2. Experiments on Identification of Tumor Cell

Sample qualitative results of the proposed method for tumor cell identification are shown in figures 4 and 5 where we test our method on diversified images. In order to maintain diversity in the dataset used we consider different CT scan views such as axial view, coronal view. The results obtained for the axial CT scan view image, coronal CT scan view image and the CT scan view image in which only the infected lung portion is present are shown in figure 4 and 5, respectively. From the figures 4 and 5, it is observed that the proposed method identify tumor cell successfully for the images of different background and contrast. Therefore, we can assert that the proposed method is promising and it helps for identifying tumor cell [13].



(a). Input image (b) Tumor cell detection

Figure 4 Experiment result of CT image in axial



(a). Input image (b)Tumor cell detection

Figure 5 Detection of tumor cell

4.3. Comparative Study

In order to show that the proposed method is effective and superior to existing method, we implement the method proposed by Sharma and Jindal [3]. This method uses several image processing operations such as noise removal, filtering and connected component analysis based features. In addition, the method proposes lots of heuristics based on geometrical features of edge components to identify tumor cell. However, the method largely depends on preprocessing steps to achieve good accuracy of 0.58%. The method proposed by Basavanna M et.al [14] explores topological properties of edge components to detect lung components and then proposed new sharpness measure to identify tumor cell instead of framing different heuristics as in the existing method to achieve detection rate of 0.70%. While our method employs new method by applying quad tree and sharpness measure with good classification rate to find the tumor cell with good accuracy rate of 0.80%.

TABLE 1: COMPARATIVE STUDY OF THE PROPOSED AND EXISTING METHODS

Methods	Classification rate in (%)
Proposed method	**0.80**
Basavanna et.al[14]	0.70
Sharma and Jindal [3]	0.58

5. CONCLUSIONS AND FUTURE WORK

In this paper, we present a new method for identificaiton of tumor cell in the lung components. We propose a new idea of quad tree for detecting tumor component in lung components. Then we propose a new sharpness mesure to identify the tumor cell which has genrally more brightness than the other components in the detected lung components. Experimental results on varieties of images show that the proposed method is better than existing methods and it identifies tumor cell of different situations. We are planing to evalute the method on large dataset and identify levels of cancer based on tumor cell size.

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