Research Journal of Recent Sciences ISSN 2277-2502
Vol. 3(**ISC-2013**), 45-49 (**2014**) *Res. J. Recent. Sci.*

ANFIS Based Tumor Detection in Thoracic Images

Anandpushparaj J.
Embedded Systems, Karunya University, Coimbatore, Tamilnadu, INDIA

Available online at: www.isca.in, www.isca.me
Received 10th December 2013, revised 1st January 2014, accepted 15th February 2014

Abstract

Lung is an important organ in our body which performs its function in both respiratory system and circulatory system. For lung cancer staging, a regional lymph node is important, and an automated system is used to detect both types of abnormalities. A fully automatic differentiation method for Lung tumor and diseased lymph node from CT image of thoracic region is used to calculate the false positive. The performance of detection and differentiation done in three stages, initially detect all potential abnormalities in thoracic image, the lung tumor and diseased lymph nodes are differentiated. Finally Benign and Malignant tumors are classified. Fuzzy logic and Neural Network in MATLAB are used to perform the tasks and also to reduce false positive rate.

Key words: Lung cancer, medical imaging techniques, computer tomography images, benign tumor, malignant tumors, fuzzy logic, neural network.

Introduction

Lung cancer currently ranks as the leading cause of cancer related deaths in men and women. Lung cancer is divided into 2 main types, small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC). The category of the cancer determines the treatment options. Small cell lung cancer (SCLC) accounts for about 15% of all lung cancers. Also known as oat cell carcinoma, SCLC tends to be aggressive[1]. The cancer often grows rapidly and spreads to other regions including lymph nodes, bone, brain, adrenal glands, and the liver. Risk of developing SCLC is highly associated with tobacco smoking. Less than 5% of patients diagnosed with the disease have never smoked. Non -small cell lung cancer (NSCLC) based on appearance and other characteristics of the cancerous cells it can be classified into three types: Squamous cell carcinoma (SCC), Adenocarcinoma, Large Cell Carcinoma (LCC)

The detection of such cancers can be done using image processing, one of the most developing technology these days[2]. The abnormal formation of cells in the lungs is detected and abnormality is diagnosed in this method. To detect the tumor from lung CT image an automatic approach is used. Here a fully automatic methodology is designed for detection of primary lung tumors and disease in regional lymph nodes simultaneously from CT thoracic images.

An artificial neural network (ANN) is a based on a learning method where several networks are used to solve a problem. This method is used to identify the lung tumor from a CT image. Training the Neural Network with a number of normal CT lung images and abnormal CT lung images is done to differentiate normal and abnormal cells in the lung region[3]. The training algorithm for Neural Network to differentiate the abnormal cells into Benign and Malignant tumor cells is done. Benign tumors are abnormal cells which does not leads to spreading of cancer cells to some other parts of the body, whereas Malignant tumors are abnormal cells which leads to cancer cells spreading to neighbor organs[4]. To detect tumors, the method used here is a multistage discriminative model and abnormal lymph nodes.

Methodology

Proposed Method: An automatic method for detecting the tumors and abnormal lymph nodes simultaneously from CT thoracic images are proposed. A multistage approach is used for detecting which detects all abnormalities, differentiates the tumors and lymph nodes, and a false positive reduction to refines the tumor which has been detected. To classify the obtained lung tissues is benign or malignant the neural network is used. The detection of tumor in existing system is based on uptake values of FDG by the normal and abnormal cells[5]. The variation in FDG causes color variation in PET/CT image, thus the output is not accurate. The proposed system uses CT thoracic image for detecting tumor which does not include tracer injection, by eliminating PET images. To achieve a better classification with high performance the use of Fuzzy rules based Neural Network is used and this method also reduces the time taken for detection of lung tumors. The accuracy rate of the proposed system result is high with low false rate when compared with the existing method.

System Implementation: The typical Lung CT image undergoes a few image processing techniques for image enhancement and feature extraction. The image is initially pre-processed to remove noise. The pre-processed CT image is endured with feature extraction. The differentiation, tumor region and to perform classification of Normal and Abnormal lung tissues the fuzzy and Neural Network rules are used. Lymph nodes in lung tissues use the feature extracted output.

