Lung Cancer Detection

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Abstract : A Lung CT image segmentation is a prerequisite in lung CT image analysis. Most of the conventional method need a post-processing to deal with the abnormal lung CT scans. Computer aided diagnostic process has already become a vital part of clinical routine, among a rush of recent development of technology and use of varied imaging modalities. CT image square measure a lot of detail than plain image In this thesis, a lung cancer detection system is proposed using minimum cut/Max-Flow algorithm for segmentation of lung region, this segmented image is then fed to convolution neural network to detect if cancer is present.
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***Index Terms* - Computer Tomography, Convolution Neural Network, Graph cut Segmentation, Lung cancer.**

I. INTRODUCTION

The lungs are cone-shaped organ in the chest and is the site of gas exchange for air coming into and leaving the body. There are two lungs, one on the left and one on the right. The thorax can be viewed from the axial view, the coronal view, or the sagittal view. The images used in this study are from the axial view.

Lung cancer is one the most common cases of cancer all over the world. About 14% of the cancer affected people is affected by lung cancer, which accounts for the death of approximately 21% of all cancer deaths. Males are more vulnerable to lung cancer than their counterpart females. Due to environment pollution, number of lungs cancer affected people is increasing very rapidly. The 5-year survival rate of lung cancer is approximately 17.7%, reported by the world health organization. Although most of the patients with lungs cancer are detected in later stages of cancer. Early detection can enhance the survival rate to above 70%.

Detecting lung cancer in the earlier stages, which is a need of the hour is very difficult since the symptoms are noticeable only in the later stages. Interpretation of the disease can take a long time, as the lung nodules are required to be checked for their malignancy. Early detection of lung cancer is necessary to minimize the death rates caused by it.

The crucial step in any CAD system is segmentation of lungs from chest images that can lead to the early diagnosis of lung cancer, as well as other pulmonary diseases. The segmentation of lungs is a very challenging problem due to inhomogeneities in the lung region, pulmonary structures of similar densities such as arteries, veins, bronchi, and bronchioles, and different scanners and scanning protocols [1].

Neural network plays a key role in the recognition of the cancer cells among the normal tissues, which in turn provides an effective tool for building an assistive AI based cancer detection. The cancer treatment will be effective only when the tumor cells are accurately separated from the normal cells Classification of the tumor cells and training of the neural network forms the basis for the machine learning based cancer diagnosis [2].

In this paper, we applied lung segmentation approach based on graph cuts [3,4] as a powerful optimization technique to get the optimal segmentation. The segmented lung region from CT image is fed to Convolution Neural network for classification. The main objective of this study is to detect whether the cancer is present in a patient's lungs.

II. LITERATURE SURVEY

Mohit Khandelwal et al.[5] proposed adaptive three level thresholding for segmenting the MRI objects using fuzzy C means clustering. Oluwakorede Monica Oluyide et al. [6] an automatic segmentation framework based on Graph Cut which makes use of a distance-constrained energy (DCE) function to produce topological restrained solutions is presented. This energy is so-called because it includes an additional term to penalise pixels based on their Euclidean distance from a coarsely estimated region containing the lungs. Moffy Vas et al. [7] proposed a lung cancer detection algorithm using mathematical morphological operations for segmentation of the lung region of interest, from which Haralick features are extracted and used for classification of cancer by artificial neural networks. Prajwal Rao et al. [8] approach uses a Convolutional Neural Network (CNNs) to classify tumours seen in lung cancer screening computed tomography scans as malignant or benign. CNNs have special properties such as spatial invariance, and allow for multiple feature extraction. When such layers are cascaded, leading to Deep CNNs, it has been shown widely that the accuracy of prediction increases dramatically. In this work, they have designed a CNN suitable for the analysis of CT scans with tumours, using domain knowledge from both medicine and neural networks.

III. RESEARCH METHODOLOGY

The methodology adopted in this project was carried out in five steps CT scan image, noise filtering,, thresholding, segmentation, classification which are shown with the help of a flow chart in Fig 1. Each step of the flow chart is explained below.

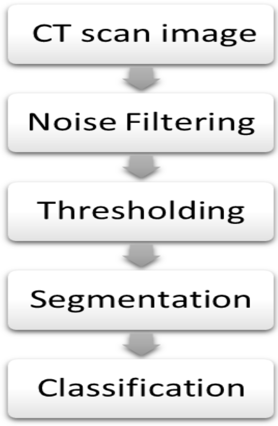

Fig. 1. Methodology block diagram.

A. Data Collection

Dataset is obtained from Lung Image Database Consortium (LIDC)[9]. The Lung Image Database Consortium image collection (LIDC-IDRI) consists of diagnostic and lung cancer screening thoracic computed tomography (CT) scans with marked-up annotated lesions. Online Dataset image is in DICOM format, it is converted to tiff format using DICOM converter. Converting the image into tiff format retains the originality of the image. Fig 2 is the original CT image from dataset.

