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Lung Cancer Nodule Cancer Detection: A Survey

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Abstract: ***In the world, out of 100 different types of cancers observed in the human body. Lung cancer is a third leading type of cancer that may cause death of a person. Early detection and diagnosis of the disease is essential to prolong the life of the patients affected with this scourge. For determining the cancer cells from medical images, various image processing and soft computing techniques can be used. CT-images are most commonly used for image processing. CT-image has properties like high resolution, better clarity, low noise and low distortion and etc. It is the best technique of image for detection of small nodules. This paper does focus on various techniques which have been proposed for detection of lung cancer modules. This survey attempt to summarize techniques such as pre-processing, segmentation, feature extraction, classification used in the lung cancer detection systems.***

Keywords: Cancer, Nodule Detection, Lung Nodule, CT Images, Preprocessing, Segmentation.

I. INTRODUCTION

About 80% of patients are diagnosed correctly in the middle or advanced stages of cancer [3]. If this had been diagnosed at initial stages, then the chance of survival rate would be high. An utmost important but difficult task for any radiologist is to detect and examine the tumorous nodules from the chest radiographs. Few nodules may not be detected as they may be masked by the anatomical structure or due to the inferior quality of the images. Also, it is influenced by the subjective and variable decision criteria used by radiologists. Hence, there is a great need for upcoming technologies to detect lung cancer in its primary stages.

A method that deals with image analysis of chest Computerized tomography (CT) scans for early detection of doubtful nodules in the lung tissue that may provide a clue for potential lung cancer detection [9].

A. Stages Of Cancer

Cancer leads to excessive multiplication of abnormal cells without control and is able to affect other tissues.

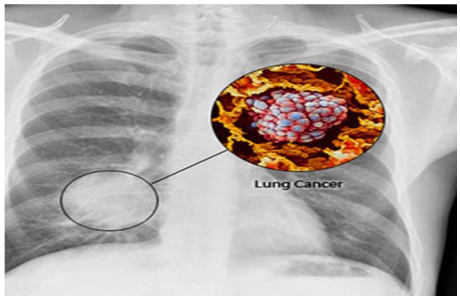

Fig 1: Lung image showing probable tumor

Cancer spreads stage by stage; Cancer is the rapid multiplication of abnormal cells with cluster formation the figure below shows the images with different stages of cancer.

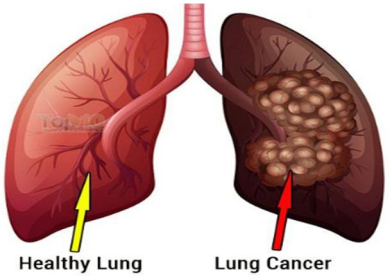

Fig 2: Comparison between Normal and cancer Nodule

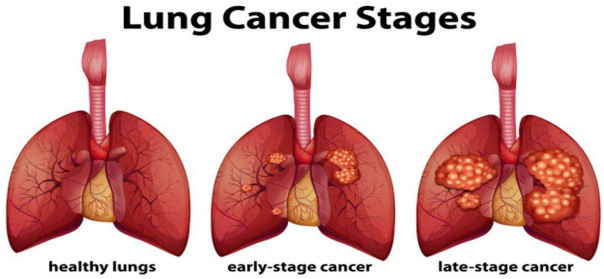

Fig 3: Nodule with smaller to increasing size

II. LITERATURE REVIEW

A. Review On Lung Cancer Detection Systems

Fundamentally any lung cancer detection system uses a variety of algorithms and techniques lead to a difference in accuracy and results. Such techniques and some of their details are given below,

1) *Image Smoothing using Median Filtering:* A. Kulkarni et al. [2] proposed a system for lung nodule cancer detection using CT images in DCOM format. Image smoothing was done by the Median filter to reduce the blurring of edges. The advantage of using a median filter is that it is not affected by individual noise spike, to eliminate impulsive noise quite well and it does not blur edges much and can be applied iteratively. Gabor filter is used for enhancement as it gives a better result compared to Fast Fourier Transform and auto enhancement. The Gabor function represents an excellent local and multi-scale decomposition, used here for the presentation of the image which is based on that is simultaneous localization in space and frequency domain. Marker controlled Watershed algorithm is used for segmentation purpose. Area and parameter were extracted feature based on which classification was done.

a) *Advantage:* The median filter gives more accurate results compared to Gaussian, mean and Wiener filters.

