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Detection of Lung Cancer from MRI Scan Images Using Image Processing Techniques

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Abstract: ***Lung cancer is one of the causes of death. Early detection of lung cancer can save the life of a patient. The detection is done by many different techniques i.e, image processing, Computer-Aided Design, etc. Digital image processing is the latest emerging tool in the medical field where researchers used for the early detection of cancer. Magnetic resonance imaging(MRI stands) of the lungs of the patient from the lung image database is used as input data for image preprocessing. In preprocessing stage conversion of the RGB image to the grayscale image takes place. Grayscale images are further converted to binary images. After image-processing, the input images become more efficient and refined. These input images are used for the convolution neural network. Convolution filtering, Max pooling filtering steps are been in CNN which will train the dataset to predict whether lung image is cancerous (Malignant) or Non-cancerous(Benign).In this paper image processing procedures such as image preprocessing, segmentation feature extraction have been implemented for different algorithms such as Support Vector Machine, K- Nearest Neighbour, Convolution Neural Network, Artificial Neural Network using the image and the CSV files with the result of 100%, 66%, 97.70%, and 83% respectively.***

Keywords: Lung cancer detection; Convolution Neural Network, Support vector machine, K-nearest neighbor, Artificial Neural Network.

I. INTRODUCTION

Lung cancer is one of the most serious cancers in worldwide diseases, which has a less survival rate after the diagnosis, with a gradual increase in the number of deaths every year. The survival rate from lung cancer is directly related to its growth and its detection time. Lung cancer is prominent cancer as it states a large number of deaths of more than a million every year. Lung cancer is the uncontrolled growth of the cells, thus leading to the formation of lung nodules. It is reported that lung cancer is responsible for around 20% of deaths globally mostly due to alcohol and tobacco consumption. The survival rate is assured by 15% chances, for the survival period of 5 years. The main cause of such a high death rate is the detection in a later stage, thus leading to delay treatment. If lung cancer is detected in the early stage the survival rate can increase up to 50-70%.

Fig 1: Non-Cancerous

The extent of the spreading of cancer is the basis for the division of lung cancer stages. It comprises of four stages namely stage-I- The cancer is confined to the lung, stages II and III- the cancer is confined to the chest, and stage IV cancer has spread from the chest to other parts of the body. There are many techniques to diagnose lung cancer such as X-rays, CT (Computer Tomography) scan, or MRI (Magnetic Resonance Imaging) scan, etc. The problems of techniques are that it can be time-consuming and makes detection possible at a later stage.

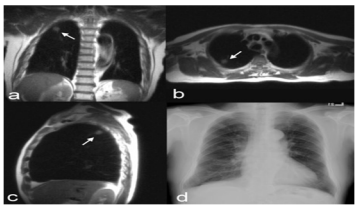


Fig 2: Cancerous

II. LITERATURE SURVEY

A. MRI for the staging provides additional information with advancement in it, whole-body MRI with DWI(Diffusion-Weighted Imaging) is emerging as a single, cost-effective imaging technique that is comparable to the 18FDG-PET/CT(18fluorodeoxyglucose positron emission tomography CT) for staging patients with metastatic carcinoma. The advantage of MRI it has superior soft-tissue contrast comparing to the CT scan, and MRI provides the morphologic and functional data with diffused-weighted. DWI has a high specificity for the N staging of non-small cell lung cancer (NSCLC) compared with 18F-FDG-PET/CT. MRI is accurate for diagnosing skeletal metastasis. The diagnosis accuracy of the whole-body MRI with the DWI is up to 87.7%. The accuracy of integrated 18-FDG-PET/CT is 90.4% was significantly higher than the whole-body MRI without DWI is 85.5% with brain metastasis excluded.

