Lung Cancer Detection Using Image Processing

Mr. Vishal Patil
Assistant professor in Instrumentation department at VPM's MPCOE, Ratnagiri

Dr. Aditya Gupta
Assistant professor in Electronics & telecommunication department at COEP, Pune

Mr. Avinash Pawar
Principal at VPM's MPCOE, Ratnagiri

Abstract- The objective of this paper is to explore an expedient image segmentation algorithm for medical images to curtail the physicians' interpretation of computer tomography (CT) scan images. Modern medical imaging modalities generate large images that are extremely grim to analyze manually. The consequences of segmentation algorithms rely on the exactitude and convergence time. At this moment, there is a compelling necessity to explore and implement new evolutionary algorithms to solve the problems associated with medical image segmentation. Nowadays, Image processing methods are commonly used in many medical areas for improvement of image for earlier detection and treatment stages. Early prediction of lung cancer can increase the survival rate of patient by using imaging tests such as computer tomography (CT) which gives better image quality and results. In Image processing procedures, methods like pre-processing, segmentation methods like thresholding or K-means clustering and feature extraction are discussed. It is the target to get more accurate results by using image enhancement and segmentation techniques on MATLAB software.

1. INTRODUCTION

Lung cancer is one of the most horrible maladies in creating nations and its death rate is 19.4% [1]. Early recognition of lung tumors is finished by utilizing many imaging strategies, for example, Computed Tomography, Sputum Cytology, Chest X-beam, and Magnetic Resonance Imaging. Location implies grouping tumor two classes (i)non-carcinogenic tumor and (ii)cancerous tumor (malignant)[2]. The possibility of endurance at the propelled stage is less when contrasted with the treatment and way of life to endure malignant growth treatment when analyzed at the beginning time of the disease. Manual examination and determination framework can be extraordinarily improved with the execution of picture handling procedures.

1.1. Lungs and Lung Cancer

Lung consists of two parts as right lung and left lung within the chest. The right lung consists of 3 sections and they are called lobes. The left lung has 2 sections [6-8]. The right lung is bigger and the left lung is smaller in order to give space for the heart. Trachea is the wind pipe which takes air in to the lungs during breathing through nose or mouth. The trachea gets separates into tubes known as bronchi. The bronchi which go into the lungs is further separated into smaller bronchi. These smaller branches are called as bronchioles. At the edge of the bronchioles, minute air sacs are present called as alveoli. During breathe in the alveoli absorb oxygen into the blood and removes carbon dioxide from the blood while breathe out. Since the primary function of the lungs is to mix the oxygen in to the blood and removes carbon dioxide from it. Lung cancers usually start from the cells backing the bronchi and from the bronchioles or alveoli of the lungs.
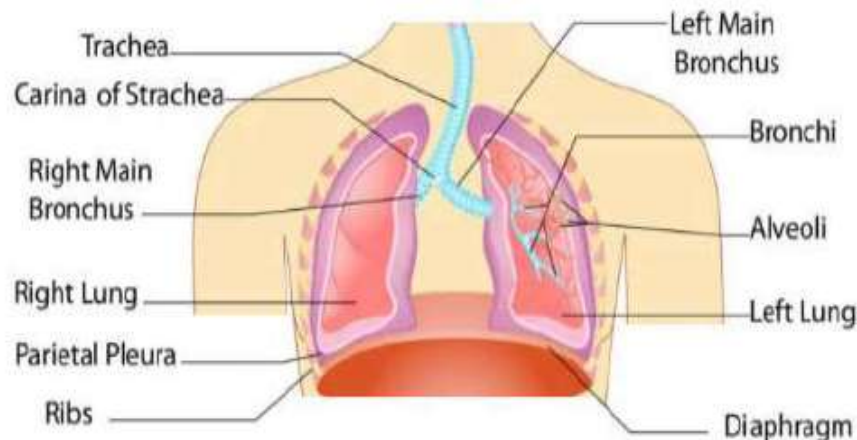
A protecting sheath surrounds the lungs known as the pleuron which protects the lungs. This pleura assists the lungs to move backward and forward towards the chest wall during breathing. A slim, dome-shaped muscle present under the lungs, which separates the chest and the abdomen is called diaphragm. During breathing, the air is forced in and out of the lungs by the up and down movement of the diaphragm. Most cancers begin, when there is an abnormal growth of cells in the body. A form of cancer that is found in the lungs are

called Lung cancers. The two major types of lung cancer are small cell lung cancers and Non-small cell lung cancers (NSCLC).It is found that 85% of the lung cancers are NSCLC [9-10]. The NSCLC are further classified as large cell carcinoma, adenocarcinoma and squamous cell carcinomas. Adenocarcinomas start in the cells that secrete typical substance along with mucus [11].