2) *CLAHE and Fuzzy Clustering Method:* K. Punithavathy et al. [3] presented a methodology for automatic lung cancer detection in PET/CT images. Along with Wiener filtering, for pre-processing contrast level, adaptive histogram equalization (CLAHE) technique is also used. Morphological operations like closing and opening are performed for accurate extraction of lung ROI. Feature classification is done using a fuzzy clustering method. FCM is unsupervised, simpler and soft clustering method that retains more information of the image as compared to hard clustering method.

a) *Advantage:* The Morphological operations enable accurate lung ROI extraction and reduce the search space.

3) *CLA (Cellular Learning Automata):* N. Hadavi et al. [6] suggested a technique for automatic detection of lung cancer using cellular learning automata. Gabor filter is used for performing Image enhancement. Due to its advantages such as fast processing and easy influence, thresholding technique can be used for image segmentation. Features like nodule size, shape, contrast and the region for analysis are extracted. Cellular Learning Automata (CLA) model is obtained by developing the cellular automata including a learning automaton to each cell. CLA model is designed for components according to experiences of themselves and other components experiences are trained and CLA also have the capability to improve their behavior.

a) *Advantages:* Cellular learning automata are well trained; the model is capable of reduced rate of error and enhances the system's reliability.

4) *Marker-Controlled Watershed Algorithm:* S. Kanitkar et al. [7] introduced a novel approach to detect lung cancer using an image processing technique. The Gaussian filter is used to smooth the image in the preprocessing stage so that it can remove high-frequency components from the image. The Marker-Controlled Watershed transform is used for the segmentation purpose. The features such as average intensity, perimeter, and area are extracted from the detected tumor. To extract the region minimum value from image watershed segmentation is used. It determines to the divide a line with the least value. The dividing line in a form of the image can give the rapid change of boundary. It behaves the image as a plane, where light pixels are high and dark pixels are low.

a) *Advantages*

i) The marker-controlled watershed segmentation technique separates the touching objects in the image.

ii) It provides the best identification of the main edge of the image and also avoids over-segmentation.

5) *Binarization and Masking Approaches:* B. Patil et al. [10] proposed an approach to predict the probability of lung cancer detection. Binarization is the initial approach is and the second approach is masking. The images that are used in the analysis are in standard JPEG format. For converting them in Grey level 'Otsu's' method can be used. Marker-controlled watershed segmentation is used that gives an accuracy of 85.27%. For the prediction of lung cancer using **Binarization** approach dependent on a number of black pixels is greater than white pixels in normal lung images is used. So the counting starts from the black pixels for normal and abnormal images, if the number of the black pixels of a new image is greater than the threshold, then it is indicated that the image is normal, otherwise, vice versa. Another method for prediction is **masking** that depends on the fact that the masses are appeared as white linked areas inside ROI (lungs), as they increase the percent of cancer presence increase.

6) *The Grey Level Co-occurrence Matrix:* Initially, Haralick et al. (1973) described that the Grey Level Co-occurrence Matrix (GLCM) and its attributes are tools for image classification. The grey level co-occurrence matrix (GLCM) was initially designed for texture classification of two-dimensional (2D) images. To calculate GLCM attributes for three-dimensional (3D) data it is necessary to adapt the methodology to work in 3D space. Therefore, it is important for the classified data to adapt the

GLCM calculation to work in the three-dimensional (3D) space. C. T. Henschke et al [1]. proposed an automatic computer-aided diagnosing system for identifying lung cancer by analyzing lung CT images. Wiener filter, erosion, slicing techniques were used by authors to extract lung image region from CT image. Bit image slicing was used to convert CT images to binary image region growing segmentation. The algorithm is used to segment extracted lung regions. After segmentation of the lung region rule-based model was used to classify the cancer nodules.

