RESEARCH ARTICLE

DETECTION AND SEGMENTATION OF PULMONARY NODULES IN LUNG IMAGES

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ABSTRACT

Lung cancer is one of the deadliest and fastest growing diseases in India. Common causes of lung cancer include smoking, asbestos, radon gas, genetics and air pollution. Lung cancer is curable if detected in early stages. This research proposes a novel method for the detection of lung cancer in early stages. Results show that the proposed system efficiently classifies the MRI images into normal, moderate and severe.

Key words: Lung cancer, smoking, asbestos, radon gas, genetics MRI.

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INTRODUCTION

Human body is a complex and wondrous living machine. Like any machine our body is also composed of many smaller parts that work together. All the organs and other body parts like our skin and muscles are made of smaller living units known as cells. Our lung is a very good example of how many cells worked together to perform a specialized task. Cells in the lungs work together to allow the human body to take oxygen from the air and get rid of waste products such as carbon-di-oxide. Our lungs are composed of many millions of cells working together to accomplish this task. Cancer is a word given to a group of diseases involving abnormal growth. They can potentially spread and frighten in our tissues. A group of misbehaving cells can cause the same kinds of problems in the body that a defective part would cause in the other type of machine. A normal cell would divide only when it receives a chemical signal telling it to do so. Cancerous cells do not follow this principle and divide themselves even if they do not receive appropriate signals. This can lead to the formation of massive cells that piles up and may form a tumor. Also different from normal cells is the ability of cancer cells to continue dividing indefinitely. An important point about cells is no matter what their job is in the body they all have same general structure. Cells that made up our lungs, heart or brain are all similar in appearance even though their jobs are quite different. Just as the organs as they formed are made of smaller structures, cells themselves are composed of smaller parts that help them to perform their job. These smaller structure are called organels. A particular importance in cancer is the organel known as nucleus.

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Related Work

A computer-aided system for detection of pulmonary nodules is proposed by ParinazEskandarian and Jamshid Bagherzadeh *et al.* [2014]. This system classifies pulmonary nodules in CT scans using Support Vector Machine (SVM) classifier. In this technique, first the volume of data is reduced by data using mining techniques. Then by dividing the area of chest suspicious nodules are identified and detected. As compared to the threshold-based methods SVM classifiers are more accurate. By combining threshold with SVM false positive rate is reduced. From the results it can be seen that the proposed system obtained sensitivity of 89.9% and 3.9 per scan of false positive rate. For effective lung segmentation Imran Fareed Nizami, SaadUl Hasan, Ibrahim Tariq Javedet.al [2014] proposed a wavelet packet frames based approach. The algorithm proposed in this research selects a collection of wavelet packet frames that is the optimal wavelet representation. To obtain the segmented lung region using k-means clustering these frames were used for clustering of coefficients. The proposed algorithm was tested on the dataset of 5 local patients containing 350 CT scan images and as low as 1.34±0.451segmentation of lung is acquired. Furthermore, this technique can segment the lugs into multiple parts without changing the parameters and is fully automated. A novel CADe system based on a hierarchical vector quantization (VQ) scheme has been proposed by Hao Han, Lihong Li, Fangfang Han and Bowen Song *et al.* [2013]. The high-level VQ yields a more accurate segmentation of the lungs if compared with the commonly-used thresholding approaches. Compared to existing approaches low-level VQ proves to be effective for INCs segmentation and detection. It is also computationally efficient compared to existing approaches. Rule-based filtering operations in conjunction with SVM feature-based classifier is used for False-positive (FP) reduction. The proposed system

was tested using data available on LIDC (Lung Image Database Consortium). A Total of 205 patients cases were taken with each case having at least one juxta-pleural nodule annotation. Experimental results demonstrated that an overall sensitivity of 82.7% at a specificity of 4 FPs/scan is obtained using the proposed CADe system. Also 89.2% sensitivity at 4.14 FPs/scan is obtained specifically for juxta-pleural nodules. If compared to available CADe systems the proposed system outperformed and demonstrated its potential for adaptive and fast detection of pulmonary nodules via CT imaging.

Theory of Techniques

A. Computed Tomography (CT) scan: Chest CT is a special X-ray with or without injection of contrast material to evaluate the abnormalities of the chest. CT may be used to help diagnose the cause of unexplained cause, shortness of breath, chest pain or fever. It is also used to evaluate various lung disorders because chest CT is able to detect small lung nodules. It is very effective for identifying potential lung cancer at its early stage when it is most curable.

B. Low-dose Computerized Tomography (LDCT): Low dose CT scan for screening is best suited for patients between the ages of 55 to 74, who are smokers or who quit within the last 15 years and have the equivalent of 30/ pack year history of smoking i.e. one pack per day for about 30 years. LDCT is also used for people not experiencing symptoms of lung cancer or who are 50 years older and have 20/ pack year history.