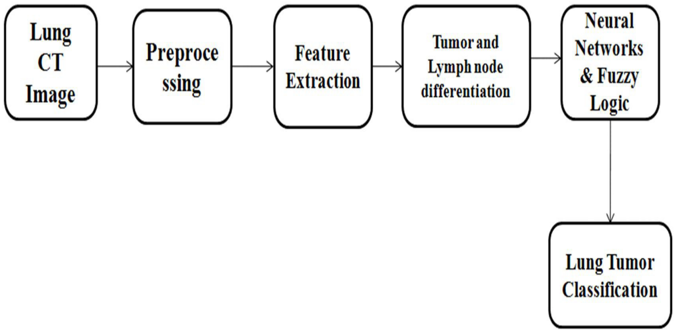

Figure-1
Block diagram

This is further distinguished into Benign and Malignant tumors. A better classification rate with high performance is achieved in this method. The system implementation involves following steps: i. Preprocessing, ii. Segmentation. iii. Feature Extraction. iv. Tumor and Lymph node differentiation. v. Fuzzy logic-tumor classification. vi. Neural Networks Classifier.

Pre-Processing: In order to find the lung tumor, pre-processing technique is used. This process removes the noise by enhancing the quality of the image[6]. Pre-processing steps should be done to limit the search before doing image processing this should be done in order to find abnormalities without any influence from background of the image. To improve the image quality a preparation phase is carried over to make the segmentation results more accurate[7]. Thus by removing the unrelated and surplus parts in the back ground of the image which improves the quality of the image to makes it ready for further Processing.

Median Filter: In pre-processing is the image de-noising is the initial process, a median filter is used. A non-linear digital filter often used to remove noise is a median filter. Edge detection on an image is improved when the noise is reduced. Images can be a low-contrast, fuzzy contours[8]. The histogram in an image occurs in many parts of the image were the gray level is used for occurrence. By thresholding the segmentation becomes quiet tedious process because of image overlapping[9].

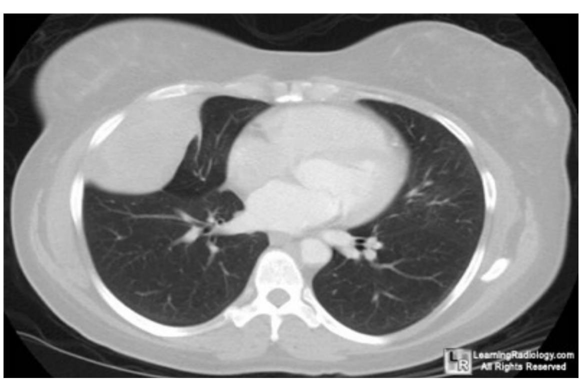

Figure-2
Lung CT original image

To improve the shape of the image histogram a pre processing technique is used which makes it more bimoda[10]. Thus by replacing the value of each pixel by the average of all pixel values in a local neighborhood, the median value is calculated in a local neighborhood is replaced in the median filter.

