REVIEW PAPER ON "LUNG CANCER"

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Abstract:

Cancer is a disease in which cells in the body grow out of control. When cancer starts in the lungs, it is called lung cancer. Lung cancer begins in the lungs and may spread to lymph nodes or other organs in the body, such as the brain. Cancer from other organs also may spread to the lungs. When cancer cells spread from one organ to another, they are called metastases. Lung cancer is a type of cancer that starts in the lungs.

Recently, image processing techniques are widely used in several medical areas for image improvement in earlier detection and treatment stages, where the time factor is very important to discover the abnormality issues in target images, especially in various cancer tumours such as lung cancer. Image quality and accuracy is the core factors of this research. Following the segmentation principles, an enhanced region of the object of interest that is used as a basic foundation of feature extraction is obtained. Relying on general features, a normality comparison is made.

The main goal of this paper is to compare various methods used in various paper in order to determine methods best for assisting the lung cancer detection in the form of early diagnosis suggestions and diagnosis based on imaging techniques.

Keywords: Cancer Detection; Image processing; Feature extraction; Lung Cancer; Segmentation

Introduction:

Lung cancer is a disease of abnormal cells multiplying and growing into a tumour. Cancer cells can be carried away from the lungs in blood, or lymph fluid that surrounds lung tissue. Lymph flows through lymphatic vessels, which drain into lymph nodes located in the lungs and in the centre of the chest. Lung cancer often spreads toward the centre of the chest because the natural flow of lymph out of the lungs is toward the centre of the chest. Metastasis occurs when a cancer cell leaves the site where it began and moves into a lymph node or to another part of the body through the blood stream. Cancer that starts in the lung is called primary lung cancer. There are several different types of lung cancer, and these are divided into two main groups: Small cell lung cancer and non-small cell lung cancer which has three subtypes: Carcinoma, Adenocarcinoma and Squamous cell carcinomas*[12]*.

Lung cancer is the leading cause of cancer-related deaths for both men and women across the developed world. Despite tremendous efforts to treat this cancer, the overall 5-year survival for all stages is dismally low at 15%, since most patients present at an advanced stage when curative treatment is no longer an option. Even in

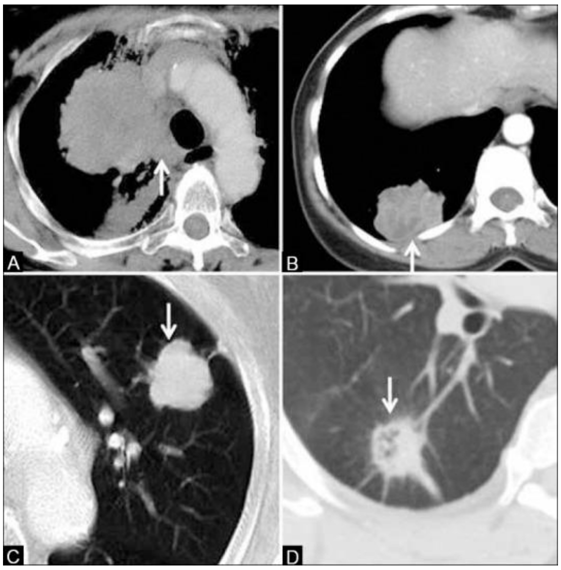
India, though the incidence of oral, breast, and cervix cancer is higher, lung cancer accounts for the highest number of cancer deaths among men. Though majority of patients present at an advanced stage, those with early-stage lung cancer can be treated with a potentially curative intent. Thus, the importance of early diagnosis as well as appropriate radiological staging cannot be overemphasized. In this review, various typical and atypical radiological patterns of lung cancer are depicted and various imaging issues which are relevant for appropriate staging are discussed. Imaging findings and their implications are included*[15]*.