III. EXISTING SYSTEM

Generalized lung cancer detection system using medical images is as shown in the following figure. The system mainly consists of following listed sections.

A. Image Acquisition
B. Image Pre-processing
1) Image Smoothing
2) Image Enhancement
C. Image Segmentation
D. Feature Extraction
E. Classification

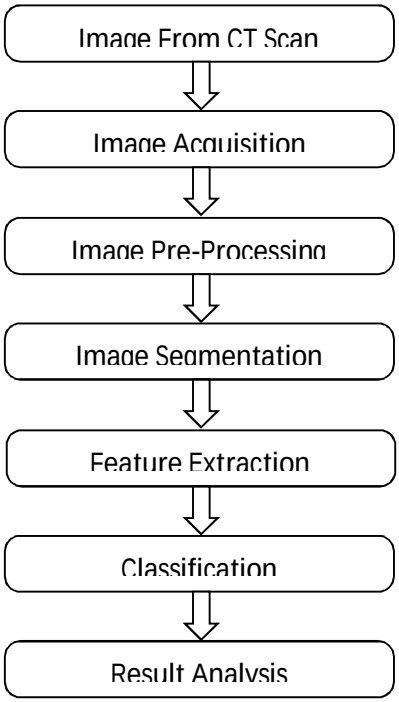

Fig 4: Generalized lung cancer detection system using CT images.

1) *Image Acquisition:* Image acquisition is the initial process. CT images will offer visualization of small volume nodules by diminishing the slice thickness. Lung CT images can be acquired from publicly available databases like Medical Image Database, Early Lung Cancer Action Program (ELCAP), and Lung Image Database Consortium (LIDC) [15].

2) *Image Pre-processing:* CT scan of a particular patient may contain various uncertainties or errors. Unreliability in a CT scan image includes spurious noise, motion artifact, and low contrast. Image processing is used to remove spurious noise by applying grayscale methods or an optimal filter is used to reduce the spurious noise while retaining anatomical features of nodules.

The following are some process are used for image pre-processing,

a) *Image Smoothing:* Basically suppresses the noise or other small fluctuations in the image.

b) *Image Enhancement:* For human viewers, image enhancement, improves the interpretability and perception of data in images and for other automated image processing techniques, it provides better and accurate input. Different techniques such as Median filter, Gabor filter, and histogram equalization are also used for image pre-processing [5, 7, 8].

3) *Image Segmentation:* Image segmentation is a basic step image analysis and it deals with separating classes in an image into continuous as well as separate regions. The goal of segmentation is to isolate the lung tissue in image processing, image segmentation is extremely rich in the image analysis and computer vision. Image segmentation methods are mainly classified into three different approaches [8].

a) Statistical Method: In this model the image information and cast the region process as a mapping from raw images.

b) Geometric Method: Geometric method exploit object shape descriptions in order to separate the image contents into classes.

c) Vibrational Method: This method creates an implicit description of class boundaries in terms of a curve/surface that evolves and cuts the particular object at its boundary.

Techniques such as thresholding, watershed algorithm, region growing algorithm can be used for segmentation purpose.

4) *Feature Extraction:* This is an important stage that algorithms and techniques to detect and isolate various desired portions or shapes of a given CT image. In image processing methods, different algorithms are used to determine normality and abnormality of an image from the final result of segmentation. The area, perimeter, eccentricity, and average intensity are main features help to form the classification of cancer region that is extracted in feature extraction technique [5,15,16].

5) *Classification:* Subsequently, the structure is analyzed; each and every region is identified and evaluated individually for the probability of a True Positive (TP).

Several methods are present for the classification process. Some of them are mention as, rule-based methods, minimum distance classifier, cascade classifier, Bayesian classifier, Multilayer perception, Radial Basis Function network (RBF), Support Vector Machine (SVM), Artificial Neural Networks, Fuzzy logic, etc [3,6,7].