Lung cancers are diagnosed mostly with people who smoke [12]. Lung cancers are also visible in people who do not smoke [13] which are due to second hand smoking. It is more common in ladies whose husbands smoke. Adenocarcinoma occurs in the exterior of the lung and it may be detected before it spreads. Squamous cells are flat cells that rim the inner way of the airways within the lungs. The cancer occur in it is called as Squamous cell carcinomas. This cancer is mostly related to the his-tory of smoking. Any part of the lung may be affected by large cell carcinoma. It is a dangerous cancer which may develop and spread quickly, making the treatment tougher. Large cell neuroendocrine carcinoma is a subtype of large cell carcinoma, which is a quick growing lung cancer. The cancer that start form the lung only is called as lung cancer .The cancers which spread from different organs like breast, kidney and pancreas to the lungs are not lung cancers [14].

1.2 Motivation:

Various investigate on the picture handling methods to recognize the beginning time disease location is accessible in the writing. Be that as it may, the hit proportion of beginning time recognition of malignant growth isn't extraordinarily improved. With the progression in the AI procedures, the early determination of the malignant growth is endeavored by a parcel of scientists. The neural system assumes a key job in the acknowledgment of the malignancy cells among the typical tissues, which thus gives a powerful device to building an assistive AI-based disease identification. The disease treatment will be successful just when the tumor cells are precisely isolated from the typical cells Classification of the tumor cells and preparing of the neural system frames the reason for the AI-based disease analysis [3]. This paper presents a CNN based technique to order the lung tumors as harmful or amiable.

1.3 Background

Lung cancer is increase in the cancer cells of the lungs. Lungs have primary work to provide oxygen to the body. But these abnormal cells do not help lungs to carry out it's function. Lung cancer can be spread throughout our body with the help of lymph nodes. These stages are called metastases. In lung cancer there are two types basically and that are small cell cancer and non-small cell cancer. Non-small cell cancer is mainly identified nowadays in many persons. There are three types of non-small cell cancer and that are adenocarcinoma, squamous cell cancer and large cell carcinoma. In these three types, adenocarcinoma is found out in many persons [1].

This research is made to be useful for estimating survival of a lung cancer patient, but it can teach doctors in decision making about the condition of patient and improve inform patient consent by giving a good understanding of risk which are present in treatment procedure, based on condition of patient. We can save some costly resources also which are not necessary for patient by taking information of condition of patient. Lung cancer is fourth in various type of cancers, in males and 6th in females. Overall in males and females it ranked third after breast and cervical cancer. Despite many advances nowadays in terms of diagnostic methods, some minor changes and theory interventions, the results of lung cancer patients remains very bad; hence, good understanding in risk factors may give better impact on preventive measures to be set in community level[1]. The main causes of lung cancer is cigarette and tobacco usually. Nowadays the causes are increased to smoke taken from any other person, exposure of certain toxins and history of family too.

1.4. Causes of Lung Cancer

The main cause of present days deaths are due to Lung cancers in both women and men. Today, nine out of 10 lung cancer deaths are caused by smoking. The various causes of lung cancers are discussed below

1.4.1. Smoking

Cigarettes [15] are packed with cancer-inflicting chemical substances. In addition they spoil the lungs' natural protection system. To protect the lungs, the airways of the lungs are lined with tiny hairs known as cilia. They sweep out pollution, bacteria, and viruses from the air while breathing. The cilia is affected by the tobacco smoke and stops working in doing its job. This is the main reason for the cancer-causing chemicals to build up in the lungs and. The cancers starts quietly. During the early stages, no symptoms or warning are found due to cancer .But when it get worse, the following symptoms may be noticed

1. Chest pain, during deep breathing
2. Cough that won't go away
3. Bloody phlegm when Coughing
4. Wheezing or shortness of breath,
5. Fatigue

1.4.2. Second hand Smoke

Even though the main cause of lung cancers is smoking, breathing in the second hand smoke released by a smoker is also danger. This second hand smoke which occur at domestic or at work place also may increase the risk of danger [16- 17]. It is found that woman's who are married to a smoking person are 20% to 30% more likely to get lung cancer when compared the woman's of non-smokers.