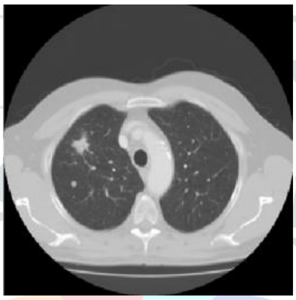

Fig 2. Original CT image.

B. Noise Filtering

Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing salt and pepper type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels [10]. The median filter of size 3*3 is used to get rid of the noise present in the image. The median filter application and its contribution towards the improvement in the image can be seen from Fig 3.

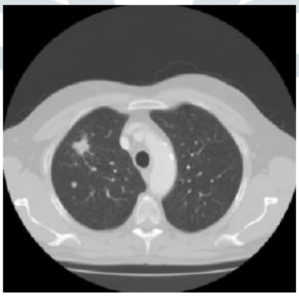

Fig 3. Median filter image.

C. Thresholding

Thresholding with 3-class fuzzy C-means Clustering technique is a combination of fuzzy algorithm, C means clustering and thresholding algorithm. FCM clustering is used to divide N objects into C classes (cluster). The FCM algorithm uses iterative optimization of an objective function and it works by assigning membership to each data point corresponding to each cluster centre on the basis of the distance between the cluster centre and data point. The algorithm starts with defining the number of clusters = 3. The cluster centres are calculated in such a way that the centre is closer to those points that have greater membership value to one cluster. Finally after performing FCM clustering, each pixel is assigned to the cluster with highest membership value and the threshold value is calculated. Threshold is obtained by averaging the maximum in the class with the smallest centre and the minimum in the class with the middle centre [5] as shown in Fig. 4.

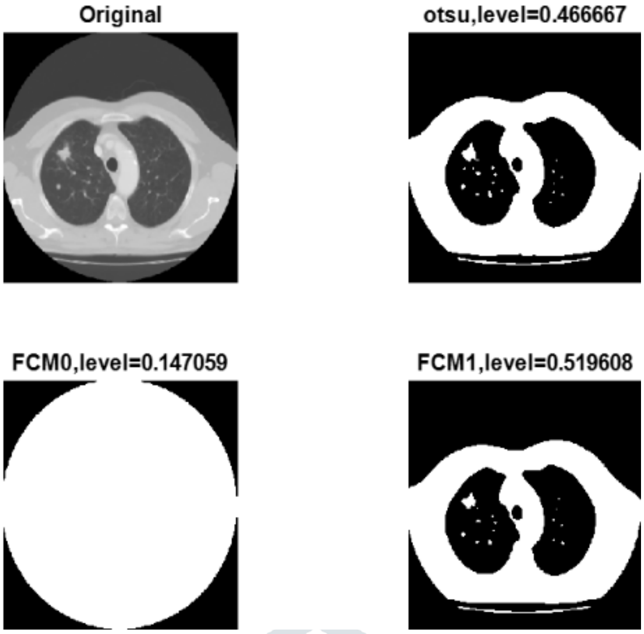

Fig 4. Thresholding with 3-class fuzzy C-means Clustering.

D. Segmentation

Segmentation is the method of separating out the region, which is the main interest of study. The accuracy of any algorithm depends on the accuracy of segmentation. Morphological operations are performed on thresholding image and mask is created. This mask along with the filtered CT image is used for graph cut segmentation. Everything outside this mask will be taken as background. Everything inside mask is unknown. A graph is built from this pixel distribution. Nodes in the graphs are pixels. Source node and Sink node are the additional two nodes which are added. Every background pixel is connected to Sink node and every foreground pixel is connected to Source node.

The weights of edges connecting pixels to source node/end node are defined by the probability of a pixel being foreground/background.The edge information or pixel similarity are defined by the weights between the pixels. The edge connecting the pixel will get a low weight, if there is a large difference in pixel colour. To segment the graph, a min cut algorithm is used. The minimum cost function is the cut in the graph by two separating source node and sink node with minimum cost function. The sum of all weights of the edges that are cut is called cost function. After the cut, all the pixels connected to Source node become foreground and those connected to Sink node become background. The process is continued until the lung region is segmented. Fig 5 is the output of graph cut segmentation.

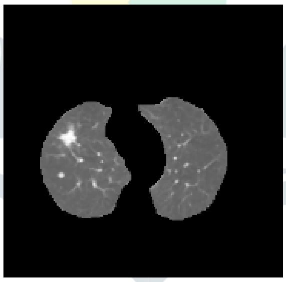

Fig 5. Graph cut Segmented image.