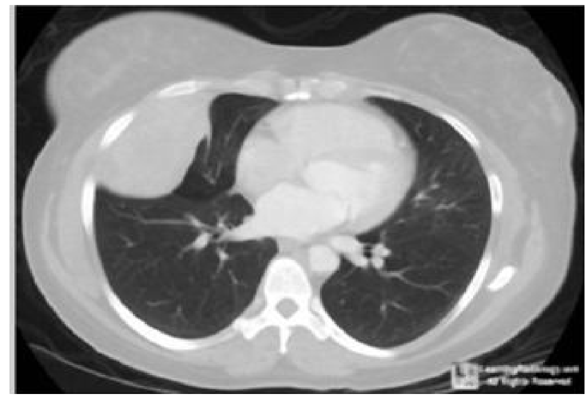

Figure-3
Median filtered lung CT image

Segmentation: Image segmentation is partitioning an image into multiple segments[11]. The segmentation process simplifies and/or changes the representation of an image into something that is more meaningful and easier to analyze. The typical use of image segmentation is to locate objects and boundaries in images[12]. More precisely, it assigns a label to every pixel in an image such that pixels with the same label share certain visual characteristics. But when adjacent regions are taken they are significantly different with respect to the same characteristics[13]. Segmentation is done to separate the image into two or more sub module regions. Segmenting saves the process time, in order to segment the tumor region from Lung CT image segmentation with a global threshold is used[14]. The process of segmenting the Lung tumor region from Lung CT image is carried on in the next step.

Morphological Closing Operation: Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. To fill the holes and small gaps in image Morphological close operation can be carried over a threshold image[5]. Reserve blocks with a bigger area and setting others to zero using the 8-connected neighbors, this is the binary lung mask. By setting a pixel to 0 and only if its 4-connected neighbors are all 1's, the boundary can be extracted, there is no connection between the boundary pixels. By multiplying the CT image with the lung masked image the final segmented image is obtained[15]. The process is based on the shape of the images. It applies a structuring element to an input image and produces the output image of an equivalent size.

Thresholding: The determination of the actual binary masks for the lung area is done using thresholding. The binary masks are generated using an iterative thresholding algorithm from an input gray level image. This is a better method to obtaining binary mask.

Figure-4
Thresholding of CT image

The threshold is the minimum between the two maxima of the gray level histogram in conventional thresholding algorithm[16]. The histogram of an image can be initially divided into two parts using a starting threshold value, which can be half the maximum of the range of the current image, or by the conventional thresholding method. Later, the gray values associated with the foreground pixels and the gray values associated with the background pixels sample mean values are computed, which determines a new threshold value as the average of these two sample means. Until the threshold value remains constant the process should be repeated.

Feature Extraction: The locating of pixels in an image with distinctive characteristics is termed as feature extraction. Typically characteristic that is inhomogeneity are the local image properties. For instance the image steps are inhomogeneities in their intensity or range[17]. The features extracted from image serves as the comparison and similarity among images, classification of observations, identification and localization of anatomical structures.

Fuzzy Logic and Neural Networks Classification: It is obvious that artificial neural networks are widely exploited on lung cancer diagnosis. The collection of data in medical domain is a challenging process and has practical limitations. Due to the low prevalence of this disease acquiring large numbers of patients is often challenging because of its low prevelance among screening population, which results in a class of imbalance[18]. It dramatically varies in the clinical presentation of patients with the same disease. By replacing the rule base classifiers neural networks are implemented, in conventional classifier systems, by neural networks. A population of classifiers or rules is the composition of classifier system. There is a "strength" associated with each classifier. During the evolution process this is used to express the energy or power of each classifier, which becomes unstable when trainees with a small size training dataset[18]. By increasing the size of the training dataset the performance can be improved.

The Neural Network Classifiers are trained to detect normal and abnormal cells in the lung region with the help of CT thoracic images. To train-up the Neural Network Classifier more number of CT thoracic images, both normal and diseased lung are taken. The detected abnormalities can be further differentiated as tumors or abnormal lymph nodes are done based on the training[18]. To achieve accuracy between the two types of cells as a normal lung and abnormal diseased cells a neural network integrated with the rules of fuzzy are designed. The Neural Network has a number of CT thoracic images of various categories like normal lung, abnormal lung cell which has lung diseases like tuberculosis and an abnormal lung image with lung cancer images are collected for training. The images are the database for the Neural Network training and finally the trained Neural network is used for differentiation of lymph nodes and lung tumor and as well as Lung tumor Classification.