B. Lung MRI scan techniques have reduced the examination time and improved diagnostic sensitivity and specificity. To understand the use of it they had conducted a study to assess the feasibility of MRI for the detection of lungs. So, they had images that were acquired using either one of two scanners(Sonata and Sonata Maestro, Siemens Medical Solutions). There are standard protocols followed for the lung examinations consisted of two components. The first involves a quick whole-lung survey with T2-weighted 2D HASTE(2-dimensional half Fourier acquisition signal shot turbo spin-echo) and the second involves which was performed with 3-dimensional axial image acquisition using the 3D VIBE(volumetric interpolated breath-hold examination) technique with fat suppression. To examiners who had additional contrasted MRI, HASTE was applied before contrast agent injection, and VIBE was applied after the contrast agent injection using 1/2 mmol/kg of gadodiamide (Omniscan) at an injection rate of 3mL/sec**.**

C. There are various advantages of MRI such as (1) it doesn't only detect the morphological information but can also detect pulmonary nodules; (2) characterization of solid pulmonary nodules; (3) prediction of post-surgical lung function; (4) prediction of tumor treatment response. Computer tomography techniques have been said to efficiently reduce the radiation dose whereas MRI doesn't provide such facilities which might be a matter of concern to the patients. The specificity and accuracy of MRI(93.6%) were significantly higher than those of dynamic CT techniques(83.6%).

D. One of the advantages of MRI over all the other scanning techniques is that MRI images help in depicting the early response to chemotherapy in patients with NSCLSC. It is also applicable to patients with renal dysfunction or poor respiratory condition. One major drawback of MRI is that it doesn't work well to take pictures of the lungs which move while each breath is taken.

E. A lung nodule detection method for thoracic MR images is proposed based on deep learning. With an optimized parameter, spatial three-channel input, and transfer learning, Faster R-CNN is designed for lung nodule detection. The detection scheme can avoid candidate extraction and be less dependent on scale. As Faster R-CNN does not consider anatomical characteristics, many FP regions exist in the detection results. Advantages: To avoid candidate extraction and be less dependent on scale, Faster R-CNN is designed for lung nodule detection and, an FP reduction scheme is proposed. With parameter optimizing, spatial three-channel input construction, and transfer learning, a faster R-convolution neural network (CNN) is designed to locate the lung nodule region.

F. A drawback of sample sizes of 120 patients in the PET-CT plus brain MRI group and 143 patients in the MRI-PET group provided 82% power to detect a difference of 15% versus 30%, respectively, at a significance level <5%. Second, instead of the simultaneous acquisition and integration of imaging data from MRI and PET (as in so-called ''simultaneous MRI-PET''), co-registered images from those 2 modalities were used for image interpretation. Advantages: MRI is advantageous for characterizing soft tissue malignancies, such as brain, bone, muscle, head and neck, breast, and liver primary tumors. MRI-PET is expected to be more accurate than PET-CT for tumor classification in primary tumors, whereas MRI is more advantageous than CT for characterizing soft tissue malignancies. MRI-PET can be advantageous compared with PET-CT for identifying metastases, depending on the target organs. Co-registered MRI-PET may help to guide appropriate treatment and to correctly predict prognosis by significantly reducing the number of under staged patients.

G. A Fully Convolutional Deep Neural Network for Lung Tumor Identification has an advantage: The software provides a detailed report on the MRI image displaying the affected area colored in red. The proposed study gives an accuracy upto90-95%. A major drawback of using CT scans over MRI scans. 3D CNN techniques are highly preferred over all the other techniques since it provides a broader spectrum for the detection of the tumors.

H. The network can be trained end-to-end from image patches. Its main requirement is the availability of a training database, but otherwise, no assumptions are made about the objects of interest or underlying image modality. The model proposed is said to determine whether or not the patient has cancer but it does not determine the exact location of the cancer nodules. After using the Kaggle dataset, the accuracy comes up to 89%, whereas on using the LUNA16 dataset, the accuracy comes up to 85%.

III. METHODOLOGY

The following algorithms are implemented to study the accuracy of the cancer-

A. Convolution Neural Network

Convolution neural network are special type of feed forward artificial neural network in which connectivity pattern between its neuron is inspired by the visual cortex. The visual cortex encompasses a small region of cells that are region sensitive to visual fields. The Convolution neural networks, which are also called covnets, are nothing but neural network, sharing their parameters.