Lung cancer Imaging:

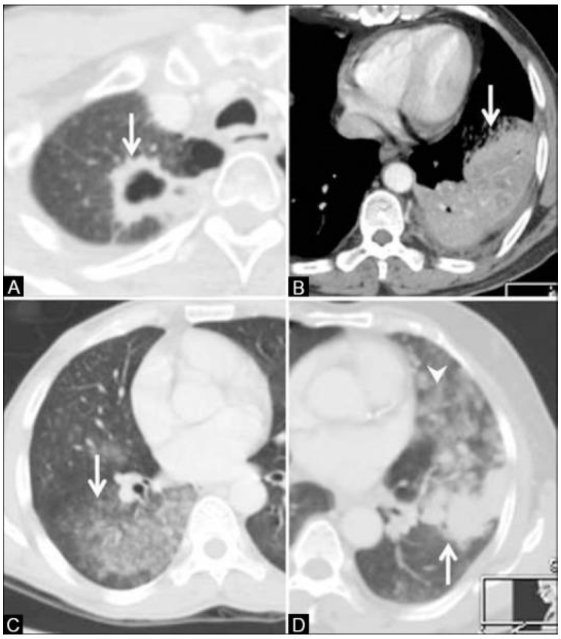
Majority of the lung cancer patients (approx 80%) are clinically symptomatic and present with cough, hemoptysis, dyspnea, chest pain, and non-resolving pneumonia. Occasionally, they present with features suggestive of metastatic disease like skeletal pain or neurological symptoms and signs. Less than 10% of the patients are asymptomatic when the cancer is detected as an incidental finding.

Lung cancer is classified as either non-small cell lung cancer (NSCLC) or small cell lung cancer, with the NSCLC accounting for the vast majority (87%). *Chest radiograph* is the first investigation which is performed while investigating a suspected case of lung cancer. Though it is a very good tool in providing preliminary information about the disease, it is inadequate for optimal characterization and staging. *Computed Tomography (CT)* scan of the chest is the cornerstone of lung cancer imaging based on which further management is decided. The primary tumor shows a wide spectrum of imaging appearances. NSCLCs can be centrally located masses, invading the mediastinal structures, or peripherally situated lesions that invade the chest wall. Tumors can have margins which are smooth, lobulated, or irregular and spiculated . They can be uniformly solid or can have central necrosis and cavitation. Centrally situated and cavitating tumors are more likely to be of squamous histology. Sometimes the tumor resembles an infective pathology and is seen as an area of consolidation, a ground-glass opacity, or a combination of both . Such an appearance is more commonly seen with *adenocarcinoma* and its subtypes. Mixed density or pure ground-glass nodules and consolidation with air bronchogram are seen in bronchoalveolar carcinomas, which are now referred to as adenocarcinoma *in situ*.

Whatever the imaging appearance of the suspected lung cancer, obtaining tissue diagnosis by performing a bronchoscopic or an image-guided biopsy is necessary. When lung cancer is incidentally detected in an asymptomatic patient, it is often seen as a solitary pulmonary nodule (SPN) which can have varied imaging appearances. Imaging algorithm of SPN is a vast subject in itself and has not been included in this review.



Common radiological appearances of lung cancer. Centrally located mass with mediastinal invasion (arrow, A), peripherally situated mass abutting the *pleura (arrow, B), mass with smooth, lobulated margins (arrow, C) and with spiculated, irregular margins (arrow, D).*



Lung cancers with atypical radiological pattern. Squamous cell cancer presenting as a cavitating mass (arrow, A). Adenocarcinoma presenting as dense consolidation (arrow, B). Bronchoalveolar carcinoma (adenocarcinoma *in situ*) presenting as ground-glass opacity (arrow, C) and mixed density, solid (arrow), and ground-glass nodules (arrowhead) in D*[13]*.

