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Optimal Deep Learning Model to Identify Lung Cancer on CT images

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Abstract-
Lung cancer is among one of the most parlous and deadly disease in all over the world. Although, prior detection and medication can save life. Computed Tomography (CT) scan images are the best form to diagnosis the cancer which makes difficult for the doctors to explicate and detect the cancer from CT scan images. The main motive behind this research is to compare the various computer-aided techniques and analyze current best technique with their limitation and drawbacks and finally give the new improved model. The method used in the lung cancer detection till now has low accuracy so a new model will be given to attain higher accuracy rate by modifying the methods which are currently used and removing the limitations and drawbacks. Our model is valid for a large number of lung nodules which increases the variation in data and analysis and detection more challenging.

Introduction

Lung Cancer is one of the most terrifying diseases in today's world. For any disease to be detected it should be analyzed and upon analysis further medical treatment is to be done, this means that firstly person symptoms are to be analyzed and if any further analysis is needed it is sent to some specialist for more precise analysis. This all can be done with

the help of patient's data, so all the data (digital data like ct scans, x-ray) is to be collected in some database for the analysis. In today's world, Deep Neural Network is very popular to detect the image classification and recognition, which category is belonging to. Early detection of tumor in cancer treatment is very crucial. It can be done using many techniques that is available to us i.e. Computed Tomography, Magnet Resonance Imaging (MRI). If the lung tumor is not detected at early stage the chances of survival is less as compared to that it detected at early stage. Cancer treatment is only possible if it is separated from normal cells, cancer cell is to be separated from normal cells in the human body. Extraction of the tumor cells can be extracted with the help Deep Neural Network and CAD System. Lung Cancer nodule is detected using CAD system. It can also be applied in many different medical areas. DNN is used in image recognition and patterns. Latest Development in DNN improved the image recognition. This paper presents the technique to determine the lung tumor.

1 Literature Review

Many researchers has suggested and implemented prediction of cancer using various techniques and technologies like machine learning and image processing. 2 Aggarwal, Furquan and Kalra [7] developed a model which categorizes between normal lung and nodules structure. This method uses LDV to classify and optimal thresholding is considered for segmentation with help of various methods like geometrical and statistical. This system has an accuracy rate of 84% with 53.33% specificity and 97.14% sensitivity. In their model elementary segmentation is used and no any machine learning techniques were used for classification and also it has a low accuracy rate which is unacceptable. Jin, Zhang and Jin [3] proposed a model using CNN (Convolution Neural Network) as a classifier to identify the cancer nodule. This system has an accuracy rate of 84.6% with 86.7% specificity and 82.5% sensitivity. In this model circular filter is used in Region of interest (ROI) during extraction phase which reduces the cost of training the model but there is no satisfactory improvement in accuracy. Sangamithraa and Govindaraju [4] suggested a method which uses unsupervised learning algorithms for segmentation and clustering. Back propagation network is used for classification. This system has an accuracy rate of 90.6%. GLCM (Gray-level cooccurrence matrix) is used to extract various features like homogeneity, entropy, correlation. From this model we observed that median filter was applied for removal of noise which we can use for removing noise and attaining greater accuracy rate. Roy, Sirohi, and Patle [8] proposed a model which uses active contour and fuzzy system to detect cancer nodule. Here contrast of image is enhanced by using gray level transformation. Before segmentation image binearization is done and then processed by active contour model for segmentation. Inference method is here used to classify the image. The accuracy rate of 92.4% is calculated by using trained

model which was trained on various parameters like entropy, area, mean minor and major axis length. The drawback in this model is that it also does not categorize the cancer nodule as beginning or advanced which may be future scope of the model. Ignatious and Joseph [9] suggested a system which uses watershed segmentation. In this model Gabor filter is used to enhance the image quality in pre processing stage. When compared with the model which uses neural fuzzy model and the region growing technique it has higher accuracy of 90.1%. This model also does not classify the cancer nodule in its phases as in this marker controlled watershed segmentation is used. So, further changes can be made to increase the accuracy rate. Gonzalez and Ponomaryvo [5] developed a system which classifies lung cancer in two phases that is malignant or benign. In this system Region of Interest (ROI) is calculated on the basis of previous information and Housefield Unit(HU). Various features were extracted on basis of variety of parameter like shape which contains eccentricity, circularity, area and textural like energy, variance, mean to train the SVM to classify the cancer as beginning or advanced. It is different than other models as it tells phase of lung cancer nodule that it is in advanced stage or beginning but to identify that ROI is required previously. We can use this classification using SVM by a little modification in our proposed model. After analyzing and a detail study we came to conclusion that the model given by Ignatius and Joseph [9] is current best model which uses Gabor filter for image enhancement and marker-controlled watershed segmentation to detect the cancer nodule. It has accuracy rate of 90.1% which is higher than other all other. After comparing all features this have also some limitations as:

• It does not classify image on the basis of phase that it is beginning or advanced.
• In feature extraction many features are there which are not considered.
• In preprocessing phase only, a single filter is applied instead many other can also be used to enhance the image quality and more accuracy.

2 Proposed Methodology

On the basis of some changes that have been made on current best model a new improved model has been given as shown in below diagram where some filters are changed in pre-3 processing stage. First of all image will pass through various filters like Median filter, Gaussian filter than the segmentation part is done using watershed segmentation where in addition with various feature like area and perimeter some other details get extracted like Diameter, Intensity and Centroid which helps in categorizing the cancer nodule. Till now the current best model ends after detecting the cancer nodule, extracting features and calculating accuracy, while in this model we can also detect the phase of cancer either it is beginning or moderate or last stage. This classification phase will be carried out with the help of Support Vector Machine (SVM). The features which were extracted during extraction phase will be used to train the model and then cancer nodule will be detected and classified based on the trained model.

