Review of Existing Techniques of Lung Nodule Cancer Detection and Existing Algorithms That Can Be Used for Efficient Detection in Future

Nidhi, Shilpa Mehta

***Abstract:** The paper studies the various methods of lung nodule cancer detection their advantage and disadvantage. The paper further aims at suggesting existing methods which can be used in detection of lung nodules of very small size accurately. The suggested methods have higher level of accuracy than existing methods thus if incorporated in detection for nodule can generate higher level of accuracy.*

***Keywords:** CAD, HRCT, rotation invariance, CT, FCM, LBP and LBPV*

I. INTRODUCTION TO LUNG CANCER

Lung cancer is a disease characterized by uncontrolled cell growth in tissues of the lung. If left untreated, this growth can spread beyond the lungs, eventually, into other parts of the body [1]. Surgery, radiation therapy, and chemotherapy are used in the treatment of lung carcinoma. In spite of that, the five-year survival rate for all stages combined is only 14% [2].The paper aims to study existing methods to detect the malignant nodules at earliest as well as suggest improvements so as to take appropriate measures to protect the patients from cancer at most initial stages.

I. Existing methods with their advantages and Disadvantages

1. Automatic segmentation and recognition of lungs and lesion from CT scans of thorax"

1) For the segmentation part, they have extracted texture features by Gabor filtering the images, and, then combined these features to segment the target volume by using Fuzzy C Means (FCM) clustering. Since clustering is sensitive to initialization of cluster prototypes, optimal initialization of the cluster prototypes was done by using a Genetic Algorithm.
2) For the recognition stage, they have used cortex like mechanism for extracting statistical features in addition to shape-based features.
3) Results reveal an accuracy of delineation to be 94.06%, 94.32% and 89.04% for left lung, right lung and lesion, respectively. Average sensitivity of the SVM classifier was seen to be 89.48% [3].

2. "Knowledge-based method for segmentation and analysis of lung boundaries in chest X-ray-images"

1) Image edges are matched to an anatomical model of the lung boundary using parametric features. Modular system architecture was developed which incorporates the model, image processing routines, an inference engine and a blackboard.
2) In preliminary testing on 14 images for a set of 18 detectable abnormalities, the system showed a sensitivity of 88% and a specificity of 95% when compared with assessment by an experienced radiologist [4].

3. "A Novel Automatic Extraction Method of Lung Texture Tree from HRCT Images"

Firstly, proposed an improved implicit active contour model driven by local binary fitting energy and the parameters are dynamic and modulated by image gradient information. Secondly, a new technique of painting background based on intensity nonlinear mapping is brought forward to remove the influence of background during the evolution of single level set function. At last, a number of contrast experiments are performed, and the results of 3D surface reconstruction show the method is efficient and powerful for the segmentation of fine lung tree texture structures [5].

4. "*Performance testing of several classifiers for differentiating obstructive lung diseases based on texture analysis at high-resolution computerized tomography (HRCT)*"

Machine classifiers have been used to automate quantitative analysis and avoid intra–inter-reader variability in previous studies. The selection of an appropriate classification scheme is important for improving performance based on the characteristics of the data set. This paper investigated the performance of several machine classifiers for differentiating obstructive lung diseases using texture analysis on various ROI (region of interest) sizes. The SVM had the best performance in overall accuracy (in ROI size of 32×32 and 64×64) (t-test, $p < 0.05$). There was no significant overall accuracy difference between Bayesian and ANN (t-test, $p < 0.05$). The naïve Bayesian method performed significantly worse than the other classifiers (t-test, $p < 0.05$). SVM showed the best performance for classification of the obstructive lung diseases in this study [6].

5. "Computer-aided Diagnosis of Pulmonary Infections Using Texture Analysis and Support Vector Machine Classification Rationale and Objectives"

The purpose of this study was to develop and test a computer-assisted detection method for the identification and measurement of pulmonary abnormalities on chest computed tomography (CT) imaging in cases of infection, such as novel H1N1 influenza. The method developed could be a potentially useful tool for classifying and quantifying pulmonary infectious disease on CT imaging

Materials and Methods: Forty chest CT examinations were studied using texture analysis and support vector machine classification to differentiate normal from abnormal lung regions on CT imaging,

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Nidhi, Department of Computer Science, National Institute of Technology, Kurukshetra,India
Shilpa Mehta, Department of Computer Science and Technology, JMIT, Radaur,India.

including 10 patients with immune histochemistry-proven infection, 10 normal controls, and 20 patients with fibrosis. Results: Statistically significant differences in the receiver-operating characteristic curves for detecting abnormal regions in H1N1 infection were obtained between normal lung and regions of fibrosis, with significant differences in texture features of different infections. These differences **fissure segmentation on CT"**.This paper describes a new approach for segmenting the major fissures in both lungs on thin-section computed tomography (CT). An image transformation called "ridge map" is proposed for enhancing the appearance of fissures on CT. A curve-growing process, modeled by a Bayesian network, is described that is influenced by both the features of the ridge map and prior knowledge of the shape of the fissure. The process is implemented in an adaptive regularization framework that balances these influences and reflects the causal dependencies in the Bayesian network using an entropy measure. The method was applied to segment and visualize the lobes of the lungs on chest CT of 10 patients with pulmonary nodules. Only 78 out of 3286 left or right lung regions with fissures (2.4%) required manual correction. The method has a linear-time worst-case complexity and segments the upper lung from the lower lung on a standard computer in less than 5 min [7].

