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Image Processing based Lung Tumor Detection System for CT Images

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Abstract - *Cancer is a major health treat disease in the world with mortality rates increasing day by day. Lung cancer is the leading cause of deaths among all other cancer types in many developing countries. Early detection of lung cancer plays a vital role for treatment of this disease for which Computed Tomography imaging is considered as an appropriate method for detection of lung tumor. This paper presents an automated approach for detection of lung tumor in CT scan images using image processing. The proposed methodology involves techniques such as median filtering for noise removal followed by segmentation of required region of interest using mathematical morphology. Geometrical and textural features are calculated from extracted ROI and these features serve as input to the SVM classifier for detection of lung cancer.*

Key Words: **Lung cancer, CT, SVM, Region of interest, Image processing.**

1. INTRODUCTION

Lung cancer is the most prevalent type of cancer having mortality rate of 19% globally. Lung cancer also referred to as lung carcinoma is characterized by uncontrolled growth of cells in lung tissues thus leading to formation of cancerous (malignant) lung nodules. Lung cancer can be classified into two types namely small cell lung cancer and non-small cell lung cancer. Non-small cell lung cancer accounts for larger number of cancer cases as compared to small cell lung cancer. Various imaging modalities such as X-rays, Computed Tomography, Magnetic Resonance Imaging and Sputum Cytology are used for lung cancer detection. However, due to better clarity CT scans are preferred over other imaging modalities as it gives detailed picture of malignant nodules present in the lungs and also tracks its growth.

Lung cancer survival chances in its advanced stages are less when compared to detecting cancer in its initial stages. The survival rate for lung cancer patient can boost from 50-70% if cancer detection is carried out in initial stages (either stage I or II).Manual analysis and diagnosis of CT scan images can be an error prone task and can cause cancer misclassification. Hence cancer detection can be greatly improved with implementation of image processing techniques. Hence, this paper proposes a methodology for automatic detection of malignant nodules in CT images thus leading to early and accurate detection of lung cancer. The various steps involved are image pre-processing, ROI segmentation, geometrical and textural feature extraction and classification.

2. RELATED WORK

A number of researches have been carried out in developing an automated lung cancer detection system. Shubhangi khobragade and Aditya Tiwari proposed an automated system for detection of three lung diseases namely tuberculosis, lung cancer and pneumonia. Chest X-ray images were preprocessed by using methods such as histogram equalization for image enhancement and high pass filtering technique was used for noise removal. Methods such as intensity based method and discontinuity based method were used to detect lung boundaries. Statistical and geometrical features were extracted and image classification was done using feed forward artificial neural network to detect major lung diseases [1]. K. Punithavathy proposed a methodology for automatic detection of lung cancer from PET/CT images. Image preprocessing methods such as wiener filtering and contrast limited adaptive histogram equalization were performed to remove artifacts due to noise and contrast variations. Morphological operators were used for segmentation of lung ROI and Haralick statistical features were extracted from segmented ROI. Fuzzy mean clustering (FCM) was finally used to classify the regions as normal or abnormal [2]. Anita chaudhary and Sonit Sukhraj Singh used three different image enhancement methods such as Fast Fourier Transform, Gabor filter, Auto Enhancement technique to pre-process the CT scan images out of which Gabor filtering technique gave the bests results. Thresholding approach and watershed segmentation technique were used for image segmentation and four geometrical features namely area, perimeter, eccentricity and average intensity were used for classification of lung cancer into stages [3]. Anjali Kulkarni and Anagha Panditroa first smoothed lung CT scan images using median filtering technique and enhanced these images using Gabor filtering method. Extraction of required ROI was done using marker controlled watershed segmentation technique and three geometrical features namely area, perimeter eccentricity were calculated from extracted ROI. The features were used for detection of lung cancer and its classification into stages [4].

3. METHODOLOGY

The proposed methodology in this study is shown with the help of flowchart in fig1. Each step in figure 1 is discussed in detail in section below.

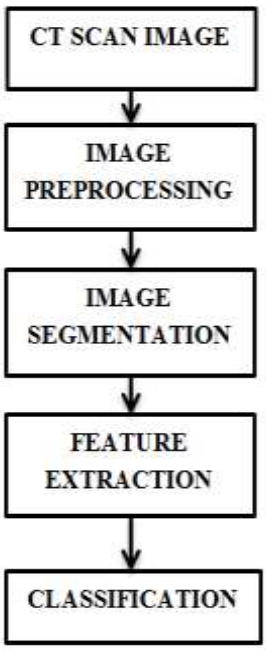

Fig -1: Overview of proposed system

3.1 Database Collection

Database collection is the first and necessary step for image analysis and study. For this study, the CT image dataset have been collected from Cancer Imaging Archive (TCIA), a website that offers database to general public for research work.

