ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

THE DETECTION OF PULMONARY NODULES IN CT IMAGES USING HEURISTIC APPROACH SEGMENTATION AND CLASSIFICATION

Sonali Singh and I. Mary Sajin Sanju
Department of Electronics and Communication, Sathyabama University, Chennai, India
E-Mail: sonalisingh893@gmail.com

ABSTRACT

Lung cancer in human body is proving to be a catastrophic threat to the mankind or humanity and is prime cause of deaths among other cancer related fatalities. The presence of solitary/isolated pulmonary nodules in human lungs in the form of benign or malignant calculates the gravity of lung ailment or disorder. In our project we are using a literature method for lung nodule detection, segmentation and classification/taxonomy using computed tomography (CT) images. One of the most common noise in CT imaging is an impulse noise which is caused by unstable voltage. In this paper, a new decision based technique called new adaptive median filter is presented which shows better performance than those already being used. The CT slices are initially preprocessed to remove the Gaussian noise by using Gaussian filter. Otsu thresholding is applied to extract the region of Interest (ROI). We have the different classifications about the nodules in the lung. It contains the different method of classification, segmentation and detection techniques. Malignant (virulent) cell presented in the lungs specified nodules are classified for the therapy processes. Now, we will classify the images into nodules and non-nodules. We will now take out the object's feature vectors in choosen /selected boxes. Lastly, the support vector machine (SVM) is applied which will classify the extracted feature vectors. The SVM will classify the images into normal or abnormal based on the second order gray level co-occurance matrix features.

Keywords: pulmonary nodules, heuristic approach, classification.

1. INTRODUCTION

The lungs of the human body are surrounded by two serous (watery) membranes, the parietal pleural membrane and the visceral pleural membrane. The parietal pleura are the outer membrane that is attached to the wall of the thoracic cavity/space and the visceral pleura is the inmost layer of the membrane that covers the outer surface of the lungs. The pleural cavity means to the space inbetween the parietal and visceral pleura. A small amount of fluid is secreted to maintain lubrication between these two pleural membranes. When there is excessive accumulation of the fluid in the pleural cavity, it results in a pleural complication called as pleural effusion. Pneumothorax is a disorder in which there is accumulation of air in the pleural space which can result in the collapsing of lung if the amount of air increases. The presence of pleural effusion or pneumothorax in the pleural cavity causes compression of lungs. This in turn results in lesser amount of oxygen entering the lungs. Pleural effusion occurs in 20%–25% of patients affected by Tuberculosis or TB and may be present on the same side where the TB is located. [6].

The lung parenchyma is porous and spongy in nature, consisting of minute or tiny air sacs called alveoli which help in the gaseous exchange. The pleural fluid accumulates at the lower portions of the lungs as the density of the pleural fluid is greater than the density of the lung parenchyma. The pleural fluid or effusion takes the shape of the lungs and the pleural cavity. When the air in the pleural cavity is less dense in contrast to the lung parenchyma, the pneumothorax area (region) will also take the lung shape and the lung cavity and will commonly occupy the apical regions of the lungs. The grayscale value of air corresponds to values close to zero or black and that of water or fluid is close to 128 [5 Hence the entire pleural effusion area in the CT image has a grayscale value near to 128. Similarly the entire pneumothorax area in the CT image has the same grayscale value as air, which is close to zero (black). Most of the segmentation schemes or plan in the literature have centred on the extraction of the lung parenchyma, so an approach is proposed for the segmentation and removal of pleural effusion and pneumothorax, both of which are present in the pleural area outside the lung parenchyma [1] Computed Tomography (CT) is recurrently used to evaluate and identify the pleural ill effects that may not be observable and may also be less detailed on supine chest radiographs. Computer aided diagnosis (CAD) aids to give a second opinion to radiologists while making a decision. The segmentation subsystem has to detach the lung regions. The region of interest (ROI) has to be detachted next. The ROIs are the diseased regions. The question is that, in the case of pleural effusion, the fluid accumulates at the bottom of the lung, while pneumothorax is commonly found only at the top areas of the lung. Proper extraction of the ROIs decides the correctness of the CAD system. The segmentation and ROI extraction (withdrawl) schemes in this work are useful in improving and elaborating the diagnostic corectness of the CAD system. [1] In our paper, we are using knowledge-based, fully automatic method for identifying lung regions in digital CT lung image/slice has been described. The procedure used an object-oriented knowledge model to suitabley integrate the anatomical knowledge and image processing routines in lung detection [13]. Lung cancer differs considerably in size, density, and shape, and can attach to surrounding anatomic formation such as chest wall. Automatic segmentation of the lesions poses a dare (challenge). This work communicates a new 2-dimensional algorithm for the segmentation of a wide

ARPN Journal of Engineering and Applied Sciences

variety of lung cancer, ranging from tumours which are found in patients with advanced lung cancer to small nodules recognised in lung cancer screening programs.

