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Research paper on Nodule Detection in Lung Image using Image Processing

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Abstract: Cancer is a group of diseases begins in cells that are the basic building blocks of a body. There are different types of cancers but all starts with the cells growing out of control. The type and stage of cancer can be determined by determining where the abnormal growth occurs in the body and the type of cells that start to grow abnormally. The type of cancers often found in adults is endometrial cancer, skin cancer, lung cancer, ovarian cancer and breast cancer. Of these cancers the most common type of cancer is the Lung cancer. This type of cancer is common due to smoking. The earlier it is detected; the better is the chance of curing. This review examines and summarizes various techniques and algorithms used for lung cancer detection.

Index Terms: ,Endometrial cancer, Lung cancer, Skin cancer, Ovarian cancer.

I. INTRODUCTION

According to the estimated statistics released by American Cancer Society in the United States for May 2016 about 1 out of 4 cancer deaths are from lung cancer. Among both men and women lung cancer by far is the leading cause of cancer deaths. There are two major types of lung cancer: small cell lung cancer and non-small cell lung cancer. Out of this non-small cell lung cancer is very often found.

For lung cancer detection one of the most important and fundamental steps 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) scan images. Lung nodules will appear in X-ray or CT scan image if and only if its diameter is at-least 1 cm. 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 nodules are non-cancerous. Another type of nodule whose size is larger than 3 cm in diameter is called as a lung mass. This type of nodule is more likely to be cancerous and needs to be detected as early as possible.

II. RELATED WORK

Detection of nodule is one of the fundamental problems but is a very important step in medical image processing, In Parinaz Eskandarian, Jamshid Bagherzadeh [1], a nodule detection system based on support vector machine is implemented. The main objective of this research was to reduce the error rate. Errors may be the image of cancer nodule detection System which may recognizes a cancerous image as a normal image (false negative) or a healthy image as a cancerous image (false positives).

In [2] Imran Fareed Nizami, Saad Ul Hasan and Ibrahim Tariq Javed presented a new technique for Segmentation of lung region from CT scan. They employed Wavelet Packet Frame (WPF) technique to acquire spatial frequency representations and applied k-Means clustering for better segmentation of lung tissues. This proved the technique to be robust and is able to efficiently segment lung regions from multiple images from various scans. In [3] Hao Han, Lihong Li, proposed a new Computer Aided Design for easy, fast and accurate detection of pulmonary nodules in CT scans. Based on their previous work on self-adaptive VQ for image segmentation [4], they developed a hierarchical high level VQ scheme to detect INC's. With high level VQ it becomes possible to change the thresholding scheme that is used to extract lungs with lower processing time and higher accuracy. The SVM classifier results show that gradient features Hessian, geometric, and intensity performed best against any other group. The forward feature selection strategy indicates that the SVM classifiers performed best in "Gradient + Intensity" feature space instead of any other feature combinations.

According to [5] Awai et al. researched that the detection rate of lung cancer is 2.5 to 10 times greater using CT than by using previous analog radiographies. 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, a CAD systems that can detect nodules efficiently and effectively within a short duration of time is needed. The two main CAD systems used by radiologists to assist them, they are:

CADe- These systems are used only to detect a tumors. CADx- These are used to check the characteristics of tumor.

Earlier these systems were separate but now a day these systems are combined to a single system and are called as a Computer - Aided Detection and Diagnosis (CAD).

In [12] to obtain more accurate results Mokhled S. Altarawneh divided the research work into three categories: Image Enhancement, Segmentation and Feature Extraction. Image Enhancement is used to increase the quality of image by reducing any noise present in the image. Image enhancement can be done using any one of the following methods: Auto enhancement algorithm, Gabor filter or Fast Fourier Transform (FFT). Out of these three methods Gabor filter shows the best results while the FFT shows the worst results. Image Segmentation is used to divide or segment the enhanced images. The images are segmented to find the Region of interest (ROI). The algorithms used for image segmentation would be Thresholding approach or Marker-Controlled Watershed Segmentation approach. Finally features are extracted from the image using Binarization or Masking approach.s

BariqiAbdillah, AlhadiBustamam, and DevviSarwindaet.al [2016] analyzed and implemented an image processing method for detection of lung cancer. To support the early medical treatment Image processing techniques are widely used in the detection phase. In this research image segmentation based method is proposed for lung cancer treatment. After detecting, an image is passed through the following steps: Image enhancement, Image segmentation and features extraction. Image segmentation is an intermediate stage in image processing. Region growing approach and Marker control watershed are used for CT scan image segmentation. From experimental results researchers found that the best approach for main features detection is watershed with masking method which has high accuracy and robust.