1.4.3. Risky work

Some of the working environments may also be the cause of lung cancers. People who are working with the metals such as uranium, arsenic, and other chemical substances have more chances for cancer and they should try to limit their exposure with such metals. People working with asbestos, for insulation, may also prone to lung cancer.

1.4.4. Radon Gas

This natural radioactive gas [18-20] which can build up inside the houses may increase the risk of lung cancers. It is found to be the second leading cause of lung cancer in some countries. This gas can"t be smelt or seen, but the presence of it can be identified using test kit.

1.4.5. Air Pollution

Air pollution is also a cause for cancer, but it less prone when compared to smoking, but for good health it is better to avoid air pollutants [21-23]. It is found that pollutants from vehicles, power plants and factories also affect the lungs like second hand smoke does. Also it is cited that each and every car corporation is producing minimum of two hundred Cars per day in India which adds air pollution.

1.5 Objective:

The aim of the proposed system is to detect the tumor in lung by using image segmentation technique and feature extraction.

2. REVIEW OF LITERATURE

2.1 Research Gap

Lung cancer detection using CT scan images of the chest. According to this paper, a computer aided lung cancer detection system involves three main processing stages: enhancement, segmentation and feature extraction. Further, these stages are explained in detail with all possible methods that can be used in each of the stages. Methods used with enhancement are: Median filter, Auto enhancement, Fast Fourier transform. Methods used with segmentation are: Thresholding approach, Watershed Segmentation, Region Growing Segmentation. Feature extraction includes parameters such as Area, Perimeter, Mean, Standard deviation. In the end it compares the efficacy of methods like Neuro-Fuzzy model and Region Growing Method against CT image analysis [1].

Fuzzy C-Means (FCM) and different extensions of FCM algorithm are discussed. The exclusive FCM algorithm yields better results for segmenting noise free images, but it fails to segment images downgraded by noise, outliers and other imaging artifacts. This paper presents an image segmentation approach using Modified Fuzzy Possibility C-Means algorithm (MFPCM), which is a generalized adaptation of the standard Fuzzy C-Means Clustering algorithm and Fuzzy Possibility C-Means algorithm [2].

The flaw of the conventional FCM technique is eliminated by modifying the standard technique. the Modified FCM algorithm is defined by modifying the distance measurement of the standard FCM algorithm to permit the labeling of a pixel to be influenced by other pixels and to restrain the noise effect during segmentation. Rather than having one term in the objective function, a second term is included, forcing the membership to be as high as possible without a maximum frontier restraint of one. Experiments are carried out on real images to observe the performance of the proposed modified Fuzzy Possibility FCM technique in segmenting the medical images. Standard FCM, Modified FCM, Possibilistic C-Means algorithm, Fuzzy Possibilistic C-Means algorithm are compared with Modified FPCM to explore the accuracy. The three most important parameters used to determine the accuracy of the Modified FPCM are similarity, false positive and the false negative ratio [3].

SVM classifier is used for classifying the tumor as Benign or Malignant once the CAD (Computer Aided Diagnosis) system for finding the lung tumor using the lung CT images is in place. Support vector machines are supervised learning models with corresponding learning algorithms that perform data analysis and pattern recognition, used for classification. The basic SVM takes a collection of input data and for each input given, predicts which of the two classes forms the input, making it a non-probabilistic binary linear classifier. From the given set of training example data, each noted as belonging to one of two categories, an SVM algorithm builds a model that assigns new examples into one category or the other. In the proposed system, we choose the linear classifier technique. Best hyper plane is the one that exhibits the largest separation or margin between the two classes. So we choose the hyper plane such that its distance from the nearest data point on each side is maximized. Such a hyper plane is known as the maximum margin hyper plane and the linear classifier it defines is known as a maximum classifier. In case of SVM classifier out of 9 features at a time only two features are selected for classification, which produces result as either benign or malignant [4].

Variation in nodule size, variation in the density of the nodule and difficulty of appearance of nodule anywhere in the lung field, where they are likely to be obscured by ribs, the mediastinum and similar structures beneath the diaphragm, causing a large variation of contrast to the background. To overcome these issues, the paper proposes a Computer Aided Diagnosis (CAD) system for detection of lung nodules. This paper initially applies different image processing techniques for lung region extraction. Further, the Fuzzy Possibilistic C Means (FPCM) algorithm is used for segmentation. For learning and classification, Extreme Learning Machine (ELM) Is used. The experimentation has been performed on 1000 images obtained from reputed hospitals [5].