Steps:

1) Convolution Operation
2) ReLU Layer
3) Pooling
4) Flattening
5) Full Connection

B. Support Vector Machine

SVM is one of the most popular supervised learning algorithm which is used for classification as well as regression problems, however primarily it is used for classification problems in machine learning. The goal of SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future.

Steps:

1) Import the dataset
2) Explore the data to figure out what they look like
3) Pre-process the data
4) Split the data into attributes and labels
5) Divide the data into training and testing sets
6) Train the SVM algorithm
7) Make some predictions
8) Evaluate the results of the algorithm.

C. K-nearest Neighbor

KNN algorithm is a type of supervised machine learning algorithm which can be used for both classification as well as regression predictive problems. However it is mainly used for classification predictive problems in industry.

STEPS:

1) Determine parameter K=number of nearest neighbor.
2) Calculate the distance between the query instance and all the training samples.
3) Sort the distance and determine nearest neighbor based on the K-th minimum distance.
4) Gather the category Y of the nearest neighbor.
5) Use simple majority of the category of nearest neighbor as the prediction value of the query instance.

D. Artificial Neural Network

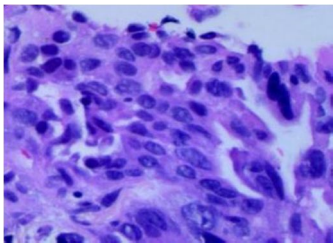
ANN is the piece of computing system designed to simulate the way the human brain analyses and processes information. It is the foundation of Artificial Intelligence(AI) and solves problem that would prove impossible or difficult by human or statistical standards.

STEPS:

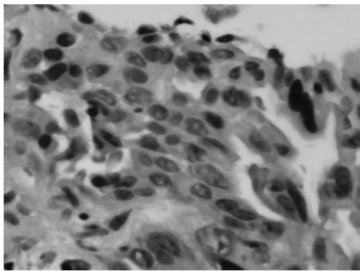
1) Choice of model architecture
2) Choice of stopping criteria
3) Choice of optimization method
4) Validations

IV. RESULT AND DISCUSSION

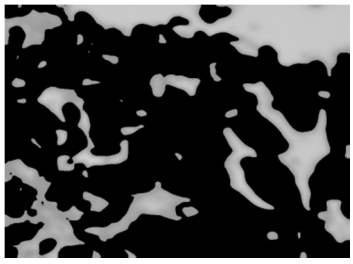
A. Input Image



B. Applying Median Filtering technique for the image

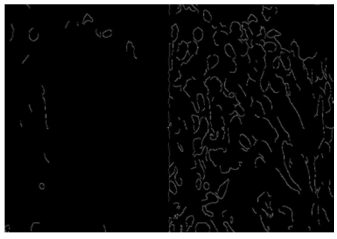


C. Applying Threshold Segmentation For the Image

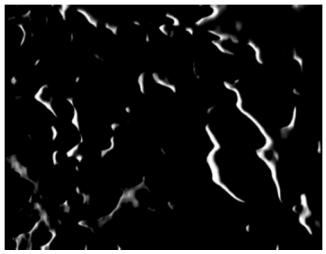


D. Applying the Boundary Edge Detection Using Canny for the Image

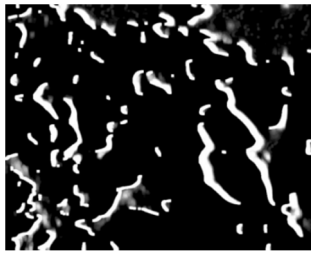
Applying Morphological operation that is thinning image and region filling and texture and color for the image.