3.2 Image Pre-processing

The purpose of image preprocessing stage is removal of irrelevant data for recovery of useful information as well as strengthening region of interest for further processing .Image pre-processing has two main steps image filtering and image enhancement. Image filtering is done to remove unwanted noise and distortions from the image. CT scan images are mostly subjected to salt and pepper noise, hence median filtering technique is used for reduction in impulsive noise. Image enhancement improves perception of information in images to human viewers, to provide a better input for further processing. CT image intensity and contrast are adjusted by using contrast adjustment technique. This method mainly enhances image contrast by mapping input intensity values to new values such that by default it saturates top 1% and bottom 1% of all pixel values.

3.3 Image Segmentation

Image segmentation is a process of extracting out region of interest of lungs. Image segmentation of CT image is done in order to obtain the lung mask and cancerous tumor region. Mathematical morphology is quite efficient technique in obtaining exact ROI from binary images. For this proposed system, first the pre-processed gray scale images are converted to binary. Morphological opening operation with disk structuring element is used to obtain desired lung and tumor effected region.

3.4 Feature Extraction

Feature extraction is the most important step that helps in extracting various features from segmented lung tumor. Features are representatives of images, which give useful and essential information of extracted ROI. In this system, geometrical and textural features are calculated and provided to the input of classifier for further processing. Three geometrical features namely area, perimeter and eccentricity and four textural features namely contrast, correlation, energy and homogeneity are considered for automatic detection of lung tumor.

3.5 Image Classification

This is the final stage which classifies the CT images as normal or abnormal. SVM classifier is used to detect the presence of lung cancer in CT images. SVM classifier creates two classes of data from given input training dataset. The hyper plane separates out one class from the other. SVM classifier then assigns each image of testing dataset to one of the two classes and thus classifies images with or without lung cancer.

4. RESULTS

MATLAB software was used for implementation of proposed image processing based lung tumor detection system. For this research work, analyses are carried out on TCIA obtained dataset which is divided into training and testing sets.

Computed Tomography scans are provided to the input of lung cancer detection system. These images undergo pre-processing methods such as median filtering and contrast adjustment. Median filter of size 3*3 removes unwanted noise and fluctuations from the image whereas contrast enhancement enhances image contrast and produces a better output image then original image. Morphological operators are further applied to preprocessed images for segmentation of lung ROI. Geometrical and textural features are extracted from effected tumor region and further used for classification of CT images into normal and abnormal.

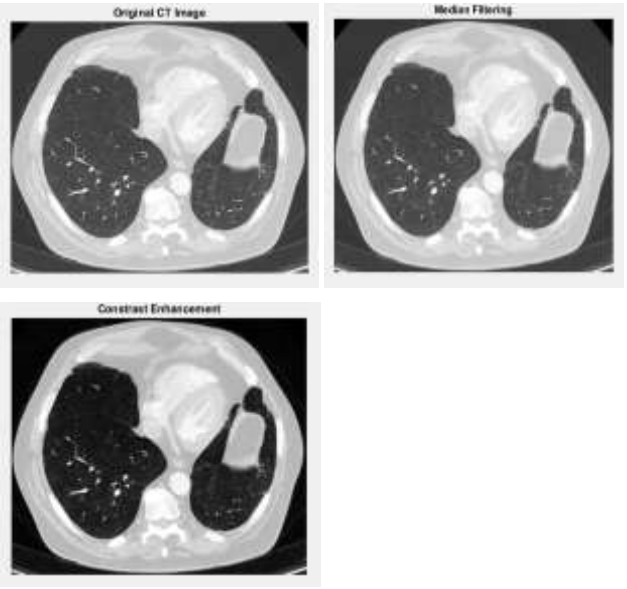

Fig -2: Image pre-processing results of lung cancer patient.

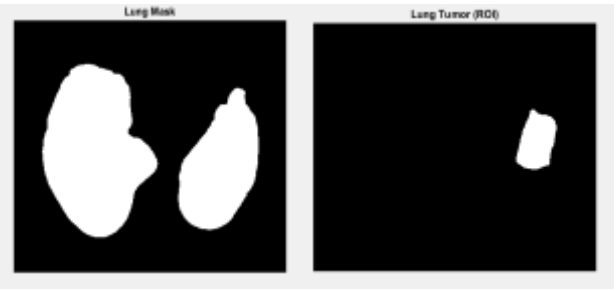

Fig-3: Image segmentation results of lung cancer patient.

Table -1: Feature extraction of lung cancer patient.

Features	Values
Area	3401
Perimeter	225.362
Eccentricity	0.7780
Contrast	0.0012
Correlation	0.9756
Energy	0.9510
Homogeneity	0.9994

5. CONCLUSION

The proposed methodology was successful in detecting lung tumor in CT images. Detection of cancerous lung nodules in computed tomography scans was done using image processing techniques such as pre-processing, lung segmentation, feature extraction and classification. Median filtering gave good results for image preprocessing and morphology helped in accurate segmentation of lung mask and malignant lung nodule. Textural and geometrical features were extracted and used for classification of CT images using support vector machine.

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