Literature Review:

Prediction of lung cancer using image processing by Arvind Kumar Tiwari[1] Prediction of lung cancer is most challenging problem due to structure of cancer cell, where most of the cells are overlapped each other. The image processing techniques are mostly used for prediction of lung cancer and also for early detection and treatment to prevent the lung cancer. To predict the lung cancer various features are extracted from the images therefore, pattern recognition based approaches are useful to predict the lung cancer. Here, a comprehensive review for the prediction of lung cancer by previous researcher using image processing techniques was presented. The summary for the prediction of lung cancer by previous researcher using image processing techniques was also presented. *Lung* ***Cancer Detection Using Image Processing Techniques by Mokhled S[2]*** An image improvement technique is developing for earlier disease detection and treatment stages; the time factor was taken in account to discover the abnormality issues in target images. Image quality and accuracy is the core factors of this research, image quality assessment as well as enhancement stage where were adopted on low pre-processing techniques based on Gabor filter within Gaussian rules. The proposed technique is efficient for segmentation principles to be a region of interest foundation for feature extraction obtaining. The proposed technique gives very promising results comparing with other used techniques. Relying on general features, a normality comparison is made. The main detected features for accurate images comparison are pixels percentage and mask-labelling with high accuracy and robust operation.

Comprehensive Computational Pathological Image Analysis Predicts Lung Cancer Prognosis by XinLuo, XiaoZang, LinYang[3].Clinicopathologic staging is a standard clinical procedure for tumor diagnosis and prognosis for lung cancer. However, it does not fully capture the complexity of the disease, so heterogeneous clinical outcomes within the same stage are common. Although the classification of lung cancer has been updated to become increasingly the disease progression and response to treatment vary widely even among patients with the same histological subtype. Therefore, it is of substantial clinical importance to be able to predict patients' clinical outcomes and thereby "tailor" the treatment for each individual patient.

Image Processing For Detection of Lung Cancer by Neha Chaudhari, Dr.A.V.Malviya[4]states that Research addressing a system for automatic detection of lung cancer in CT images is developed using image processing and machine learning technique. The existing methods are not computationally fast and adaptive. Most algorithms are based on the clustering approach. In which, the fuzzy c-means technique separates the image into different clusters, but each time the cluster changes its place while running the program which means the system can't call the particular image at all-time that leads to giving the wrong output. This segmentation is going to segment not only the cancer parts alone but segment the background also leads to wrong calculations of cancer area. Also, some author has implemented it using deep learning. The deep learning techniques need more advanced hardware requirements leads to more cost. Therefore, there is a need to develop such a method that removes the drawbacks of an existing system to get classify the perfect lung cancer region with less execution time. After examined all the methods noticed that various methods gave various levels of efficiency. Lung cancer is the leading cause of death all over the world .it is curable if detects in the early stage. For future studies, we can use Image Processing Techniques to improve the accuracy of X-ray and MRI pictures. K-mean or fuzzy c-mean clustering can also be utilized for categorization. Moreover, For a better lung cancer detection result, a comparison of X-ray and CT scan pictures can be made. The CAD system not only improves detection outcomes but also reduces human intervention.

Lung Cancer Detection Using Image Segmentation by means of Various Evolutionary Algorithms by Senthil Kumar[5] *concluded that* Various optimization algorithms have been evaluated to detect the tumor. Medical images often need preprocessing before being subjected to statistical analysis. The adaptive median filter has better results than median and mean filters because the speckle suppression index and speckle and mean preservation index values are lower for the adaptive median filter. Comparing the five algorithms, the accuracy of the tumor extraction is improved in GCPSO with the highest accuracy of 95.8079%, and it obtained above 90% of precision in all the 20 images. It is more accurate when compared to the previous method which had an accuracy of 90% in 4 out of 10 datasets only. In future studies, the use of more number of optimization algorithms will be included to improve the accuracy**.**

Detection of lung cancer using image processing techniques by Prathamesh Gawade and R.P. Chauhan[6]

The method is processed in two steps 1) Processing of noisy input image using filter and segmentation 2) Morphological operations on CT image. The cancer affected lungs region can be observed in the final output image to CT input image provided. The proposed method can also be applied to some other cancer types like breast cancer, skin cancer etc. Also it finds its application in the medical research as well**.**

