

Automated CAD for Lung Nodule Detection using CT Scan

Shilpa Gundagi¹

¹Asst Professor, Department of Electronics & Communication, SMSMPITR,
Akluj-413118, Maharashtra, India
ssgundagi@gmail.com

Abstract: *To evaluate the performance of the CAD system for automatic pulmonary nodule detect in lungs by using CT scan images. The problem can be summarized as to detect lung nodule in CT-Scan images using combined text feature and supervised learning. Detection of cancerous cells or classification of nodules are the most important factor, to be identified by the radiologist or cancer specialist, as this forms the preliminary state for proper diagnosis of the disease. Hence our work describes on automated computer aided technique for detecting lung nodule on CT scan images.*

Keywords: CAD, CT scan, pulmonary parenchyma

1. Introduction

The lung cancer is the second most commonly diagnosed cancer and the lung is a most frequent site of metastasis from other cancers that manifest as pulmonary nodules. The CT is the most sensitive diagnostic imaging modality for the detection of lung cancer and the resolution of any equivocal abnormalities detected on chest radiographs. Recently, CT techniques have been applied to be promising for detection of early lung cancers in high-risk populations and have been shown to be promising for detection of early lung cancers. Thin-section three-dimensional CT of the thorax may allow us to evaluate small lung nodules automatically at early stages. With sequential follow up CT scans, early changes in nodule size and number can be assessed. The main characteristics to diagnose malignant nodules are their growth over time. Algorithms are already being developed to do temporal comparisons on follow up studies. All the detected nodules would be automatically assessed to see if they have increased in volume and at what rate? This feature probably will greatly enhance the diagnostic value of CAD systems in CT screening for early lung cancer. CAD software is useful to supplement radiologists' detection performance. However, at present, it is not adequate as a standalone procedure. Furthermore, all suspected lesions detected by CAD must be increased by radiologists to rule out false-positives. In the future, temporal comparison should further improve the usefulness of CAD in the early detection of lung cancer. Pulmonary nodules are a frequent incidental finding in CT, but their prevalence in the general population is not known precisely. With the improvement in resolution and broad availability of multi-detector CT, an increasing number of small pulmonary nodules are being detected. Although many of these small pulmonary nodules are being (i.e. hamartoma, granuloma), nodules frequently remain undetermined. In fact, only fully calcified and fat-containing nodules can be considered being lesions.

Related work

A computer assisted automatic diagnosis system for lung cancer that detects tumor candidates at an early stage from

helical CT images. This mechanization of the process decreases the time complexity and increases the diagnosis confidence. The proposed algorithm consists of an analysis part and a diagnosis part. In the analysis part, this paper extracts the lung and pulmonary blood vessel regions and analyzes the features of these regions using image processing techniques [1]. , the CAD system is equipped with functions to automatically detect suspicious regions from chest CT images, and to assist the comparative reading in retrospect. The main purpose of the CAD system are a slice matching algorithm for comparison of each slice image of the present and past CT scans, and an interface to display some features of the suspicious regions. The experimental results show that this CAD system can work effectively [2]. To produce a successful Computer Aided Diagnosis system, several problems has to be resolved. Segmentation is the first problem to be considered which helps in generation of candidate region for detecting cancer nodules. The second problem is identification of affected nodules from all the candidate nodules. Initially, the basic image processing techniques such as, Median Filter, de noising, is 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 [3].

2. CT Scan

CT scanning sometimes called CAT (Computer Axial Tomography) scanning is a noninvasive medical test that helps physicians diagnose and treat medical conditions. CT scanning combines special x-ray equipment with sophisticated computers to produce multiple images or pictures of the body. These cross-sectional images of the area being studied can then be examined on a computer monitor, printed or transferred to a CD.

Using a variety of techniques, including adjusting the radiation dose based on patient size and new software technology, the amount of radiation needed to perform a chest CT scan can be significantly reduced. A low-dose chest CT produces images of sufficient image quality to detect many lung diseases and abnormalities using up to 65

percent less ionizing radiation than a conventional chest CT scan. This is especially true for detecting of lung cancer.

3. Principal Of Computed Tomography

CT is a powerful nondestructive evaluation (NDE) technique for producing 2-D and 3-D cross-sectional images of an object from flat X-ray images. Characteristics of the internal structure of an object such as dimensions, shape, internal defects, and density are readily available from CT images. Shown below is a schematic of a CT system.

