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Lung Segmentation and Nodule Detection based on CT Images using Image Processing Method

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Abstract - *Lung nodule detection and segmentation is important for clinical diagnosis. Standard Computer Aided Diagnosis (CAD) systems for Lung cancer detection should employ four steps: preprocessing, lungs segmentation, nodule detection and reduction of False Positives (FP). This paper proposes a lung nodule detection and segmentation method based on a region growing method, circle fit algorithm and other image processing techniques. In the proposed approach during the preprocessing step, several masks are calculated using thresholding technique and morphological operations, eliminating this way, background and surrounding tissue. Following, Regions of Interest (ROI) are calculated using a priori information and Hounsfield Units (HU). During feature extraction, numerous features are calculated in order to restrict the suspicious zones. Finally, Artificial Neural Network (ANN) algorithm is employed in classification stage.*

***Key Words*: CAD; CT Image.; Lung Nodule; ANN**

1. INTRODUCTION

Lung cancer is common due to smoking and it is mainly caused by uncontrollable irregular growth of cells in lung tissue. If it is detected earlier, then it is better is the chance of curing. For lung cancer detection, one of the most important and fundamental step is screening. Screening is the process used for identification of nodule. A nodule is a white color spot present on lungs that is visible on an X-ray or Computed Tomography (CT) scans images. A nodule may be of two types: Either a benign or a mass. A nodule that is 3 cm or less in diameter is called a Pulmonary or Benign nodule. These types of nodule are noncancerous. Pulmonary nodules are the characterization of early stage of lung cancer. Another type of nodule whose size is larger than 3 cm is in diameter is called as a lung mass. This type of nodule is likely to be cancerous and needs to be detected as early as possible. These nodules need to be followed over time to check if they are growing. The larger the nodule more is its possibility of being cancer. Thus, a nodule needs to be under observation. Most of the nodules which are noncancerous have a very smooth or round margin.

The survival rate of lung cancer is very low when compared with all other types of cancer. The need for identifying lung cancer at an early stage is very essential and is an active research area in the field of medical image processing.

2. RELATED WORK

Madhura J et al [ICIMIA] [2017] [1]: Author has described the different types of noise in medical imaging and explained the different techniques for the removal of noise. Detection of a nodule is fundamental problem in medical image processing. According to Kostis, W.J., Reeves, A.P., Yankelevitz, D.F. [2], there 4 types of nodules. (i). Well-circumscribed: In this case, the nodules are not connected to vasculature but are at the core of the lung tissue. (ii). Juxta - vascular: In this case, the nodules are at the centre of the lung field and are connected to the surrounding lung vessels. (iii). Pleural Tail: These types of nodule are connected by a thin structure and are located near the pleural surface. (iv). Juxta-pleural: Here a thin structure is connected by the substantial portion of the nodule. Qing Wu and Wenbing Zhao (ISCSIC) [2017] [3] : Author has proposed a novel neural-network based algorithm, which they refer as entropy degradation method (EDM), to detect small celllung cancer (SCLC) from computed tomography (CT) images for early cancer prediction. Rachid Sammouda (KACST) [2016] [4] :Author has developed an automatic CAD system for early detection of lung cancer for that purpose they analyzed lung human CT images using several phases & the approach starts by extracting the lung regions from the CT image using classical image processing techniques, including bit-planes representation of raw 3D-CT images producing 2D slices. They have applied various procedures, Erosion, Median filter, Dilation, Outlining, Lung Border Extraction and Flood Fill algorithm, in sequence.

However, due to the number of patients increasing day by day it is the workload of radiologists who need to analyze the tests in a short time is also increasing. Due to this, the radiologists may misinterpret causing errors in detection. Therefore, CAD systems that can detect nodules efficiently and effectively within a short duration of time is needed [5]. The two main CAD systems used byradiologists to assist them, they are: CADe– These systems are used only to detect a tumor. CADx– Theses are used to check the characteristics of a tumor. Nanusha [6] proposed an approach is quantitative surface characterization of pulmonary nodules based on thin section CT images. In this approach describes segmentation of the three-dimensional (3D) nodule images are obtained by a 3D deformable surfaces approach.

3. PROPOSED METHOD

The proposed system consist of three modules such as pre-processing the CT chest image, segmentation of lung region, extraction of lung nodule candidates and classification of nodules. This can be shown in Figure 1.

3.1 Pre-processing

The pre-processing is done before the main data is processed. The main objective of pre-processing is to improve the quality of the image that may be corrupted due to noise during data acquisition. To separate the background noise, it is required to pre-process the images. It is mainly to enhance the quality of data through the application of methods for denoising. [9]. Some of the important techniques used for data pre-processing are Median Filtering [4][5], Histogram Equalization [5], Fast Fourier Transform [6]

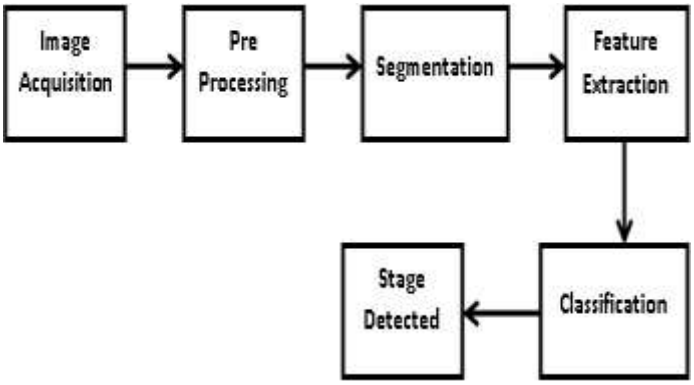

Fig-1: Flow Diagram of lung nodule detection

3.2 Segmentation of lungs

Image segmentation is process of partitioning a digital image into multiple segments. So the goal of segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to analyse. Region based segmentation is used to find region of interest (ROI) and segmented for further processing [4]. Region based methods have the purpose of grouping pixels having similar intensities. Region based segmentation follows this basic procedure as follows:

i) For region-based lung segmentation, the "seeded" scheme is commonly applied. In such cases, small patch (seed) that is considered to be most representative of the target region (lung) is first identified.