Lung Cancer Detection and Classification by Meraj Begum Shaikh Ismail[7]

CAD system for lung cancer includes the stages of pre-processing, nodule detection, nodule segmentation, feature extraction and classification of the nodule as benign or malignant. Once the nodules are detected and segmented the feature extraction process begins. The features necessary for classification are extracted using feature extraction techniques from the segmented nodule. Based on the features extracted, a classifier is used for classifying the nodule as benign or malignant. The performance of both the CNN and classifiers were similar, with the classifiers performing slightly better. Compared to the performance of radiologists, the sensitivity of nodule detection was within the range of radiologists at 65% with the two stage neural networks vs 51-81.3% with radiologists. The false positive rate is much higher than the neural networks which is at 6.78 false positives per case with the neural networks vs 0.33-1.39 false positives per case with radiologists. Despite the large number of false positives rate, by solely using the largest nodule detected for cancer prediction. The precision with the classifiers is substantially higher at 41% compared to 1-2% by radiologists.

Lung Cancer Detection and Classification based on Image Processing by Md Rashidul Hasan and Muntasir Al Kabi[8] Lung cancer detection identifies the tumor within the lung. The CT image is pre-processed and the pre-processed image is then subjected to segmentation by using Marker Controlled watershed segmentation. Segmented image is used for feature extraction. With the extracted features the tumor is detected within the lung. Both supervised and unsupervised classifier is used for the identifying of the cancer. The accuracy rate of the proposed system is 72.2% by using support vector machine. Thus this system helps the radiologist to identify the stage of the tumor and increase the accuracy.

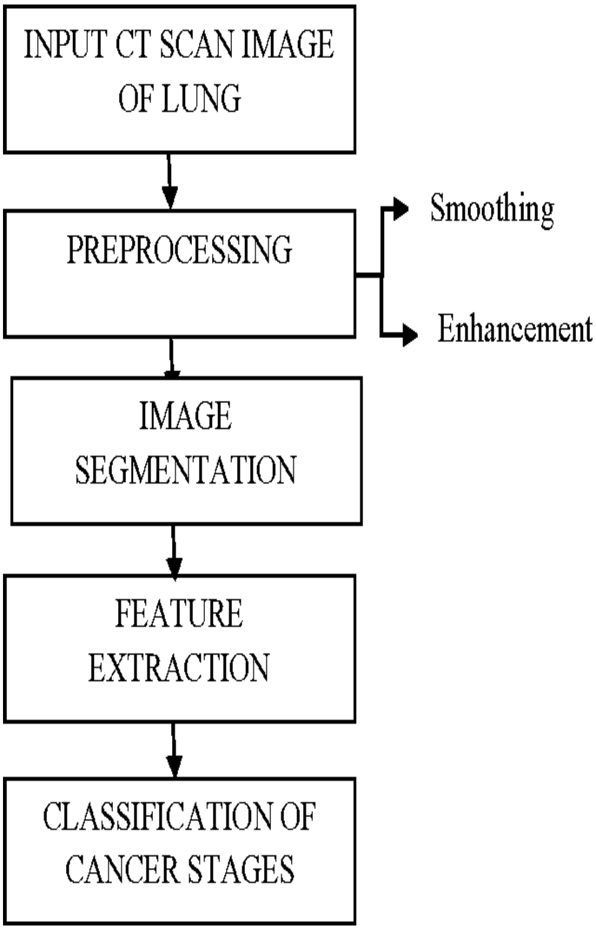
Image processing based detection of lung cancer on CT scan images by Bariqi Abdillah, Alhadi Bustamam, and Devvi Sarwinda[9] In the study they've implement and evaluate three image segmentation methods for analyzing lung cancer, such as Region Growing, Marker Controlled Watershed, and Marker Controlled Watershed with Masking. The results show that Marker Controlled Watershed with Masking give us the best performance in term of segmentation result and running time. Therefore, we select Marker Controlled Watershed with Masking method in image segmentation stage. Furthermore, in the feature extraction stage, we use color attribute for the analysis of lung cancer using binarization. Finally, the binarization method was successfully determined condition of lung (normal or cancer) from the CT scan image.