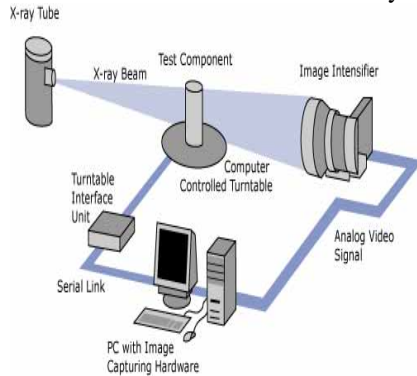


Figure 1: Principle of CT machine

The test component is placed on a turntable stage that is between a radiation source and an imaging system. The turntable and the imaging system are connected to a computer so that x-ray images collected can be correlated to the position of the test component. The imaging system produces a 2-dimensional shadowgraph image of the specimen just like a film radiograph. Specialized computer software makes it possible to produce cross-sectional images of the test component as if it was being sliced. CT scan is a medical technology that uses X-rays and computers to produce three-dimensional images of the human body. Unlike traditional X-rays, which highlight dense body parts, such as bones, CT provides detailed views of the body's soft tissues, including blood vessels, muscle tissue, and organs, such as the lungs. While conventional X-rays provide flat two-dimensional images, CT images depict a cross-section of the body.

4. Computer Aided Detection

CAD software is useful to supplement radiologists' detection performance. However, at present, it is not adequate as a stand-alone procedure. Furthermore, all suspected lesions detected by CAD must be interpreted by radiologists to rule out false-positives. In the future, temporal comparison should further improve the usefulness of CAD in the early detection of lung cancer.

4.1 Main objective of CAD

- 1 Improve the quality of diagnosis.
- 2 Increase therapy success by early detection of Cancer.
- 3 Avoid unnecessary biopsies.

1. Improving the quality of diagnosis

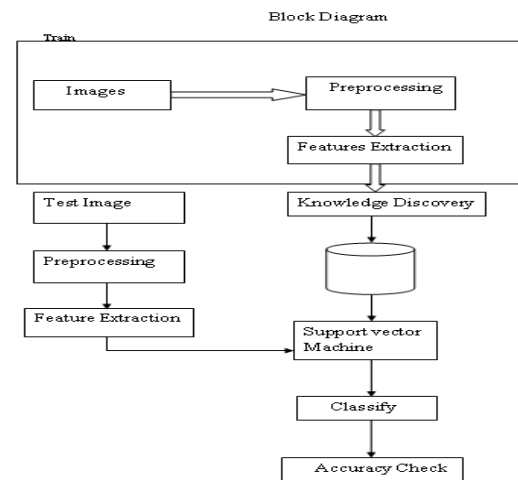
The quality of diagnosis can be improved by Detecting and marking suspicious lesions, CAD can help to avoid potential nodules being overlooked by the radiologist.

2. Increasing therapy success by early detection of Cancer

Down staging the typical stage at which a Cancer is detected will provide earlier diagnosis, it is hoped that this will increase the survival rates.

3. Avoiding unnecessary biopsies

Computation of growth rates and doubling times of lung nodules between follow-up examinations will allow many of the detected nodules to be evaluated non-invasively, thus avoiding the risks associated with invasive procedures such as needle biopsies.



5. Extraction of Pulmonary Parenchyma

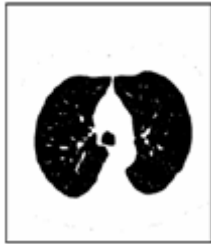
The extraction methodology of the pulmonary parenchyma can be regulated by removing the background as an initial step (i.e., the pixels with the same grey level as the lungs but located outside the chest) from the image to avoid confusion. This is intended, due to the high similarity between the grey levels of the lungs and the image background, which cannot be simply applied by using a Segmentation (preprocessing) technique instead an ad-hoc operator is used which, starting from the four corners of the image, moves along the four directions identifying as background pixels, those pixels whose grey level is within a pre-fixed range. Figure 8.2 show an original image from CT before removing the background.

