Region Growing based Tumor Detection and Classification using Convolutional Neural Networks(CNN)

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***Abstract*—** Lung tumor has been seen into lot of patients. If it would not treated early it can get converted into malignant tumor called cancerous tumor which can be hazardous. CT scan imaging is the best medical imaging modality for lung tumor, but for doctors it is difficult to identify tumor area. In order to get higher accuracy of detecting tumor and treating in early stages Computer Aided Diagnosis(CAD) can be beneficial. The idea behind this research is to find out limitations in the current literature and finding best way to detect tumor with some degree of improvements.

Keywords—Computer Aided Diagnosis(CAD), Convolutional Neural Networks, Region Growing

I. INTRODUCTION

Tumour is the growth of abnormal cells which can be malignant(cancerous) or benign which is non cancerous tumors. If it can be detected whether the tumor is cancerous or not on early basis, patient can get cured and the death rate can get decreased. Among all the types of cancer Lung cancer is most common which is the reason of increasing death rate. Worldwide current evaluation given by health association says that due to lung cancer around 7.6 million human deaths are there. Additionally death rate caused by tumors is increasing and will become around 17 million in 2030[1].

In the medical imaging field there are different kinds of modalities like CT scan, MRI, PET scan which can be used to detect cancer. Among these CT imaging are reliable for lung cancer detection. However with only human eyes detection can become difficult or can become false in some cases because sometimes small nodules can be missed. With the rapid advancements in the field of medical imaging radiologists can take a second opinion from the computer generated results also called Computer Aided Diagnosis(CAD). There has been done many research in the detection of lung cancer but system still needs to achieve accuracy about 100%. A new model has been proposed in which image processing techniques and deep learning techniques are combined for detecting lung cancer.

II. IMAGE CASES

In the proposed system CT scan dataset of various patients has been used for implementing the model. Dataset has been downloaded from a standard archive called Lung Image Database Consortium(LIDC) [2]. LIDC has total 1018 different cases. All the images are in DICOM format having size 512*512 pixels, which were difficult to process. So the images has been converted into JPEG gray scale image using MicroDicom tool.

III. LITERATURE REVIEW

Many researchers have proposed and implemented model regarding early detection of lung cancer. Shoji Kido, Yasusi Hirano,Noriaki Hashimoto [3] proposed a CAD model in which CNN is used as a classifier and Region based CNN(R-CNN) for detection of different objects like tumor part using bounding boxes. The accuracy for classification is 95.2%,for diffuse lung diseases system has accuracy of 84.7%.The main advantage of the model is it does not require image feature extractor which is hard to implement instead it uses image itself. But the limitation of this model is to train CNN large dataset is required.

Lilik Anifah,Haryanto,Rina Harimurti,Zaimah Permatasari [4] have used median filter to remove noise from the image and histogram equalization for enhancement. They have used ROI based segmentation technique to extract tumor part and classification is based on Backpropogation neural network. They have extracted features like contrast, correlation, homogeneity, variance, energy using GLCM method. The accuracy of the model is 80% which is still less.

Deep Prakash Kaucha, Abeer Alsadoon, A. Elchouemi, Sasikumaran Sreedharan [5] proposed a model whose accuracy is 95.16%,sensitivity is 98.21% and specificity is 78.69%. They have applied preprocessing to remove noise. After that they have first extracted different regions from lung

image using ROI and then applied Discrete Wavelet Transform (DWT) as segmentation.DWT is having more memory and power consumption. Feature extraction is based on GLCM.SVM based classification to classify cancerous and non-cancerous tumors.

Suren Makaju, A. K. Singh [6] proposed a model having accuracy of detecting cancer is 92% and classifier accuracy is 86.6%.They have used median filter and Gaussian filter to remove noise. Gaussian filter gives somewhat blurred output because it smoothens the image. Sometimes after applying Gaussian filter pixels having important details also get missed out due to smoothening. They have used watershed algorithm for segmentation which can separate touching objects so that it can help proper segmentation of cancer nodules if it is touching to other false nodules. For classification they have used SVM. The model doesn't justify stages of the cancer.

K.Gopi [7] proposed a model having an accuracy of 92.46%.They have separated lung lobes from CT image in preprocessing stage using binarization, thresholding, segmentation. But in some cases tumor touches the lung walls so separating lung lobes from original CT image can also remove some details of tumor pixels. They have used EK means clustering algorithm for tumor segmentation. But clustering is sensitive to initialization condition of cluster number and centre. They have extracted features like entropy, correlation, convexity using GLCM and used SVM as a classifier.

IV. PROPOSED METHOD

A. Preprocessing

Preprocessing methods are useful for image intensity improvement, image enhancement, noise removal. In case of CT-scan images there may have some kind of noise due to image acquisition. Sometimes noise present in the image causes false tumor detection. To remove it there are different methods available, we have used Median filter to remove salt and pepper noise and wiener filter for preserving sharp edges and less blurring[8].

B. Tumor Detection

This process finds the tumor in the CT scan and describes it with a bounding box. In this proposed model region growing based segmentation has been used. Region based techniques generates clear object boundaries than other methods.

C. *Tumor Classification*

This step basically classifies the tumor is malignant or not. So that after watching the results doctor can start the treatment. For this CNN classifier is used. CNN requires image itself as an input rather than features extracted from an image because feature extraction is difficult and which feature we need to extract to find accurate result is also difficult. CNN is having an input layer, an output layer and multiple hidden layers. The hidden layer is mainly having three layers: Convolutional layer, max pooling and fully connected layers. Convolutional layers apply a convolution operation to the input, passing the result to the next layer. Convolution layer performs convolution operation to the input and passes it to the next layer. After the convolution process, an image downsampling is performed by the max-pooling layer. While such down-sampling can be done by averaging, empirical results have suggested that by taking the maximum in each sub-region can yield better performance in most cases [9]. Fully connected layers connect every neuron in one layer to every neuron in another layer.