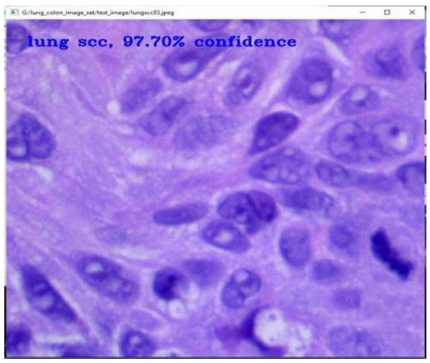
E. Thinning Image



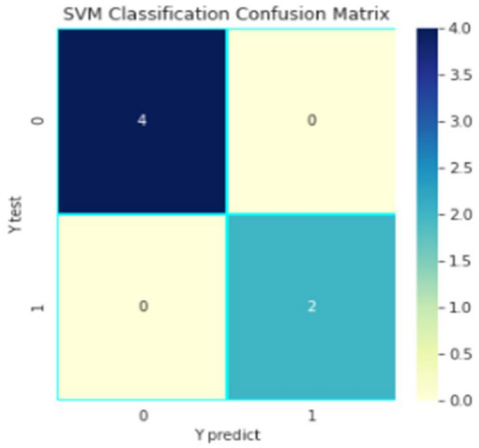
F. Region Filling



G. Classification Using CNN



H. Classification using SVM



Confusion Matrix using SVM

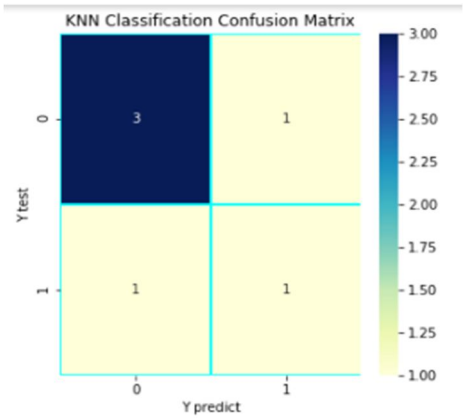
I. Accuracy of SVM algorithm is 1.0

```
from sklearn.metrics import classification_report,confusion_matrix
print(classification_report(Y_test, Y_predict2))
```

	precision	recall	f1-score	support
0	1.00	1.00	1.00	4
1	1.00	1.00	1.00	2
accuracy			1.00	6
macro avg	1.00	1.00	1.00	6
weighted avg	1.00	1.00	1.00	6

Prediction classification accuracy using SVM

J. Classification using KNN



Confusion Matrix using KNN algorithm

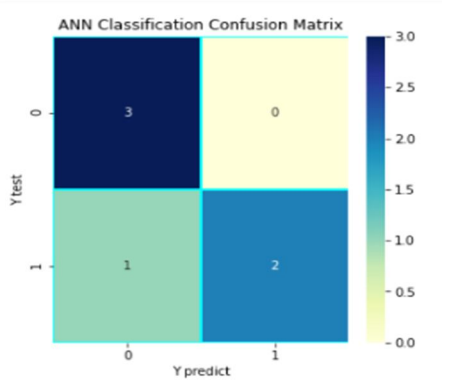
K. Accuracy of KNN algorithm is 66%.

```
from sklearn.metrics import classification_report,confusion_matrix
print(classification_report(Y_test, Y_predict6))
```

	precision	recall	f1-score	support
0	0.75	0.75	0.75	4
1	0.50	0.50	0.50	2
accuracy			0.67	6
macro avg	0.62	0.62	0.62	6
weighted avg	0.67	0.67	0.67	6

Prediction Classification accuracy using KNN

L. Classification using ANN



Confusion Matrix using ANN algorithm

M. Accuracy of ANN Algorithm is 83%.

```
from sklearn.metrics import classification_report,confusion_matrix
print(classification_report(y_test,y_pred))
```

	precision	recall	f1-score	support
0	0.75	1.00	0.86	3
1	1.00	0.67	0.80	3
accuracy			0.83	6
macro avg	0.88	0.83	0.83	6
weighted avg	0.88	0.83	0.83	6

Prediction classification accuracy using ANN.

V. CONCLUSION

A comparative analysis of four different image processing techniques are carried out for lung cancer detection using Convolution neural networks, Support vector machine, K-nearest neighbour and Artificial neural network algorithms for lung cancer detection classification. From the study it is observed that machine trained with CNN, SVM, KNN, ANN classifiers gives an accuracy upto 97.70%, 100%, 60%, 83%. respectively.