6. "The effects of co-occurrence matrix based texture parameters on the classification of solitary pulmonary nodules imaged on computed tomography "

In this project, patients with a solitary pulmonary nodule were imaged using high resolution computed tomography. Quantitative measures of texture were extracted from these images using co-occurrence matrices. These matrices were formed with different combinations of gray level quantization, distance between pixels and angles. The derived measures were input to a linear discriminant classifier to predict the classification (benign or malignant) of each nodule. Using a relative quantization scheme with eight levels, four features yielded an area under the ROC curve (A_z) of 0.992; 93.8% (30/32) of cases were correctly classified when training and testing on the same cases; while 90.6% (29/32) were correctly classified when jackknifing was used [8].

7. "Computationally efficient CAD system for pulmonary nodule detection in CT imagery"

The CAD system uses a fully automated lung segmentation algorithm to define the boundaries of the lung regions. It combines intensity thresholding with morphological processing to detect and segment nodule candidates simultaneously. A set of 245 features is computed for each segmented nodule candidate. A sequential forward selection process is used to determine the optimum subset of features for two distinct classifiers, a Fisher Linear Discriminant (FLD) classifier and a quadratic classifier. A performance comparison between the two classifiers is presented, and based on this, the FLD classifier is selected for the CAD system. The proposed front-end detector / segmentor is able to detect 92.8% of all the nodules in the LIDC/testing dataset (based on merged ground truth). Overall, with a specificity of 80.4% of the nodules (115/143) using 40 selected features. A 7-fold cross-validation performance analysis using the LIDC database only shows CAD sensitivity of 82.66% [9].

II. PROPOSED METHODS

1. Scale and rotation invariant feature using DFT method

In this method, [10] the purpose of scale and rotation invariant texture feature is to enable segmentation through the classification process to different groups into a single class. The process for generating approximately scale and rotation invariant texture features suitable for segmentation is based on computing the magnitude of coefficients from the DFT. This feature combines the technique for generating rotation invariant texture features together with the approach for producing scale invariant texture features.

2. Scale and rotation invariant feature, non-DFT method

1) Rather, an identifying feature characteristic is extracted at each pixel location and used as a scale and rotation invariant texture feature.
2) Feature extraction model for rotation or scale and rotation invariant texture features generated from the magnitude of the DFT over wavelet coefficients caused the texture feature to shift in scale dimension while a change in orientation caused the texture feature to shift in rotation dimension. [11,12]

3. "Multiresolution Gray-Scale and Rotation Invariant Texture Classification with Local Binary Patterns"

This paper presents a theoretically very simple, yet efficient, multi-resolution approach to gray-scale and rotation invariant texture classification based on local binary patterns and nonparametric discrimination of sample and prototype distributions. The method is based on recognizing that certain local binary patterns, termed uniform, are fundamental properties of local image texture and their occurrence histogram is proven to be a very powerful texture feature. We derive a generalized gray-scale and rotation invariant operator presentation that allows for detecting the uniform patterns for any quantization of the angular space and for any spatial resolution and presents a method for combining multiple operators for multi-resolution analysis

4. Rotation invariant texture classification using LBP variance (LBPV) with global matching

1) This paper proposes an alternative hybrid scheme, globally rotation invariant matching with locally variant LBP texture features. Using LBP distribution, paper first estimate the principal orientations of the texture image and then use them to align LBP histograms. The aligned histograms are then in turn used to measure the dissimilarity between images.
2) A new texture descriptor, LBP variance (LBPV), is proposed to characterize the local contrast information into the one-dimensional LBP histogram. LBPV does not need any quantization and it is totally training-free. To further speed up the proposed matching scheme, this method reduces feature dimensions using distance measurement. The experimental results on representative databases show that the proposed LBPV operator and global matching scheme can achieve significant improvement, sometimes more than 10% in terms of classification accuracy, over traditional locally rotation invariant LBP method [13].

5. "Unsupervised texture segmentation"

1) A method based on comparison of feature distributions, is used to find homogeneously textured image regions and to localize boundaries between regions. Texture information is measured with a method based on local binary patterns and contrast (LBP/C). A region-based algorithm is developed for coarse image segmentation and a pixel-wise classification scheme for improving the localization of region boundaries. The method performed very well in experiments. It is not sensitive to the selection of parameter values, does not require any prior knowledge about the number of textures or regions in the image, and seems to provide significantly better results than existing unsupervised texture segmentation approaches. The method can be easily generalized, e.g. to utilize other texture features, multi-scale information, color features, and combinations of multiple features [14].

2) Segmentation algorithm consists of three phases:

1. Hierarchical splitting
2. Agglomerative merging
3. pixel wise classification

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III. CONCLUSION

The above proposed concepts if incorporated in detection of lung nodule cancer will bring the specificity and sensitivity to nearly 96% as the features will be easily detectable after incorporating above concepts. The change of basic structure of image however will not affect accuracy of nodule in any way because of only change in representation structure is suggested. Thus this will improve the efficiency of methods without affecting the accuracy.

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