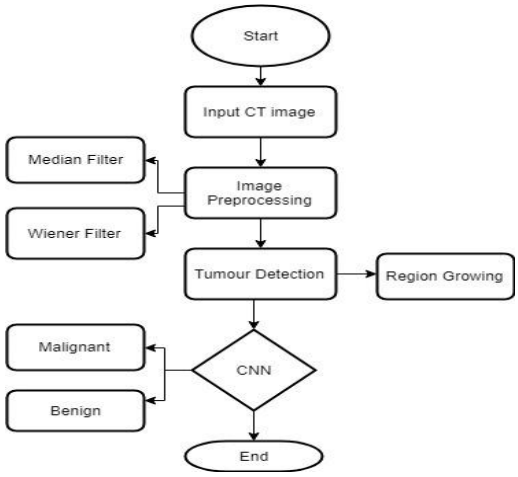

Fig. 1 Proposed System

V. RESULTS AND DISCUSSION

A. Preprocessing

Fig. 2 Original CT-scan

Fig. 3 Median Filter

Fig. 4 Median+Wiener

Table 1 Comparative analysis of preprocessing filters

	Entropy	SNR	PSNR
Median Filter	2.7011	0.1041	23.0296
Gaussian Filter	3.6901	0.0872	27.0961
Wiener Filter	3.6303	0.0278	37.8257
Median+ wiener Filter	**3.7443**	**0.1377**	**22.8465**

B. Tumor Detection

Fig. 5 Original Pre-processed image

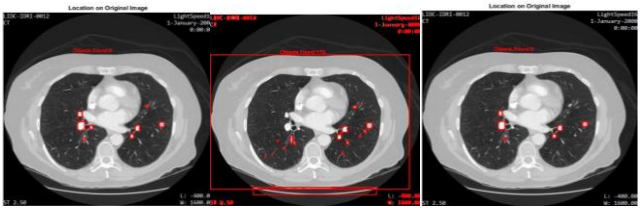

Fig. 6 Morphological operations

Fig. 7 Watershed based

Fig. 8 Proposed method

Table 2 Comparative analysis of tumor detection methods

Method	Execution time (sec.)	Area (pixels)	Perimeter (pixels)	Eccentricity	PSNR (db)	SSIM
Morpho -logical operations	12.6946	416	70.81	0.3801	5.8908	0.4966
Watershed segmen -tation	12.8984	523	80.724	0.3889	5.87	0.1704
Region growing	**11.6547**	**379**	**66.294**	**0.3994**	**5.9012**	**0.4958**

a. Description of parameters[10]:

1. *Area*: Number of pixels in the region.

2. *Perimeter*: Distance between the adjoining pair of pixels around the border of the region.

3. *Eccentricity*:

$$\text{Eccentricity} = \frac{foci\ of\ an\ eclipse}{major\ axis\ lenth} \quad (1)$$

4. *PSNR(Peak signal-to-noise ratio):*

$$PSNR = 10\log_{10}(peakval^2/MSE) \quad (2)$$

5. *SSIM(Structural Similarity Index Matrix)*:

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu^2{}_x + \mu^2{}_y + C_1)(\sigma^2{}_x + \sigma^2{}_y + C_2)} \quad (3)$$

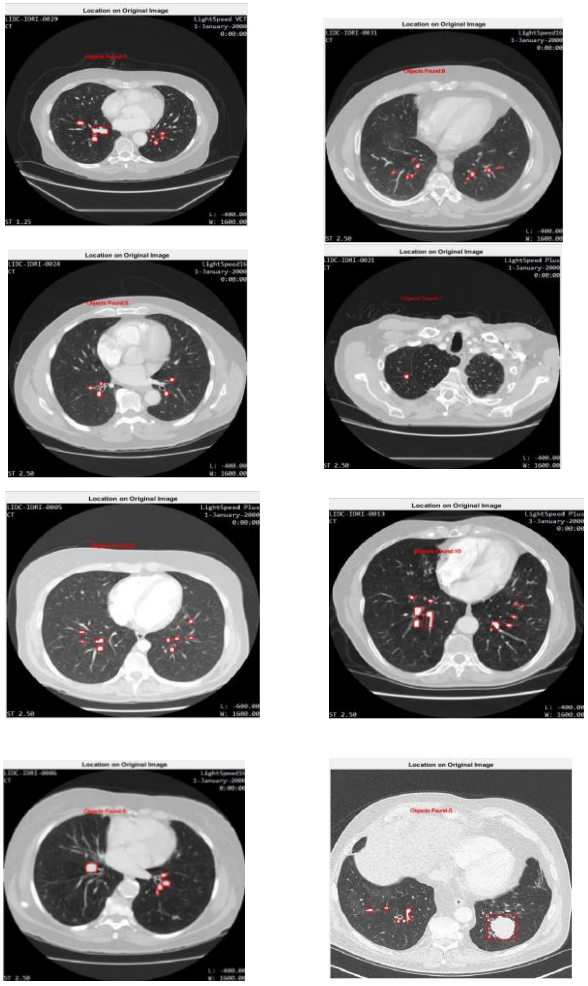

Fig. 9 Different cases of tumor detection

VI. CONCLUSION

This paper proposes a CAD model in which Region of Interest(tumor) has been identified. As seen in the results in addition with actual tumor area watershed and morphological operators identifies some pixels which are non-tumor pixels, so the area of identified tumor is more compared to the area of actual tumor part. The proposed algorithm identifies the tumor area nearly similar to actual tumor area having time efficiency. This work can be extended in future to classify the tumor as malignant or not using CNN.

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