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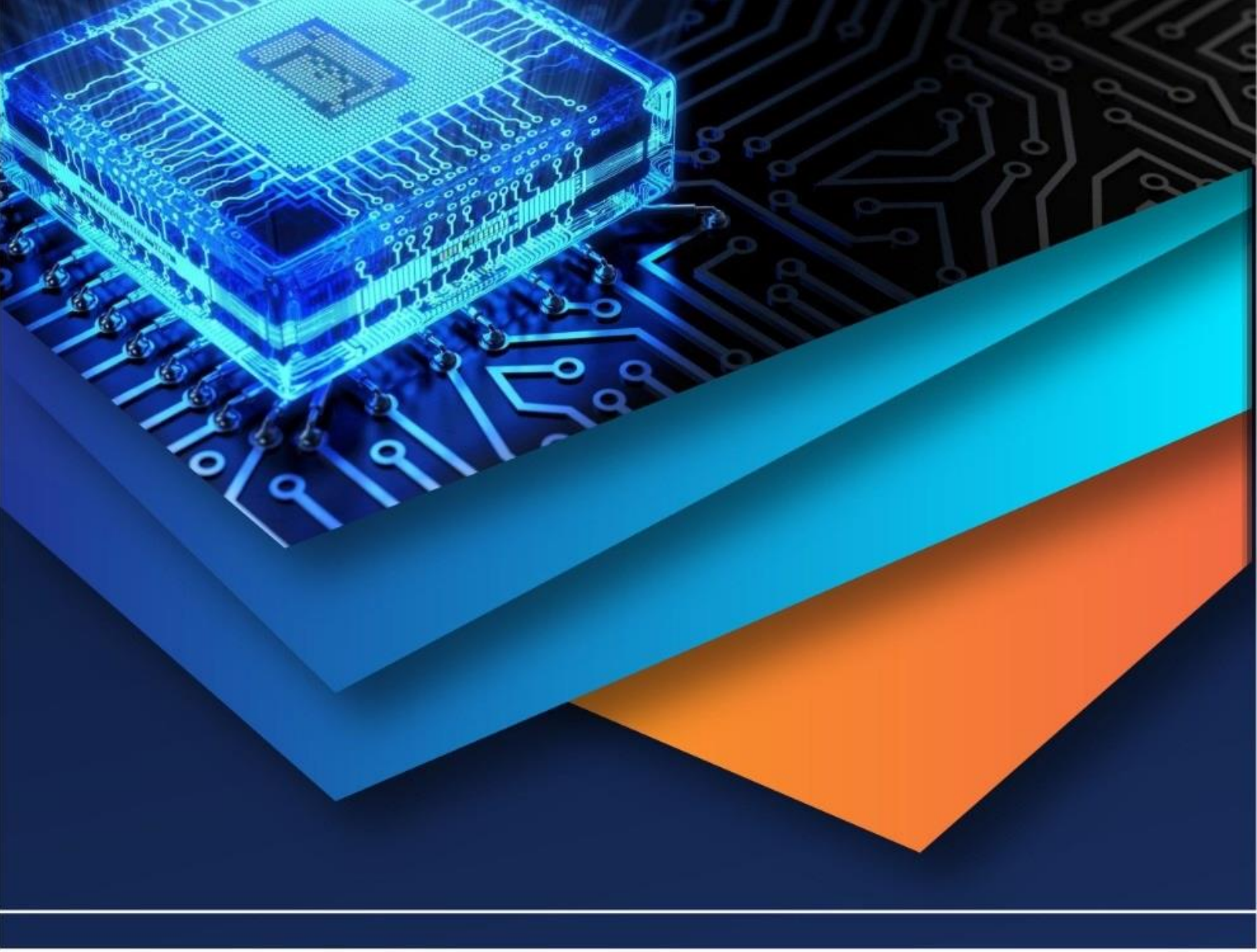

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