When a pixel value is found outside the range (out pixel), then it analyses for few more pixels in the scan direction, if any such of the pixels have values within the range then both these pixels and the out pixel are marked as background pixels and the scan goes on to be continued. If not, the scan is interrupted along the direction under examination and the successive row or the particular column is analyzed in a similar way. These images produced by the operator are converted to binary images by means of some specific technique, like segmentation, thresholding technique that uses either a static or a dynamic

on the lung zone the slice that belongs to the zone in the lungs.



Figure: Image before background removal



5.1 Nodule detection

The Lung nodule detection is a very difficult step in every CAD system development. Actually, In CT lung images, nodules are frequently attached to blood vessels or to the pleura and also the grey tone is so similar to vessel sections that traditional intensity based methods are inappropriate. Instead, an effective nodule detection algorithm must take both grey level and the object shape into account. In our CAD system we adopt a method that uses 3D shape information to identify spherical regions with a given level. Following the approach described. The idea is to distinguish spherical from cylindrical (typically blood vessels) shapes analyzing a shape index (SI), defined terms of 3D characteristics, extracted from sets of voxels with grey level in the range of the nodule intensity.

Various CAD systems have been proposed for the detection of pulmonary nodules on CT images. The majority of CAD systems were developed and evaluated on single-detector row CT images with 5-10 mm section thickness, while more recent systems were assessed with thin section single or multi-detector row CT images. The sensitivity for detecting nodules with reported CAD systems varied from 38% to 100% and the false – positive detections per case ranged from 1 to 75. The performance of CAD systems appears to be highly associated with the section thickness (or reconstruction interval) and seems to be better on thin-section than on thick section CT images.

6. Calculation & Feature Extraction

After the segmentation is performed on lung region, the features can be obtained from it and the diagnosis rule can be designed to exactly detect the cancer nodules in the lungs.

1. Energy: The motivation for using the term ‘energy’ is that typical object detection segmentation tasks are posed as energy is that typical object detection segmentation tasks are posed as an energy minimization problem. Resulting of this is a solution for the image segmentation.

Energy = $\sum_i \sum_j pd^2(i, j)$ it is minimum Value of Square of the matrix

2. Entropy: Entropy returns E, a scalar value representing the entropy of grayscale image (I). Entropy is a statistical measure of randomness that can be used to characterize the texture of the input image. Entropy is defined as

$$\text{Entropy} = - \sum_i \sum_j pd^2(i, j) \text{Log Pd}(i, j)$$

Entropy converts logical to histogram count calculation so that the pixel values are discrete and directly correspond to a bin value

3. Contrast: The contrast feature yields a measure of the difference moment of co-occurrence matrix. It is a measure of the amount of local variation present in the image for uniform images. The value of contrast is zero, which is the minimum value for the contrast. As the variations in the image increase, the value of contrast also increases.

$$\text{Contrast} = \sum_i \sum_j (i, j)^2 pd(i, j)$$

4. Inverse different Moment = $\sum_i \sum_j \frac{pd(i, j)}{|i - j|^2}, i \neq j$

$$\text{5. Mean} = \frac{\sum_i \sum_j p(i, j)}{MXN}$$

Less than the maximum of co-occurrence matrix

6. Std. deviation = $\sum_i \sum_j m - p(i, j)^2$ should be less than half of mean

Where (i, j) → are number of occurrence in a pair of gray level

D → Distance part from original image

P → Matrix of the Image.