ii) Seed points are the coordinates of a representative set of points belonging to the target organ to be segmented, and they can be selected either manually or automatically.

iii) Once the seed points are identified, a predefined neighbourhood criterion is used to extract the desired region. Different methods, features are used for determining the lung boundaries. For instance, one of possible criterion could be to grow the region until the lung edge is detected.

3.3 Extract Nodules

Before extracting desired nodules, image enhancement pre-processing is done again. Some of the important techniques used for data pre-processing are image background, gray Thresholding for binarization and image boundary connected objects are cleared.

Then desired nodule with area greater than minimum area and less than maximum area is segmented.

Using circle fit algorithm with maximum radius a nodule is detected with desired area.

3.4 Classification and Detection

Nodule detection is the most important step in the detection of lung cancer. After the nodule detection, the next step is the classification of the nodule as benign or malignant. Most of the pulmonary nodules are benign but may represent an early stage of lung cancer. If a malignant nodule is detected at an early stage the survival rate of the diseased may increase. Nodule classification involves assigning pathology to the detected and isolated nodules. This is the ultimate goal of computerized nodule detection for early detection of doubtful nodules.

4. EXPERIMENTAL RESULTS

First image is selected then lung is extracted

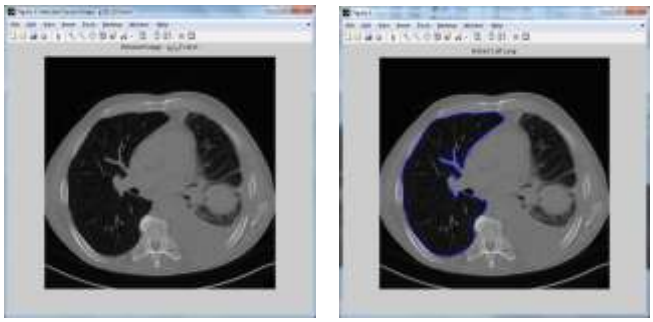

Fig-1: Select Image

Extracted lung Region is obtained using region growing method. Then applying lung mask proper lung is extracted.

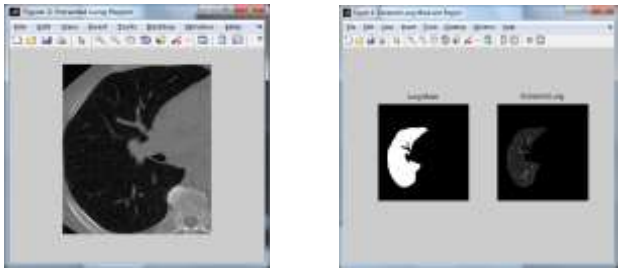

Fig-2: Extracted Lung Mask and Region

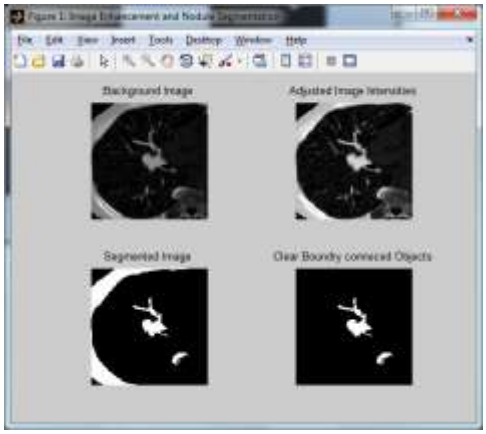

Fig-3: Image Enhancement and Nodule Segmentation

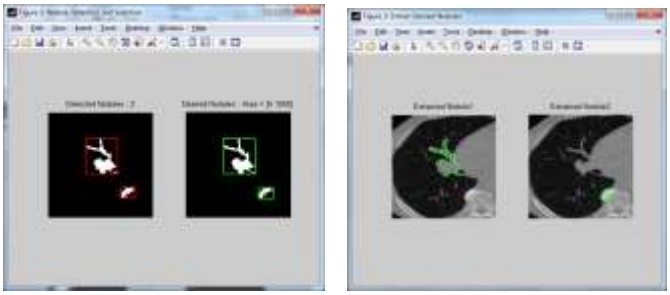

Fig-4: Nodule Detection and Selection and Extract Desired Nodule

Table -1: Sample Data

Nodule #	Radius	Mean Intensity	Area	Euler Number	ECD
# 1	5.4	940.8	482	1	24.8
# 2	2.8	1530.9	106	1	11.6

5. CONCLUSION

Lung cancer is one of the most harmful diseases in the world. There is a need of proper diagnosis and early stage detection of lung cancer which will increase the survival rate of the patient. Computer Aided Diagnosis (CAD) involving Image Processing techniques for nodule detection helps in the diagnosis of cancer. In this paper, region growing algorithms is implemented to segment lung and circle fit algorithm to detect nodules in lungs from a CT Scan image of Lungs. It can obtain accurate and effective result of pulmonary nodule detection based on CT images.

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