2.2 Literature Review

1. **Title: Lung cancer detection using image processing techniques**

Authors: Mokhled s. Altarwaneh

In this paper, the authors first explain the theory part of the image segmentation then he explains image segmentation into three parts:

1. Thresholding Approach
2. Watershed Segmentation
3. Feature Extraction
4. Tumor Extraction

Here, the authors explain the Image enhancement and binarization approach techniques. But here tumor part extraction is not accurate due to watershed segmentation.

2. Title: Medical Image Fusion via an Effective Wavelet-Based Approach.
Authors: Yong Yang, Dong Sun Park, Shuying Huang, Nini Rao.

In this paper, the Authors design wavelet transform technique for CT and MRI images. Here the author takes skull images to fusion. After fusion compares the results with other techniques like Pixel average DWT, Gradient pyramid. here author shows that wavelet transform is the best technique for image fusion using the following parameters Standard deviation, Average gradient, Information entropy, Cross entropy.

3. Title: Lung Cancer detection by means evolutionary detections.
Authors: K. Senthil kumar, K. Venkatlaxami

The objective of this paper is to find out an image segmentation algorithm for various medical images. In this paper, K-means clustering, K-median clustering and swarm optimization of particle & inertia techniques are used. It is also proved that adaptive median filter gives better result than median or average filters. By using MATLAB software it is observed that 95.89% accuracy is obtained by verifying sample of 20 images.

4. Identifying lung cancer using Image Processing Techniques.
Authors: Disha Sharma, Gagandeep Jindal

The automatic CAD system is explianed in this paper for the analysis of lung cancer from CT images. The main objevtive of the project is to built a CAD system for finding the early lung cancer nodules by taking the lung CT images and classify them in two types such as benign and malignant.

5. Lung Cancer Detection By using Fuzzy Clustering Techniques

This paper includes the steps like: Preprocesing, Thresholding, Fuzzy Clustering. Fuzzy clustering is carried out by dividing data into homogenous region. The advancement is done by using the Hopfield nueral network for the segmentation. It is used for increase in accuracy.

6. Lung Cancer Cell identification based on artificial neural network
Authors: Zhi hua zhou

This paper includes an artificial neural network ensemble which is a grasping paradigm where many artificial neural networks are jointly used to answer a problem. In this paper, diagnosis procedure named as NED is proposed, which uses an ANN to detect lung cancer cells in images of the specimens of needle which is obtained from the bodies of the patients which are diagnosed.

7. Lung Tumor detection and classification using K-means clustering
Authors: P.B Sangamitraa, S. Govindaraju

In this paper, image processing techniques are used widely in many medical areas for improvement prior detection and treatment stages, in which the time or elapse is very essential factor to detect the disease in the patient as soon as possible.

8. Segmentation and classification of lung tumor from 3D CT image using K-means Clustering
Authors: Prionjit Sarkar, Zakir Hussain

In this paper, for detection of exact location of tumor and size of tumor, 3D CT images are used. This paper shows the utilization of neighborhood and connectivity properties seen in CT image pixels to control this problems.

9. Lung Cancer detection system using lung CT image Processing
Authors: Moffy Vyas, Amita Dessai

In this paper, CT scan is used by radiologists to find cancer in the body and track the increase of cancer. In this paper a lung cancer detection algorithm is presented using mathematical morphological operations for partition of the lung region of interest, in which haralick features have extracted and utilized for categorization of cancer by ANN.

10.   Comparison of Lung Cancer detection Algorithms
Authors: Ozge Gunaydin, Melike gunay

In this paper, various machine learning methods are learnt and find out which is more efficient during detection of lung cancer. Principal component analysis, K-nearest neighbours, SVM, Naïve Bayes, Decision trees and ANN learning methods are used in this papers for comparison of lung cancer detection in which accuracy of decision tree is maximum as 93.24%.

11.   Lung Cancer Detection on CT images by using Image Processing
Authors: Anita Chaudhary, Sonit Sukhraj Singh

In CT , problems is observed to mix in time constraints in predicting the present of lung cancer regarding the diagnosing procedure which are used. In this paper, Image processing, Segmentation and feature extraction methods are discuss in detail.