E. Classification

Special architecture of artificial neural networks is Convolutional neural networks (CNN). Some features of the visual cortex is used by CNN. One of the most popular uses of this architecture is image classification. The main task of image classification is acceptance of the input image and the following definition of its class. The image, the computer sees an array of pixels. The image is passed through a series of convolutional, nonlinear, pooling layers and fully connected layers, and then generates the output.

Pretrained network called resnet50 is used. ResNet-50 is a deep residual network. The 50 refers to the number of layers it has. Its a subclass of convolutional neural networks, with Res Net most popularly used for image classification. Fig 6. is the First convolutional layer feature in the trained CNN.

Fig 6. First section of ResNet-50.

Each layer of a CNN produces a response, or activation, to an input image. However, there are only a few layers within a CNN that are suitable for image feature extraction. The layers at the beginning of the network capture basic image features, such as edges and blobs[12]. To see this, visualization of the network filter weights from the first convolutional layer is shown in Fig 7.

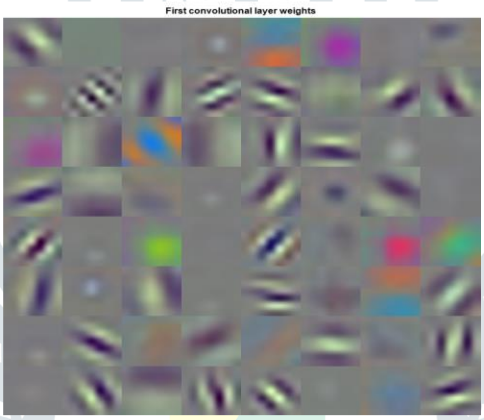

Fig 7. The visualization of the learned First convolutional layer features in the trained CNN.

First layer of the network has learned filters for capturing blob and edge features. These "primitive" features are then processed by deeper network layers, which combine the early features to form higher level image features. These higher level features are better suited for recognition tasks because they combine all the primitive features into a richer image representation [11].

Extracting features from one of the deeper layers using the activations method is easy but selecting which of the deep layers to choose is a design choice, but typically starting with the layer right before the classification layer is a good place to start. In `net`, this layer is named 'fc1000'. Extraction of training features is done using this layer. The 'Mini Batch Size' is set 32 to ensure that the CNN and image data fit into GPU memory. CNN image features is used to train a classifier. Accordingly the classifier detects if cancer is present.

IV. RESULTS AND DISCUSSION

Experiment was performed using system with following specification:16 GB RAM, Intel Xeon CPU E5-2620 v4@2.10 GHz, 64-bit Operating System,x64 based processor and 16 GB NVIDIA Titan XP GPU, and MATLAB R2018b as application software tool.

In order to do k-fold cross validation data set is split into two parts. One for training and other for testing. We take 90% data for training and 10% data for testing. Accuracy obtained is 88.27%.

A sample image has been fed as an input to the trained model and the model at this stage is able to tell the presence of cancer. The process involves the feeding the input image, noise filtering, thresholding, segmentation and classification. In case of cancer is present, a message indicating the presence of will be displayed on the screen as shown in Fig 8.

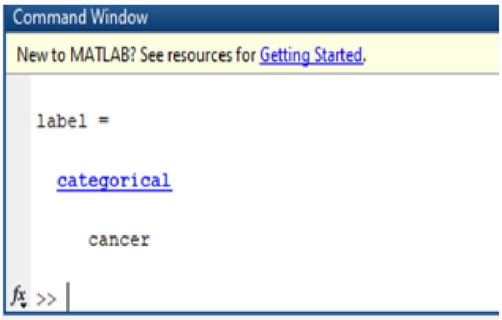

Fig 8. Result display

V. CONCLUSION

Application of median filter to eliminate impulse noise in the images proved to be quite a success. Segmentation is very important in medical imaging, especially in the area of medical image analysis. Advances in data acquisition technologies have inspired research on ways that Diagnostic Medicine can benefit from the increasing capability of the computers. Early works attempted to make the computer output diagnosis independently, but were met with limited success as it proved difficult to program the complex human thought process into the machine. The adoption of Computer-aided Detection (CAD) systems has been quite slow due to the high rate of false positive detections which limit the reliability of its output. Therefore, much work still needs to be done to increase the accuracy of the results. By using CNNs, one can forget the tedious process of manually extracting features for classification which requires specific domain knowledge. This work automatically does the classification procedure, and eventually becoming better than trained technicians at this particularly crucial and critical task.

VI. FUTURE SCOPE

In the future, it could be possible to extend our current model to not only determine whether or not the patient has cancer, but also determine the exact location of the cancerous nodules. Other future work include extending our models to 3D images for other cancers. Using Graph cut segmentation different deep neural network can be used for classification.

VII. ACKNOWLEDGMENT

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