2. BLOCK DIAGRAM

The proposed block diagram of our project is given below:

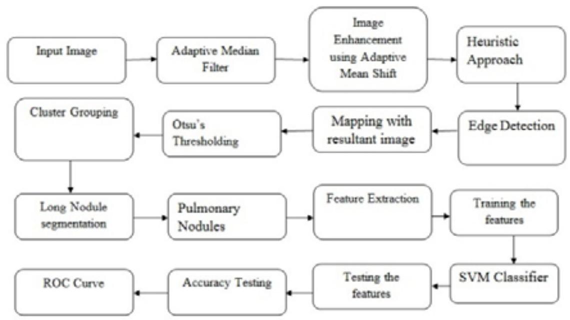


Figure-1. Block diagram of proposed system.

3. IMPLEMENTATION

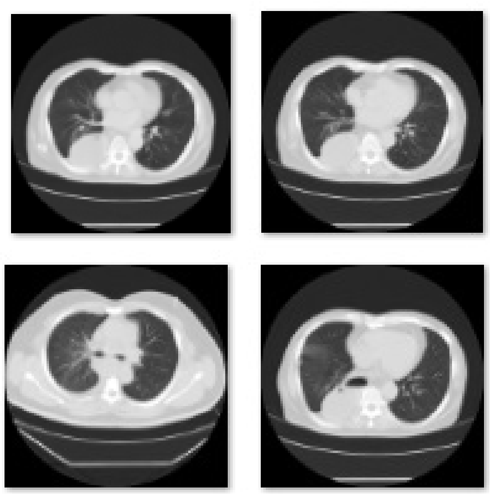


Figure-2. Input images.

A. New adaptive median filter

The CT image contains impulse noise of voltage of the CT image scanners. This noise can be eliminated using New Adaptive Median Filter. The Hybrid Median filtering is similar to an averaging filter, in which each and every output pixel is set to an average of the pixel values in the environs of the corresponding input pixel. Nevertheless, in the median filtering, the value of an output pixel is estimated by the median of the environ pixels, instead of the average. The median is very far less delicate than the mean to the outliers which are the extreme values. New Adaptive Median filtering is therefore able to maintain the sharpness of the image or slice and are able to separate these outliers.

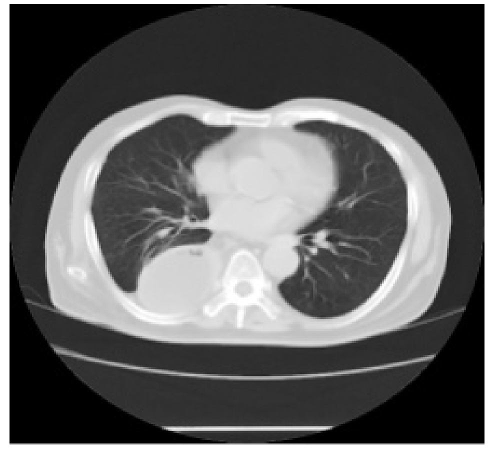


Figure-3. Filtered image.

B. Image enhancement using mean adjustment

In Image enhancement, the histogram is cut at some threshold and then equalization is applied. Contrast Image enhancement with mean adjustment is an adaptive contrast histogram equalization procedure, where the contrast of an image is enhanced by applying the algorithm on small data regions called tiles rather than the entire image. The resulting neighbouring tiles are then stitched back seamlessly by making use of bilinear interpolation. The variance in the homogeneous region can be restricted so that noise amplification can be avoided [12]. The orthogonal transformation which is used by PCA which transforms a group of outputs of the possibly connected variables into the group of linearly unconnected variables which is called as the principal component. PCA is the simplest of the faithful eigen vector-based multiple variable investigation .In order to ultimately explain the variance of the data, the operation should be ass revealing the intramural structure of the data. The PCA can be difined mathematically as the transformation the data to the fresh co ordinate system. The extremest variance of the data is considered as the first co-ordinate which is also alled as the principal component and goen on.