III. THEORY OF TECHNIQUES

A. COMPUTED TOMOGRAPHY(CT) SCAN

Computed Tomography (CT) scan is a technique in which a 3 cross-sectional view of an image is derived by capturing several two dimensional x-ray images of an object. A CT scan continuously transmits a narrow width beam through the body that gives more detailed information than the standard X-ray. The advantage of CT scan over conventional x-ray is it is able to distinguish tissues inside the organ. [2]

B. Low-dose Computerized Tomography (ldct)

An LDCT scan looks for abnormalities in the lungs that could be a cancer or may turn into it. A conventional CT scan is more sensitive than LDCT but still LDCT is preferred over CT because of its ability to continuously acquire data, less scanning time and lower radiation exposure dose. In LDCT a 3-dimensional image of the lungs is taken and nodules with size as small as that of a grain of rice can be detected. As LDCT scans are very much sensitive they always show nodules that may not be cancer. 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.

C. Margin Of Nodule

The margin of nodule means the area or boundary or edge where the nodule is in contact with the normal lung tissue. The margins of many cancerous nodules are uneven and look spiky and are generally termed as speculated. Most of the nodules which are non-cancerous have a very smooth or round margin.

D. Lung Image Database Consortium (Lidc)/Image Database Resource Initiative (Idri)

The Lung Image Database Consortium (LIDC) or Image Database Resource Initiative (IDRI) is the name given to a Data Base Management System (DBMS) by National Cancer Institute (NCI) that is available publically for the medical imaging research community for image processing or CAD based algorithms.

E. 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 image that may be corrupted due to noise during data acquisition. Some of the important techniques used for data pre-processing are Median Filtering [07], Histogram Equalization [07], Fast Fourier Transform [08], Wavelet Transform [08], and Noise Correction [09].

F. Segmentation

Segmentation is a method used to separate out part of an image. Here, the segmentation is carried out to extract only the part of lungs from the CT scan image. Some of the important techniques used for image segmentation are Thresholding, Clustering, Compression based method, Histogram-based method, Edge detection, Region growing and Graphical Partitioning method.

G. Nodule Detection

Nodule detection is the most important step in detection of lung cancer. Nodule detection includes its identification and its location in the lung field. The success of this process greatly depends on the previous stages. 4 types of nodules given by Kostis, W.J., Reeves, A.P., Yankelevitz, D.F., et al. in [10] are,

- 1) *Well-Circumscribed*: In this case the nodules are not connected to vasculature but are at the core of the lung tissue.
- 2) *Juxta - vascular*: In this case the nodules are at the centre of the lung field and are connected to the surrounding lung vessels.
- 3) *Pleural Tail*: These types of nodule are connected by a thin structure and are located near the pleural surface.
- 4) *Juxta-pleural*: Here a thin structure is connected by the substantial portion of the nodule.

Out of these four types of nodules juxta-plural and juxta-vascular nodules are very much difficult to detect and may cause false results. [11].

H. False Positive Reduction

In machine designing after the machine is designed it is tested based on the confusion matrix parameters. The confusion matrix parameters include the following parameters:

- 1) True Positive: Result is positive and True.
- 2) True Negative: Result is negative and True.
- 3) False Positive: Result is positive but False.
- 4) False Negative: Result is negative but False.

Here, all the four parameters are important but the most important out of these in our case is the False Positive reduction. The commonly used methods for false positive reduction of nodules include Neural Networks, Support Vector Machines (SVM), Linear Discriminant Analysis (LDA), and Selective enhancement filtering.

I. Nodule Classification

After the nodule is detected the next step is to classify the nodule as benign or malignant. The nodules are classified based on their morphological features like Shape and size, appearance and growth rate. Most of the pulmonary nodules are benign but may represent an early stage of lung cancer. If a malignant nodule is detected in an early stage the survival rate of the diseased may increase.

IV. CONCLUSION

Recent progress into the nodule detection in the lung cancer has been achieved using modern technologies. Earlier detection and precision of such events are necessary for the early diagnosis and therapy and in this study such methods are discussed.

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