IV. CONCLUSION

In this paper, we survey different techniques and method that are used in lung cancer detection system. The generalized structure of lung cancer detection system using medical CT images is also described. Also Median filtering, Level Set-Active Contour Model, CLA and Binarization enhance the performance of lung cancer detection system.

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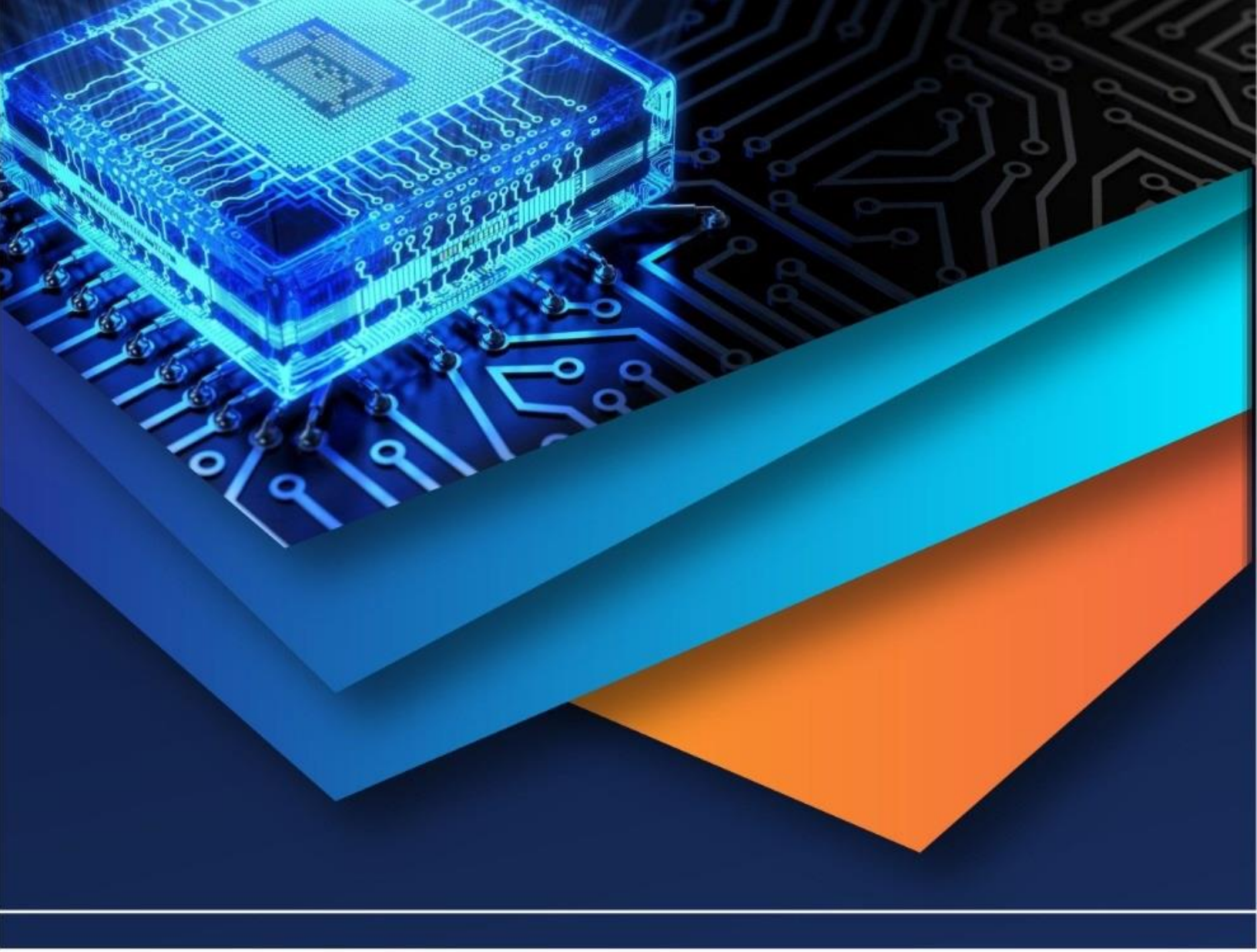

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