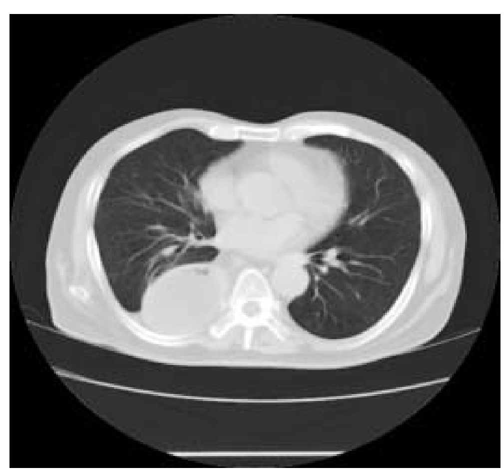
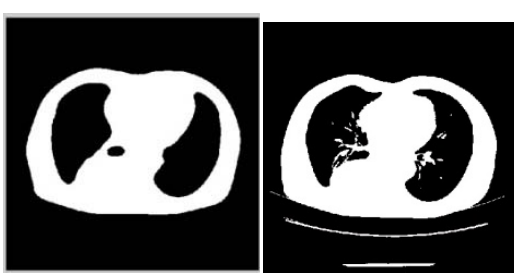


Figure-4. Contrast enhanced input image.

ARPN Journal of Engineering and Applied Sciences

C. Heuristic approach for Lung Nodule segmentation

In order to segment the medical snapshot using K Means clustering algorithm, we need an algorithm that can be superior for the large datasets and to find inceptive centroid to equate the accomplishment. We describe an algorithm for the segmentation of CT images into k different that cosists of gray, white matter and CSF, and maybe other unusual tissues. Between scale-valued or multi valued either can be considered by slice (image). Every scale-valued image is formed as an assembly of areas with leisurely diversifing intensity with the white Gaussian noise. The lung image segmentation and the processing applications, specially for the loction of cancer boundaries can be don ebby using heuristic approach. Heuristic approach is considered as optimistic and focibly researched model-based approach to computer assisted medical image analysis. Heuristic approach segmentation strategy is given out that is directed by precised confined characteristics, opposite to normalized first order derivative profiles, like as in the actual (original) formulation. A nonlinear classifier is used, instead of the linear Mahalanobis distance (interspace), to find optimal displacements/shifts for landmarks. For each of the landmarks or indicators that describe the shape, at each resolution level taken into account throughout the segmentation optimization procedure, a definite set of optimal features is found out. The selection of features is mechanical or automatic, using the training images and sequential feature forward and backward selection [10]. The segmentation of imaging data necessitate divisioning the image space into different cluster regions with alike intensity image values. The most medical snapshots always display overlapping gray-scale intensities for different tissues. Consequently, fuzzy clustering methods are particularly satisfactory for the segmentation of medical snapshots. There are several FCM clustering uses in the lung segmentation [11]. The fuzzified edition of the k-means algorithm is also called as FUZZY C-MEANS (FCM) which is a method of clustering which allows one piece of data to lie in more than one cluster. This method is generally used in pattern recognition. The method that process an optimal c partition by lessening the weighted within group sum of squared error objective function is an iterative clustering method.



(a) (b)

Figure-5. (a) Otsu thresholding image. (b) Clustered image.

D. Lung segmentation

The input lung CT slices which are in JPEG format initially preprocessed in which they are converted into a grayscale slice. Gaussian noise is removed using a Gaussian filter which retains the higher valued edges in the slices that are necessary for the ROI extraction. Segmentation is carried out to differ both the left and right lungs in the CT slice by removal of the surrounding regions and unwanted muscles from the thin CT slice (image). The different segmentation techniques are used depending on the portion of the lung that is affected and also on the type of disease by which the lung is affected. So the same segmentation techniques cannot be used for both pleural effusion and pneumothorax. Both the segmentation techniques that are used for the segmentation of lungs with pleural effusion and pneumothorax are given to the entire chest CT dataset. The slices are segmented first using the technique for pleural effusion and thereafter followed by the segmentation technique for pneumothorax.

Figure-6. Lung segmentation.