12.   Lung Cancer Detection Using image Processing and Machine Learning
Authors: Wasudeo Rahane, Himali Dalvi

In this paper it is shown that SVM is a efficient method for lung cancer detection by any other methods. In this paper, only abnormal images are given for segmentation and tumor is find out by using segmentation.

13.   A Comparative Study of Lung Cancer Detection Using Machine Learning Algorithms
Authors: Radhika P.R, Veena G.

In this Paper, lung cancer detection was done using categorization algorithms such as Naïve Bayes, SVM, Decision tree and logistic Regression and shown that decision tree gives the highest accuracy among all algorithms.

14.   Lung tumor detection and diagnosis in CT scan images
Authors: A.Amutha, R.S.D Wahidabanu

In this paper, segmentation is carried out by using histogram based feature extraction and non local denoising for pre-processing. Experiments shows that the procedure can segment the lung field with pathology of different forms more shortly.

15.   Detection of Lung Cancer in CT images using Image processing
Authors: Nidhi S. Nadkarni, Sangam Borkar

In this paper, median filtering is used for image preprocessing and by using mathematical morphological operations image segmentation is carried out. Then features are find out from the region of interest.

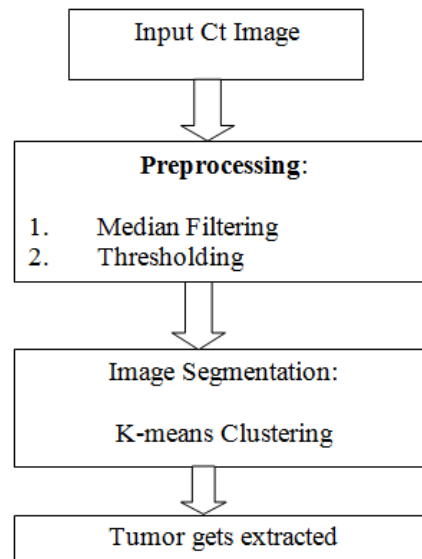**16.   A comparative study of Lung Cancer Detection using supervised neural network**
Authors: Kyamella Roy, Madhurima Burman

In this paper, salient features like energy, entropy and variation are extracted from lung images by the use of SVM classifier. This classification detects the image is healthy or not and 94.5% efficiency is obtained from SVM classification.

3. RESEARCH METHODOLOGY

3.1 Operational procedure contain following Steps:

1. Convert RGB to Gray image
2. Preprocessing
3. Thresholding
4. Image Segmentation
5. Feature Extraction
6. Tumor Detection

Input Ct Image

⬇

Preprocessing:

1. Median Filtering
2. Thresholding

⬇

Image Segmentation:

K-means Clustering

⬇

Tumor gets extracted

Fig 1 . Lung Cancer Detection Steps

3.2 Image Enhancement Introduction:

The Image Pre-processing stage basically starts from image enhancement stage; Image enhancement technique is used to upgrade the perception of image for human being who are viewers. Image enhancement techniques are also usedto give good input for automated image processing techniques. Spatial domain methods and frequency domain methods are the types of image enhancement technique. There are many methods for image enhancement in image processing such as median filtering, Unsharp mask filtering, histogram equalization and linear contrast adjustment. Nowadays, binarization, intensity adjustment and morphological operations are also used for image enhancement technique.

3.3 Image Segmentation:

Image Segmentation is the technique to divide the image into multiple parts. The aim of segmentation is to change interpretation of the image and do it easy to inspect. Here, color based segmentation is used. In the segmentation first image acquired. Then, find out the sample colours in L*a*b space for region of lungs. Then nearest neighbor rule is used for finding out each pixel. Finally nearest neighbor classification is done and values of a* and b* are displayed. Image segmentation is used to separate region of interest and other parts of the lung. In color based segmentation, similar colors in the image belongs to one cluster and other colors belongs to their corresponding cluster in an image. Simply every cluster is a class of pixel with the same color and the properties of color. This color based segmentation partitions the lung image into constituents regions. This segmentation has many applications like visualization and volume estimation of ROI which can detect abnormalities in lung.
More shortly, image segmentation is the technique of giving a label to each pixel in an image so that pixels with the same label show some visual characteristics. Tissue quantification and classification can also be done by using color image segmentation. The result of image segmentation is set of same ROI of lung region in which all regions are dissimilar from each other. In color based segmentation K-means clustering is used for segmentation.