C.Lung Nodule: A lung nodule is a single well-circumscribed radiographic opacity that measures up to 3 cm in diameter and is surrounded by aerated lung. A lung nodule could represent lung cancer. If not then who cares. But, the whole goal of finding the nodule is to see can we prevent the development of module into a lung cancer.
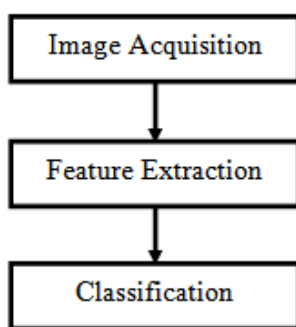
MATERIALS AND METHODS

Fig. 1. A high level flowchart of proposed algorithm

To test our system the CT scan images of 52 patients were taken from the Lung Image Database Consortium (LIDB). These CT scan images are first passed through the pre-processing stage to remove any noise present in the image and to improve its quality. Some of common techniques used for pre-processing the image are Wavelet Transform [08], Noise Correction [09], Fast Fourier Transform [08], Median Filtering [07] and Histogram Equalization [07]. After pre-processing the next step is segmentation. Segmentation process divides the image into various required parts. Segmentation is used to separate out the area of lungs from the CT scan image.

Fig. 2. CT scan Image

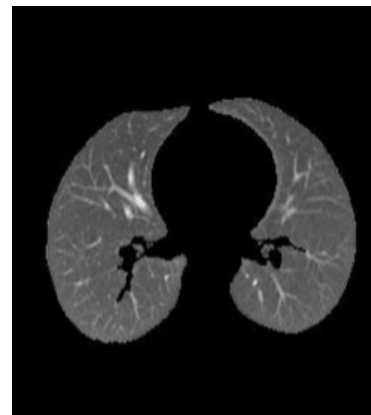**Fig. 3. Enhanced Image after Pre-Processing**

Fig. 4. Extracted Lung Image

Some common techniques used for segmentation are Edge detection, Thresholding; Compression based method, Clustering, Histogram-based method, Graphical Partitioning method and Region growing. After segmentation the next and most important step is nodule detection. Nodule detection involves two important things i.e. its identification and location. Success of this stage is purely dependent on previous stages. Fourtypes of nodules given by Kostis, Reeves, Yankelevitz, et al. in [10] are

- Well-circumscribed
- Juxta - vascular
- Pleural Tail
- Juxta-pleural

Out of these nodules that are listed above Juxta-vascular and Juxta-plural nodules are difficult to detect and may cause fault results. After the detection of nodule the next important step is

its classification. A nodule can be classified into two categories as benign or malignant. Classification of nodule is done based on its morphological features like shape, appearance, growth rate and size. Here in this research we have used SVM classifier to classify the nodules. The SVM classifier classifies data based on the clustering. For clustering K-means clustering is used in this research. Figure below shows the flow used for K-means clustering.
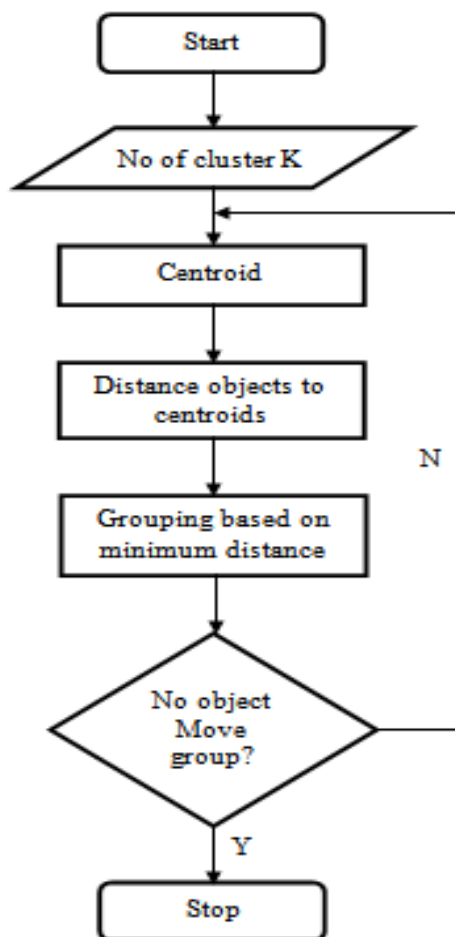
Fig. 5. K-means clustering flow

After machine designing an important concept is the false positive reduction. Some important methods for false positive reduction of nodules include Support Vector Machines (SVM), Neural Networks, Selective enhancement filtering and Linear Discriminant Analysis (LDA).

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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