2.1 CT scan Images

Firstly, we will take the CT scan images from data sets which contain various different images of similar case. Lung Image Database Consortium (LIDC), Image Database Resource Initiative (IDRI) are the publicly available database which contains 1018 CT scan images with different shapes and sizes. Here images lies in DICOM format (512*512 pixels) which is difficult to process so, we convert them to JPEG format using Gray scale imaging with help of MicroDicom software.

2.2 Image Processing

The CT scan images from database contain various noises which may result in false detection of cancer nodule. The noises are needed to be removed for accurate detection of nodule. So, in image processing Median filter is applied on grayscale images which remove salt and pepper noise from the CT images [2][6]. Then Gaussian filter helps in image smoothening and removing speckling noises. We used MATLAB to develop the model and apply functionalities which has machine learning tools which are used for research and analysis purpose.

2.3 Segmentation

By using segmentation, we can obtain region of interest in the image with help of objects and boundaries [10]. In this step image is portioned into various regions to identify important information. In given model watershed segmentation is implemented which segments cancer nodule from the CT scan image. It has a feature separate the objects sharing boundary which helps in proper segmentation which reduces chances of detecting false nodules [1].

2.4 Feature Extraction

To train the model to classify the nodule various parameters are needed like perimeter, diameter, centroid, area, intensity and eccentricity which are extracted during this phase.

2.5 Classification

In this step we classify the detected nodule as it is in beginning phase or advanced phase. We use SVM (Support Vector Machine) as a classifier which is a supervised learning method which contains a function to find out nodule lies in one of which two phases. The function is $Z(x) = a^t .xi + b$ where xi are training inputs, at is m dimensional vector, and b is bias term. Here, i=1…. N.

$$Z(x) = a^t .xi + b \geq 1 \text{ for } yi=1 \quad (1)$$

$Z(x) = a^t .xi + b \leq -1$ for yi=-1 (2)

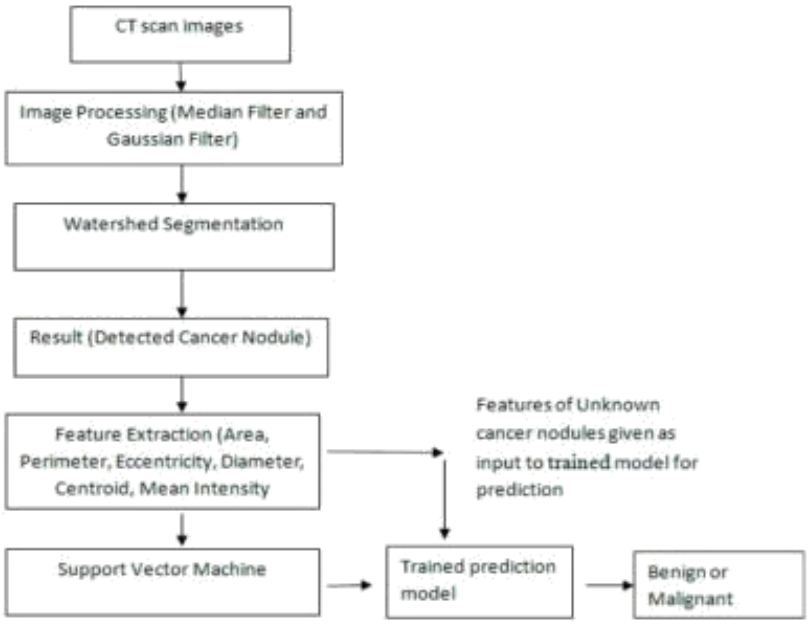

Fig. 1. Proposed Model

Some improved features of this model are:

• Salt-pepper and speckle noises are removed which generates false detection.

• Increased accuracy.

• Classification as beginning or advanced.

Some drawbacks are as follows:

• It only classifies cancer in two phases than detailed stages like I, II, II• It has increased accuracy but it can be further increased nearer to 100%.

4. Result

Our proposed model has accuracy from 92.3% to 96% while there is not effective change in sensitivity and specificity is also increased from 35% to 48%. We got the result by comparing with the current model. In Feature detection phase various features where extracted like perimeter, diameter, centroid, area, intensity and eccentricity which were used to train the SVM and a trained model was made using this data of detected cancer nodes. The average time taken by classifier was 5.56sec. Classifier helps to decide prediction time which is 293 observations per second.

Table 1. Comparison analysis of Current and Proposed model

r Current best Model	r Proposed Model
tal number of nodes detected=24	tal number of nodes detected=24
mber of True Positive (TP)=21	mber of True Positive (TP)=22
mber of True Negative (TN)=2	mber of True Negative (TN)=2
mber of False Positive (FP)=3	mber of False Positive (FP)=1
mber of False Negative (FN)=0	mber of False Negative (FN)=0
curacy=23/26=88.4%	curacy=24/25=96%
nsitivity=TP/(TP+FN) =21/21=100%	nsitivity=TP/(TP+FN) =22/22=100%

So, we can conclude that a higher accuracy is attained than current best model along with the classification of cancer nodule which was not present in previous model. A better result is given by our proposed model.

5. Conclusion

A Deep Neural Network based system is implemented to classify the tumor which causes cancer using CT images, X-ray. Many images of lung are collected from many different sources of different shapes and sizes. Tissue size is given as input for the training of the system. The system is able to detect the cells which cause cancer with the accuracy rate of about 96% and our classifier has a accuracy rate of 93.3%. In Future, this system will be trained with larger dataset to detect different shapes size of cancer. System accuracy is more improved with the help of 3D Convolution Network. Further classification can be made in stages which are now as beginning and advanced.

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