3.4 Thresholding Approach:

In image segmentation, thresholding is the most useful technique. There are many uses of thresholding such as smaller space for storage and ease in manipulation. The processing speed of thresholding is very fast as compared to other segmentation techniques in medical images. From last 10-15 years there is lot of attention on thresholding technique[10]. In thresholding, two levels are given to the pixels because it converts gray image to binary image. In thresholding, threshold value is find out for segmentation. In this research, Otsu's thresholding is used to find the global image threshold for the segmentation of lung image.

3.5 K-means Clustering:

It is the simple algorithm for dividing given samples into required number of clusters so as to reduce the sum of squared distances to the cluster centre. This algorithm reduces the errors since no squared operation is there.

Weaknesses :

1) Randomly choose K samples
2) Try for number of different starting points as they produce suboptimal partitions.
3) It can happens that set of samples must be empty but we can ignore it.
4) Result depends on measure ||x-m|| solution is to normalize each variable.
5) Result depends on value of K.

When the number of data is not much then initial grouping can detect or determine the cluster significantly.

Algorithm(Using Centroid):

K-means clustering is an step by step algorithm that helps us to partition the dataset into predefined different non-overlapping subgroups where each data point belongs to one group only. Keep iterating until there is no further change in the centroids.

Begin with k number of clusters,
Get centroid updates.
Compute distance of each sample and cluster.
Again perform step 3 untill convergence.

Algorithm(Using Euclidean Distance):

1. Select any number of random cluster centers named as "C."
2. Find out the Euclidean distance.
3. Construct the cluster having similar pixels into it if the Euclidean distance is less between constructed cluster and pixel.
4. Find out new cluster center after separation of all pixels. Here, median value is used to find out the new cluster.
5. Repeat steps 2 to 4 till any number of iterations. After required iteration, stop when some condition is encountered.
Here, We are using the first algorithm which is done by centroid calculation, because image segmentation by centroid calculation is easy.

3.6 Feature Extraction:

Image features Extraction stage is an essential stage that utilizes algorithm to predict and isolate the different portion of the image. Dimensions are also reduced by use of feature extraction. Binarization and masking are two methods which are used to find out probability of lung cancer.

Features:

1. Area: It gives number of pixels.
2. Convex Area: It gives how many pixels are there in convex images.
3. Equidistant Parameter: The diameter is same as ROI
4. Eccentricity: Focci/ Major Axis Length
5. Skewness: It is a measure of symmetry
6. Energy: It is sum the of squared elements in GLCM
7. Contrast: It is measure of intensity contrast between pixel and neighbor of pixel.
8. Correlation: It is related to, how the pixel is related to its neighbor over ROI.
9. Homogenity: It is measure of nearness of elements in the GLCM.
10. Kurtosis: Shape of random variables probability distribution.

4. RESULTS AND DISCUSSION

The standard database images of lungs are taken from the available Database from IMBA Home (VIA-ELCAP Public Access)[5]. Fig2 contains the standard database image of lung and fig3 contains the image that we get after thresholding. But after thresholding we cannot get exact tumor area in some cases.

Fig 2. Lung Image

Fig 3. Image obtained after thresholding

Since, we cant get perfect result after thresholding for all images, K-means clustering is used to reduce this error. Because sometimes bone defect or other abnormalities in lung can also be shown as lung tumor. Fig 4 and Fig 5 shows lung image and image after preprocessing. Fig 6 shows the extracted tumor region from lung image.