Results and Discussion

The process of detecting lung tumors and classifying the same was done using MATLAB software. For the testing process the image is taken from the test database where the images are saved. Initially the image that is given as input is tested for tumor identification and the classification of tumor is also done. To train the image with neural network classifiers is continued, which classifies the given input is a benign tumor or a malignant tumor. If the classification result is a Benign tumor then it need not be trained. If the output is a malignant tumor the it is further processed and the MATLAB output is as shown below:

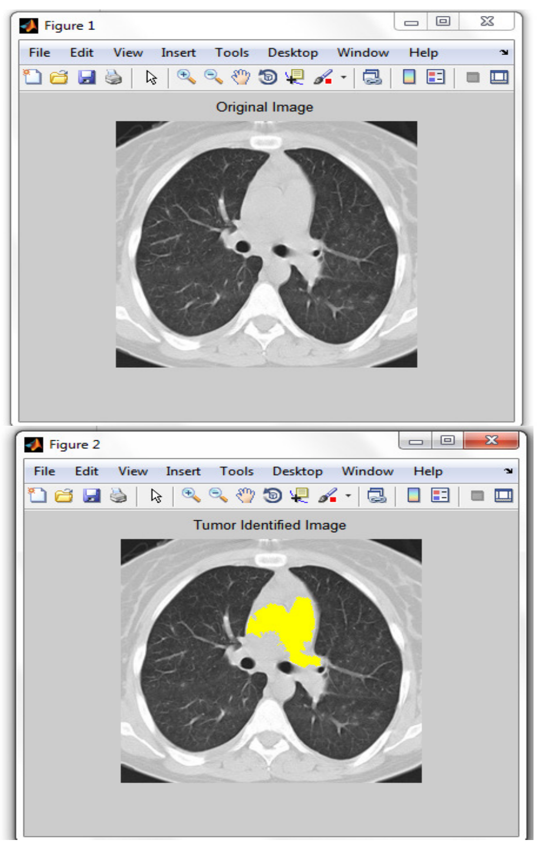

Figure-5
Output images obtained after testing and identification

For the classified tumor, the output is further trained using Fuzzy logic rules which are set initially. Based on the neighbor pixels and their arrangement the process is done and the output is shown with the average value obtained.

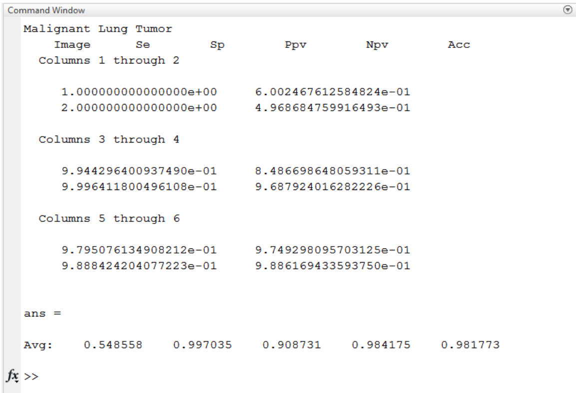

Figure-6
Neural Network Classification and Fuzzy Training

Conclusion

A fully automatic detection and classification of lung tumor from CT thoracic images is done using MATLAB. The Neural Network Classifiers are trained with more number of CT thoracic images to improve accuracy. The Fuzzy logic rules are used in training of the classifiers which make the classification between normal and abnormal as well as benign and malignant with less false positive rate. There is a maximum reduction is false rate and increase in the accuracy of the process. These results obtained from Neural Network Classifier are accurate when compared to any other method. The time taken for detection and classification of lung tumors is also less and when Neural Network Classifier are trained with more number of CT images, its classification becomes 2-5 times faster than SVM (Support Vector Machine) and CRF (Conditional Random Fields) methods. The faster detection and classification of this method provides an effective application in Lung tumor Diagnosis and Lung tumor Surgery. By further reducing false negatives of abnormal lymph nodes which is misidentified as lung tumor will be helpful in finding the accurate results.

Future Work: The lung tumor detection and classification in lung MRI images and PET images can be done. The extraction and lung tumor detection in 3-D thoracic images can be done with further extension. The tumor detection and classification of any other CT images like brain, abdomen and uterus can also be used by training the Neural Network for tumor diagnosis.