MXN → Order of matrix

7. Dissimilarities; - Entropy & energy in between these values

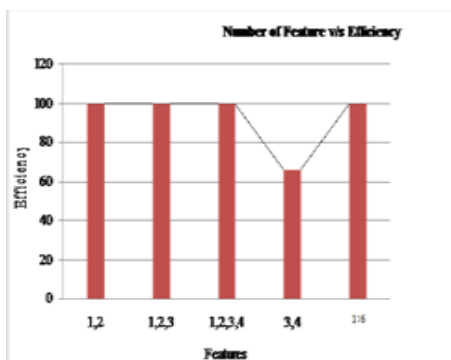
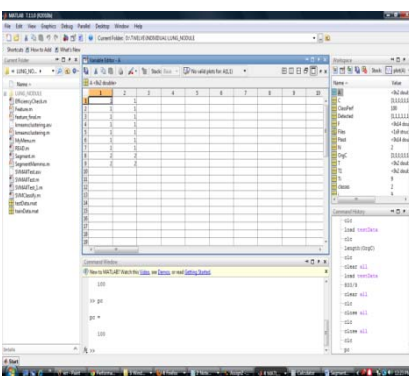
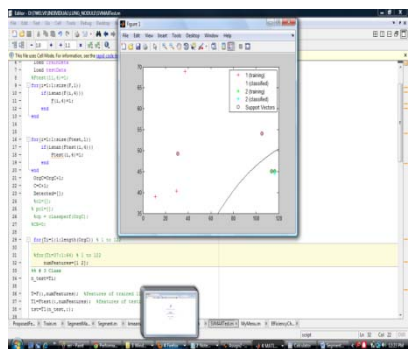
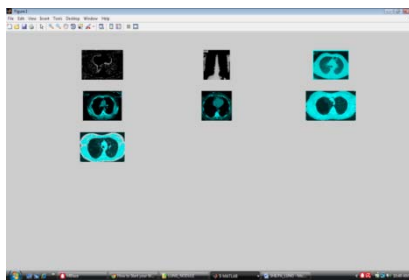
8. Homogenty: - The value of homogenty should be in between mean and entropy.

9. Correlation: This measure analyzes the linear dependency of gray levels of neighboring pixels. Typical this measure is high, when the scale of local texture is larger than the distance, the correlation feature is a measure of gray tone linear dependencies in the image.

If a pixel size is standard then efficiency is. When distance d=1

320x320 → 93 %
 160x160 → 80.25%
 128x128 → 78.24%
 These above values are standard value.

7. Result



8. Implementation

In this section deals with an implementation of the project, here we extract the features from original using CT scanning and feature can extract by using GLCM technique, wavelet due to this we can detect lung cancer nodule.

9. Conclusion

They are several Techniques for compute aided lung nodule diagnosis. There basically characterized ether supervise classification or unsupervised classification with different feature say like morphological features test feature, The classification tech are supported by proper segmentation to remove form the image data, in this project we have proposed technique for lung nodule detection by using support vector machine. In the grey level to remove noise from image data due to combine feature of wavelet & gray level co-occurrence matrix the efficiency rate is as high as 93%. This project describes a CAD system for automated detection of pulmonary parenchyma, and nodule detection for lung cancer. This project presents and discusses the results of the method applied to CT examinations performed in a screening program for early detection of lung cancer. The results achieved by applying the system to a database, which is the information collected from a real time environment of hospital, of CT scans for digital images have been judged definitely well by experienced chest radiologists. In Particular, as regards nodule detection, all malignant nodules were detected and very low false-positive detection rate was achieved. Lung Nodule Detection in CT scans is an active area of research which is continuously emerging and there are many enhancements that can be included to make more efficient.

References

1. Kanazawa. K, Kubo. M and Niki. N, “Computer aided diagnosis system for lung cancer based on helical CT images”, Vol. 1973, (pp. 610-621). (Proceedings of the 13th International Conference on Pattern Recognition).
2. Yamamoto. T, Ukai. Y, Kubo. M, Niki. N, Satou. H and Eguchi. K, “Computer aided diagnosis system with functions to assist comparative reading for lung cancer based on helical CT image”, (Proceeding of the 2000 International Conference on image processing).
3. “A Computer Aided Diagnosis System For Detection Of Lungcancer Nodules Using Extreme Learning Machine”, M.Gomathi, Dr.P.Thangaraj, (International Journal of Engineering Science and Technology) Vol. 2, 2010, 5770-5779
4. A CAD system for nodule detection in low-dose lung CTs based on region growing and a new active contour model R. Bellotti Dipartimento di Fisica, Università di Bari; Sezione INFN di Bari, Italy and Center of Innovative Technologies for Signal Detection and Processing (TIRES), Bari, Italy
5. Support Vector Machines for Candidate Nodules Classification Paola Campadelli, Elena Casiraghi and Giorgio Valentini DSI - Dipartimento di Science Dell’Informazione University’s degli StudydiMilano, Italy.
6. M.J.R. Dalrymple-Hay, N.E. Drury, “Screening for lung cancer”, Journal of the Royal Society of Medicine, vol. 94, January 2001, pp. 2-5.
7. S. Hu, E.A. Hoffman, J.M. Reinhardt, “Automatic lung segmentation for accurate quantitation of volumetric x-ray CT images”, IEEE Trans. Medical Imaging, vol. 20, n. 6, June 2001, pp. 490-498.