Fig 4. Lung image
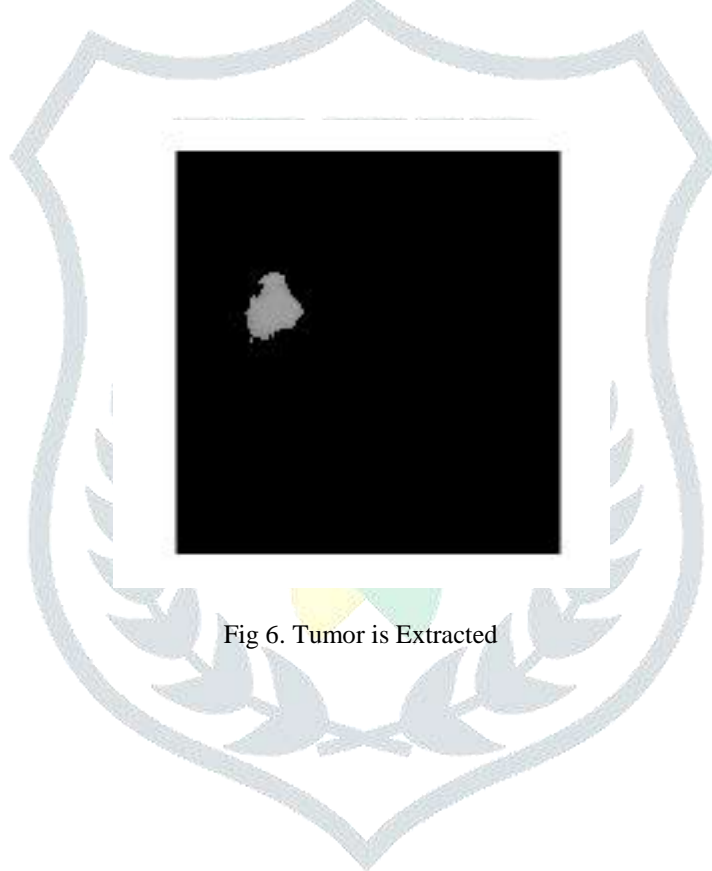
Fig 5. Image After Thresholding

Fig 6. Tumor is Extracted

Features(Values):

For classification of lung cancer stages information of feature extraction is used. Here feature extraction of 6 lung images is carried out. In which Lung3 and Lung5 is the image of lung having tumor because the values of features are changing due to abnormalities in the image. Feature extraction is also used for dimensionality reduction in image processing. This values can also distinguish between lung image and image having tumor because features of lung image having tumor should be different than normal lung image.

Table 1. Table of values of features

	Lung 1	Lung 2	Lung 3	Lung 4	Lung 5	Lung 6
Contrast	0	0	1.75	0	3.500	0
Energy	1	1	0.9305	1	0.8648	1
Kurtosis	33.8630	23.3982	24.7197	24.6175	30.1891	22.94
Entropy	0	0	0.1161	0	0.226	0
Mean	4080	4080	4080	4080	4080	4080
Smoothness	1	1	1	1	1	1
Standard deviation	1.7946e+04	1.550e+04	1.4563e+04	1.5625e+04	1.455e+04	1.5769e+04
Skewness	5.452	4.5643	4.5720	4.6498	4.9855	4.5744
Homogenity	1	1	0.9688	1	0.9375	1
Variance	3.2785e+08	2.4646e+08	2.1535e+08	2.4913e+08	2.1577e+08	2.5146e+08

CONCLUSION

In this research, we conclude that K-means clustering and thresholding are the efficient techniques for lung cancer detection because K-means clustering is utilized to discover groups in the image efficiently, and in the tumor of lung there is a group of cells. Similarly, in thresholding it is observed that by setting a threshold, image processing is carried out successfully. Comparing to all algorithms, the accuracy of the tumor extraction is better in given proposed technique. From this, it can be conclude that CT images are most useful for lung cancer detection than MRI or X-ray because of better image quality.

FUTURE SCOPE

In future studies, many algorithms can be used to increase the accuracy. In this, thresholding is used to get edges and tumor but other techniques such as Sobel, Canny edge detector are present to edge detection. Using this technique in the place of the thresholding will improve the performance of edge detection. Some advanced concepts of Machine learning such as CNN(Convolution Neural Network) and PNN(Probabilistic Neural Network) can be used for accurate detection of size and location of tumor in lung.

REFERENCES

1. Mokhled S-Altarawaneh," Lung cancer Detection Using Image Processing Techniques", Leonardo Electronic Journal of Practice and Technologies, Issue 20, January-June 2012
2. K. Venkatalakshmi and S. M. Shalinie, "Classification of multispectral images using support vector machines based on PSO and K-means clustering," in Proceedings of IEEE In- ternational Conference on Intelligent Sensing and Information Processing, pp. 127–133, Melbourne, VIC, Australia, December 2005.
3. K.Madheswari', N.Venkateswaran, and V.Sowmiya "Visible and Thermal image fusion using Curve let Transform and Brain Storm Optimization" 2016 IEEE Conference.
4. Navneet kaur, Madhu Bahl,Harsimran Kaur "Review On: Image Fusion Using   Wavelet and Curvelet Transform" International Journal of Computer Science and Information Technologies, Vol. 5 (2) , 2014, 2467-2470
5. Lung Cancer Database, Available at: https://eddie.via.cornell.edu/cgi- bin/datac/signon.cgi, (accessed July 2011).
6. Non-Small Cell Lung Cancer, Available at: http://www.katemacintyrefoundation.org/ pdf/non-small-cell.pdf, Adapted from National Cancer Institute (NCI) and Patients Living with Cancer (PLWC), 2007, (accessed July 2011).
7. Levner I., Zhang H.," Classification-Driven Watershed Segmentation", IEEE Transactions on Image Processing, 2007, 16(5), 1437-45.
8. D. Lin and C. Yan, "Lung nodules identification rules extraction with neural fuzzy network", IEEE, Neural Information Processing, vol. 4,(2002).