References

1. Yang Song, Weidong Cai, Jinman Kim and David Dagan Feng, Multistage Discriminative Model for Tumor and Lymph Node Detection in Thoracic Images, **(2011)**

2. W. De Wever, S. Stroobants, J. Coolen and J.A. Verschakelen, Integrated PET/CT in the staging of nonsmall cell lung cancer:technical aspects and clinical integration, **(2009)**

3. W. Wever, S. Stroobants, J. Coolen, and J. Verschakelen, Integrated PET/CT in the staging of nonsmall cell lung cancer: Technical aspects and clinical integration, *Eur. Respir. J.,* **3, (2009)**

4. Poonam Bhayan, Gagandeep Jindal, A Segmented Morphological Approach to Detect Tumor in Lung Images, **(2011)**

5. Yuri Boykov, and Vladimir Kolmogorov, An Experimental Comparison of Min-Cut/Max-Flow Algorithms for Energy Minimization in Vision, **(2004)**

6. Jan-Martin Kuhnigk, Volker Dicken, Lars Bornemann, Annemarie Bakai, Dag Wormanns, Stefan Krass, and Heinz-Otto Peitgen, Morphological Segmentation and Partial Volume Analysis for Volumetry of Solid Pulmonary Lesions in Thoracic CT Scans, **(2006)**

7. Zhi-Hua Zhou, Yuan Jiang, Yu-Bin Yang, Shi-Fu Chen, Lung Cancer Cell Identification Based on Artificial Neural Network Ensembles, **(2002)**

8. Li Zhang, Weida Zhou, and Licheng Jiao, Wavelet SupportVector Machine, **(2004)**

9. Survey Paper on Diagnosis of Breast Cancer Using Image Processing Techniques, Mussarat Yasmin, Muhammad Sharif and Sajjad Mohsin*, Res. J. Recent Sci.,* **2(10),** 88-98 **(2013)**

10. Framework for the Comparison of Classifiers for Medical Image Segmentation with Transform and Moment based features, Maria Hameed, Muhammad Sharif, Mudassar Raza, Syed Waqas Haider, Muhammad Iqbal, *Res. J. Recent Sci.,* **2(6),** 1-10 **(2013)**

11. Bone Mineral Density Correlation against Bone Radiograph Texture Analysis: An Alternative Approach, Abdul Basit Shaikh, Muhammad Sarim, Sheikh Kashif Raffat, Mansoor Khan2 and Amin Chinoy, *Res. J. Recent Sci.,* **2(3),** 87-91 **(2013)**

12. Anticancer activity of Ethanol extract of Polygala javana DC whole Plant Against Dalton Ascites Lymphoma, Alagammal M., Paulpriya K. and Mohan V.R., *Res. J. Recent Sci.,* **2(2),** 18-22 **(2013)**

13. Cherry Ballangan, Xiuying Wang, Michael Fulham, Stefan Eberl, Yong Yin, and Dagan Feng, Automated Delineation of Lung Tumors in PET Images Based on Monotonicity and a Tumor-Customized Criterion, **(2011)**

14. Manaswini Padhan, An Extensive Survey on Artificial Neural Network Based Cancer Prediction Using Soft-Computing Approach **(2011)**

15. Hanford J. Deglint, Rangaraj M. Rangayyan, Fábio J. Ayres, Graham S. Boag, Marcelo K.Zuffo, Three-Dimensional Segmentation of the Tumor in Computed Tomographic Images of Neuroblastoma **(2007)**

16. Y. Song, W. Cai, S. Eberl, M. Fulham, and D. Feng, Discriminative pathological context detection in thoracic imagesbased on multi-level inference, **6893 (2011)**

17. HBVO: Human Biological Viruses Ontology, Sheikh Kashif Raffat, Mohd. Shahab Siddiqui, Mohd. Siddiq, Zubair A. Shaikh and Abdul Rahman Memon, *Res. J. Recent Sci.,* **1(10),** 45-50 **(2012)**

18. OncmiRs: Small Noncoding RNA with Multifaceted Role in Cancer Joseph Baby and Nair Vrundha M., *Res. J. Recent Sci.,* **1(11),** 70-76 **(2012)**