E. Feature extraction

2D CT slices look like grayscale sanpshots and hence the colour features are not withdrawn. The shape of the pathologically affected region is neither specific nor geometrical in nature so the shape features are also not taken out. So ten texture features are extracted from the segmented lung areas and from the ROIs of both the diseases. In this section we are training the features and then giving it to the classifier. The training is done by Neural Network.

VOL. 11, NO. 9, MAY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

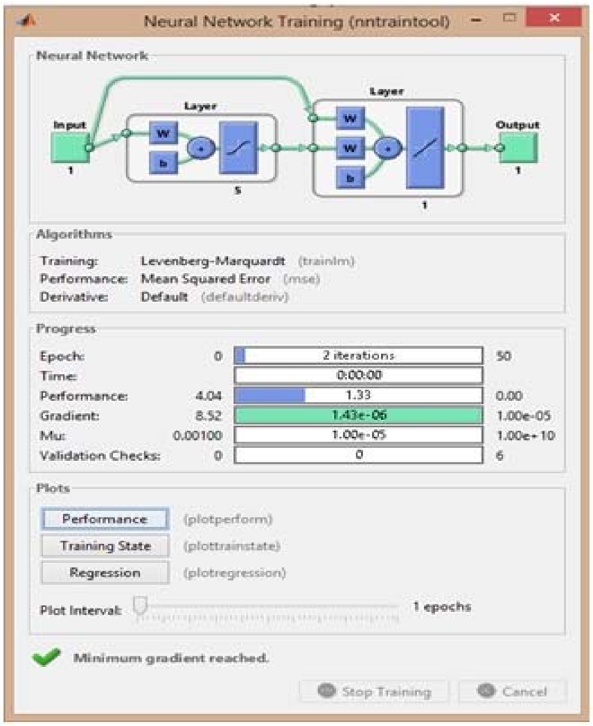


Figure-7. Neural network training.

F. Classification using SVM

This project proposes an intelligent classification technique to identify normal and abnormal slices of lung CT data. The manual interpretation of tumour slices based on visual examination by radiologist/physician may cause missing diagnosis when a large number of CTs are analyzed. To avoid the human error/delusion, an automated intelligent classification system is proposed which serve the need for classification of image slices after identifying abnormal CT volume, for tumour identification. In this research work, advanced classification techniques found on Least Squares Support Vector Machines (LS-SVM) are proposed and applied to CT image slices classification using features derived from slices [9].

Figure-8. Image is classified as abnormal.

4. CONCLUSIONS

In the context of medical image analysis, the proposed methods of lung segmentation eliminates the lung boundaries and separating the attached right and lungs lungs, which are the two most common implemetation in most lung segmentation methods and require a significant amount of time. After, to detect the diseases of lungs nodules using modified fuzzy c-means algorithm. We have applied segmentation tools on several lungs CT images. Experiments results show that the proposed method can upgrade the speed, robustness and accuracy of diagnosis. FCM is one of an accepted clustering method and has been broadly applied for medical image segmentation. Conversely, conventional FCM at all times suffers from noise in the images. Even though the original FCM algorithm yields good results for segmenting noise free images, it is not successfulo to segment images corrupted by noise, outliers and other imaging artifact. Although many researchers have developed a variety of extended algorithms based on FCM, not any of them are perfect. The CAD system has been developed for the classification of pleural illness like pleural effusion and pneumothorax. The algorithms or procedures proposed in this work use morphological and arithmetic operations for the extraction of the regions in the lung which are affected by pleural effusion and pneumothorax and the performance measures have been computed. The classification outcomes (results) exhibit an accuracy of 94.25% for pleural effusion and 96.77% for Pneumothorax. The sensitivity of the system for pleural effusion was 85.84% and 92% was for pneumothorax and the specificity was 97.5% and 98.27% for pleural effusion and pneumothorax respectively.

It is good for the convergence of the gradients of the snapshot pixels. It is the fastest algorithm when compared to the k means algorithm and Fuzzy C Means algorithm. The proposed Heuristic approach can have linear convergence and the speed is based on how many information is lost. The proposed algorithm is applicable for RGB colour space images. The suggested methods or approaches have higher level of accuracy than existing methodologies cosequently if incorporated in observation for nodule can generate higher level of accuracy. For the classification stage, they have used cortex like mechanism for extracting statistical features in inclusion to shape-based features. The exact/accurate segmentation of the tumour of lung is feasible. The ROC (receiver opertating characteristics) curve is drawn which shows the true positive accuracy between existing and proposed system.