9. D. Sharma and G. Jindal, "Identifying Lung Cancer Using Image Processing Techniques," International Conference on Computational Techniques and ArtifiCial Intelligence (ICCTAf'2011), 2011, pp. 115-120

10. Md. Badrul Alam, Miah Mohammad Abu Yousuf, "Detection of Lung Cancer from CT Image Using Image Processing and Neural Network" 2nd Int'l Conf on Electrical Engineering and Information & Communication Technology (ICEEICT) 20 IS Jahangirnagar University, Dhaka-1342, Bangladesh, 21-23 May 2015

11. S.K. Vijai Anand, "Segmentation coupled Textural Feature Classification for Lung Tumor Prediction" ICCCC'10, Department of Computer Science & Engineering College of Engineering Guindy, Anna University Chennai Chennai-600 025, India.

12. Levner I., Zhang H., Classification-Driven Watershed Segmentation, IEEE Transactions on Image Processing, 2007, 16(5), 1437-45.

13. Rachid Sammouda, Jamal Abu Hassan, Mohamed Sammouda, Abdulridha Al-Zuhairy, Hatem abou ElAbbas, "Computer Aided Diagnosis System for Early Detection of Lung Cancer Using Chest Computer Tomography Images", GVIP 05 Conference, 19-21 December 2005, CICC, Cairo, Egypt.

14. Penedo. M. G, Carreira. M. J, Mosquera. A and Cabello. D, "Computer-aided diagnosis: a neuralnetwork- based approach to lung nodule detection", IEEE Transactions on Medical Imaging, vol: 17, pp: 872 – 880, 1998.

15. Kanazawa. K, Kubo. M and Niki. N, "Computer aided diagnosis system for lung cancer based on helical CT images", Proceedings of the 13th International Conference on Pattern Recognition, pp: 381 - 385 vol.3, 1996.

16. Yamamoto. T, Ukai. Y, Kubo. M, Niki. N, Satou. H and Eguchi. K, "Computer aided diagnosis system with functions to assist comparative reading for lung cancer based on helical CT image", Image Processing, 2000 International Conference on Proceedings, pp: 180 – 183, vol.1, 2000.

17. R. Wiemker, P. Rogalla, T. Blaffert, D. Sifri, O. Hay, Y. Srinivas and R. Truyen "Computer-aided detection (CAD) and volumetry of pulmonary nodules on high-resolution CT data", 2003.

18. Radhika P.R, Rakhi A.S Nair, Veena G " A Comparative study of lung cancer detection using machine learning algorithms", 2019.

19. S. G. Armato, M. L. Giger and H. MacMahon, "Automated detection of lung nodules in CT scans: Preliminary results", Med. Phys., Vol.28,2001

20. A.Sindhu1 , S.Meera2 "A Survey on Detecting Brain Tumor in MRI Images Using Image Processing Techniques "International Journal of Innovative Research in Computer and Communication EngineeringVol. 3, Issue 1, January 2015

21. Zeynel Cebeci1 , Figen Yildiz 2 "Comparison between K-Means and Fuzzy C-Means Algorithms on Different Cluster Structures"Journal of Agricultural Informatics (ISSN 2061-862X) 2015 Vol. 6, No. 3:13-23

22. Soumi Ghosh , Sanjay Kumar Dubey "Comparative Analysis of K-Means and Fuzzy CMeans Algorithms" ((IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 4, No.4, 2013

23. Russell C. Eberhart and Yuhui Shi "Comparison between Genetic Algorithms and Particle Swarm Optimization " Indiana University Purdue University Indianapolis 723 W.Michigan St., SL160 Indianapolis, IN 46202