Lung Cancer Detection using CT Scan Images by Suren Makajua , P.W.C. Prasad, Abeer Alsadoona , A. K. Singhb , A. Elchouemic[10]

The current best model has no satisfactory result of accuracy and does not classify degree of cancer of detected nodules. Therefore new system is proposed. The proposed system is used to detect the cancerous nodule from the lung CT scan image using watershed segmentation for detection and SVM for classification of nodule as Malignant or benign. Proposed model detects the cancer with 92% accuracy which is higher than current model and classifier has accuracy of 86.6%. Overall, we can see improvement in the proposed system in comparison to current best model However, this proposed does not classifies into different stages as stage I, II, III, IV of cancer. Therefore, as future scope improvement in this can be done by implementing classification in different stages. Also, further accuracy can be increased by proper pre-processing and eliminations of false objects.

Lung Cancer Image Processing:

Figure shows a general description of *Lung Cancer Image Processing.* The following system that contains four basic stages.



Input CT scan image of lung:

At first Input lung CT images to the system and then passed through the image preprocessing stage by using some image processing techniques. In first stage, Binarization technique is used to convert binary image and then compare it with threshold value to detect lung cancer.

Image preprocessing

Median filters are widely used to minimize the presence of the noise and adjacent organs on CT-Images due to which certain types of random noise produced are reduced thereby they play a role called very good noise reduction capabilities, with considerably less blurring when compared with linear smoothing filters of same size. The median filter is the best known order-statistics filter, the value of a pixel is replaced by the median of the gray level found in the neighborhood of that pixel.

Image Segmentation

In the methods processing scheme segmentation of the lung regions is the second stage. The pre-processed CT images are partitioned into multiple regions to separate the pixels corresponding to the lung tissue from the surrounding anatomy. For the image segmentation Thresholding approach has been used

Feature Extraction

In a texture the objects contained inside a CT scan can offer great information to describe the objects in the medical imaging. In an artificial vision implementations Texture plays an important role. The spatial distribution of gray levels in a neighborhood is characterized by Texture. So to that extent the texture cannot be defined at a point. Based on the resolution where an image is observed is determined by the scale where the texture is perceived .In an examined organ the most important source of information on the state of the health is offered by Texture in CT images. The healthy counterparts are smoother whereas the

diseased tissue usually has more rough structure, the same can be characterized quantitatively in an automated diagnostic system. For a correct classification the quality of the extracted texture measures is of significant importance, especially when there is difference between two different tissues which becomes minor. In distinguishing malignant from benign nodules it is critical to observe that the texture at the edge of the lung nodules, at the medical point of time*[13]*.

Classification of cancer stages:

The classification module follows this where distinction between benign and malignant tumors based on CT scan images is established. Extracted features are used as training features and the corresponding trained model is generated for the classification followed by model evaluation for detection and classification with improved accuracy, specificity and sensitivity.

The first stage starts with taking a collection of images (normal and abnormal) from the available Database. The second stage applies several techniques of image enhancement, to get best level of quality and clearness. The third stage applies image segmentation algorithms which play an effective rule in image processing stages, and the fourth stage obtains the general features from enhanced segmented image which gives indicators of normality or abnormality of images.

Lung cancer is the most dangerous and widespread cancer in the world according to stage of discovery of the cancer cells in the lungs, so the process early detection of the disease Image Capture Image Enhancement Image Segmentation, Features Extraction plays a very important and essential role to avoid serious advanced stages to reduce its percentage of distribution.