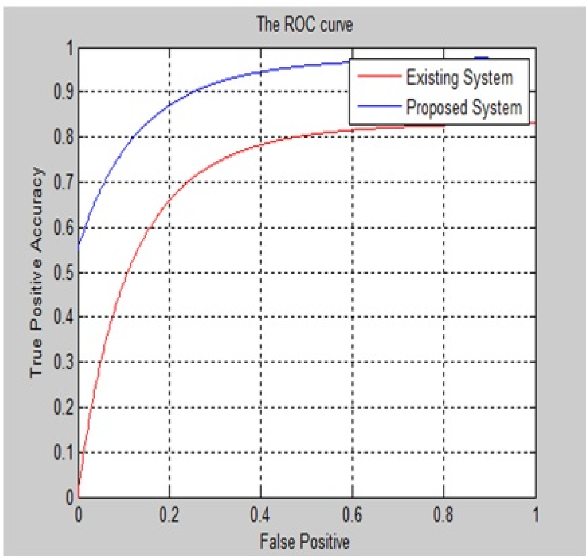


Figure-9. ROC (Reciever operating characteristics) curve.

REFRENCES

[1] A Morphological Approach for the Extraction of the Disorders of the Pleura from Chest CT Slices, Elsevier Publications 2014.

[2] Hao Han; Lihong Li; Fangfang Han; Hao Zhang; Moore W.; Zhengrong Liang. Vector quantization-based automatic detection of pulmonary nodules in thoracic CT images Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC), 2013 IEEE.

[3] Namin S.T.; Moghaddam H.A.; Jafari R.; Esmaeil-Zadeh M.; Gity M. 2010. Automated detection and classification of pulmonary nodules in 3D thoracic CT images Systems Man and Cybernetics (SMC), 2010 IEEE International Conference.

[4] Eskandarian, P.; Bagherzadeh, J. 2015. Computer-aided detection of Pulmonary Nodules based on SVM in thoracic CT images Information and Knowledge Technology (IKT), 2015 7th Conference.

[5] A. C. Horwood, S. J. Hogan, P. R. Goddard and J. Rossiter. 2008. Image Normalization, a Basic Requirement for Computer-based Automatic Diagnostic Applications. http://facweb.cs.Depaul.edu/research/vc/seminar/Paper/Feb22 2008Emili Image Normalization.pdf.

[6] Y.J. Jeong and K. S. Lee. 2008. Pulmonary Tuberculosis: Up-to-date Imaging and Management, American Journal of Roentgenology. 191(3): 834–844.

[7] Enhancement Filter for Computer-Aided Detection of Pulmonary Nodules on Thoracic CT images Yang Yu; Hong Zhao Intelligent Systems Design and Applications, 2006. ISDA '06. Sixth International Conference on Year: 2006, Volume: 2

[8] Takagi N.; Kawata Y.; Niki N.; Mori K.; Ohmatsu H.; Kakinuma R.; Eguchi K.; Kusumoto M.; Kaneko M.; Moriyama N. 2000. Computerized characterization of contrast enhancement patterns for classifying pulmonary nodules. Image Processing, 2000. Proceedings. 2000 International Conference . Vol. 1.

[9] Selvaraj H., S. Thamarai Selvi, D. Selvathi and L. Gewali. 2007. Brain MRI Slices Classification Using Least Squares Support Vector Machine. International Journal of Intelligent Computing in Medical Sciences and Image Processing.

[10] Sapthagirivasan V, M Anburajan and Venkatesh Mahadevan. 2011. Segmentation of proximal femur in digital radiographic image using principal component model. 2011 3rd International Conference on Electronics Computer Technology.

[11] Shamsi Hamed and Seyedarabi, Hadi. 2011. A New Modifies Spatial FPCM that Incorporates the Spatial Information into the Membership Function to Improve the Segmentation Results. International Journal of Advanced Science and Technology.

[12] Bhuvana S.; Selvy P. Tamije and Asha S. 2015. ANFIM: Adaptive Neuro Fuzzy Inference Model for Content Based Image Retrieval. International Journal of Applied Engineering Research.

[13] R. Acharya. 2000. Automatic segmentation of lung regions in chest radiographs: a model guided approach. Proceedings 2000 International Conference on Image Processing (Cat No 00CH37101) ICIP-00.