The first step is pre-processing of the image to locate particles using intensity measure. The processed image is segmented using a standard segmentation technique. Thus, cancer nodules are marked in the image. In addition to features like area, perimeter and eccentricity, other features like centroid, diameter and pixel mean intensity have been extracted during feature extraction. The classification module follows this where distinction between benign and malignant tumors based on CT scan images is established. Extracted features are used as training features and the corresponding trained model is generated for the classification followed by model evaluation for detection and classification with improved accuracy, specificity and sensitivity*[14]*.

COMPARATIVE RESULT:

1)Comparative result of Image Processing Techniques

Ref.	Year	Preprocessing	Methods	Datasets	Results
(Li et al., 2020)	2020	lung field segmentation and rib suppression	multi-resolution patch-based CNNs were trained for lung nodule detection	Japanese Society of Radiological Technology (JSRT) database	The method can detect 99% lung nodules on JSRT database
(Bhandary et al., 2020)	2020	Morphological segmentation and watershed segmentation are used for automated nodule segmentation	MAN is used to classify chest X-Rays images and EFT is used to classify the lung CT images.	Dataset of Chest X-Ray and Lung cancer (LIDC-IDRI)	DL accuracy is 96% for X-Ray images while the accuracy is 97.27% for CT images
(Shakeel et al., 2020)	2020	multilevel brightness-preserving approach	improved deep neural network and ensemble classifier.	Database of cancer imaging archive (CIA) dataset	The proposed system recognized the cancer with maximum accuracy.
Shakeel et al., 2019	2019	The noise is removed using weighted mean histogram equalization approach. In addition, improved profuse clustering technique (IPCT) is applied for segmenting the affected region.	Deep learning instantaneously trained neural network (DITNN) is used.	Image was collected from Cancer imaging Archive (CIA) dataset	accuracy 98.42% & minimum classification error of 0.038.
(Reddy et al. 2019)	2019	Picture securing, pre-handling, binarization, thresholding, division, feature extraction are applied.	The fuzzy neural system is used to test the neural system with machine learning approaches.	Dataset obtained from UCI repository	Accuracy 96.67 %.

The above table analyses some of the research papers and compares them for various image pre-processing and detection techniques for Lung Cancer Imaging and detection. The Lung Field Segmentation Technique used gives almost 99% accuracy with multi-resolution patch based CNN. Morphological Segmentation and watershed segmentation used with automated nodule detection gives 96% accuracy. Multilevel brightness preserving approach gives maximum accuracy in comparison. Picture securing, binarization, thresholding and feature extraction processes when applied gave accuracy of 96.67% accuracy*[11]*.

2)Comparision of Algorithm Accuracy levels:

Accuracy levels of various algorithm techniques after image processing in lung cancer processing and detection.

The accuracy for lung cancer can be described as follows i.e by using logistic algorithm we get all predictor accuracy is 60.10% and the subset accuracy is 69.19%.

By using QDA algorithm we get all predictor accuracy is 69.70% and the subset accuracy is 71.21%.

By using KNN algorithm we get all predictor accuracy is 62.12% and the subset accuracy is 64.65%.

By using Classification algorithm we get all predictor accuracy is 71.72% and the subset accuracy is 71.21%.

By using Random Forest algorithm we get all predictor accuracy is 71.21% and the subset accuracy is 71.21%.

By using K-Mean Clustering (1397) algorithm we get all predictor accuracy is 52.97% and the subset accuracy is 54.61%.

By using K-Mean Clustering (198) algorithm we get all predictor accuracy is 47.47% and the subset accuracy is 55.05%.

By using SVM algorithm we get all predictor accuracy is 71.21% and the subset accuracy is 72.22%.

CONCLUSION:

Image processing can be used to improve the quality of an image, remove undesired objects from an image, or even create new images from scratch.

With the advent of fast and cheap machines, digital image processing has become a very highly demanded field of study and practice. It provides solutions to various real-life applications in an economical way.

CT scan images and X-ray images of patients can be processed using image processing techniques. These can be then used in machine learning , deep learning algorithms and techniques to predict lung cancer.

As discussed in above paper various algorithms and techniques can be applied to detect lung cancer in efficient and economical way.

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