

Detection of Lung Cancer Nodule on Computed Tomography Images by Using Image Processing

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ABSTRACT

Lung cancer seems to be the common cause of death among people throughout the world. Early detection of lung cancer can increase the chance of survival among people. The overall 5-year survival rate for lung cancer patients increases from 14 to 49% if the disease is detected in time. Although Computed Tomography (CT) can be more efficient than X-ray. However, problem seemed to merge due to time constraint in detecting the present of lung cancer regarding on the several diagnosing method used. Hence, a lung cancer detection system using image processing is used to classify the present of lung cancer in a CT- images. In this study, MATLAB have been used through every procedures made. In image processing procedures, process such as image pre-processing, segmentation and feature extraction have been discussed in detail. We are aiming to get the more accurate results by using various enhancement and segmentation techniques.

Keywords- LCDS, Watershed Segmentation, ROI, Thresholding, morphologic, Metastasis, CT.

1. INTRODUCTION

The mortality rate of lung cancer is the highest among all other types of cancer. Lung cancer is one of the most serious cancers in the world, with the smallest survival rate after the diagnosis, with a gradual increase in the number of deaths every year. Survival from lung cancer is directly related to its growth at its detection time. But people do have a higher chance of survival if the cancer can be detected in the early stages [1]. Lung cancer can be divided into two main groups, non-small cell lung cancer and small cell lung cancer. These assigned of the lung cancer types are depends on their cellular characteristics. As for the stages, in general there are four stages of lung cancer; I through IV. Staging is based on tumor size and tumor and lymph node location. Presently, CT are said to be more effective than plain chest x-ray in detecting and diagnosing the lung cancer. The earlier the detection is, the higher the chances of successful treatment. An estimated 85% of lung cancer cases in males and 75% in females are caused by cigarette smoking [2]. In 2005, approximately 1,372,910 new cancer cases are expected and about 570,280 cancer deaths are expected to occur in the United States. It is estimated that there will be 163,510 deaths from lung cancer, which forms 29% of all cancer deaths. The overall survival rate for all types of cancer is 63%. Although surgery, radiation therapy, and chemotherapy have been used in the treatment of lung cancer, the five-year survival rate for all stages combined is only 14%. This has not changed in the past three decades [2]. The purpose of this paper is to find the early stage of lung cancer and more accurate result by using various enhancement and segmentation techniques.

2. RELATED WORK

In 2010 M.Gomathi and Dr.P.Thangaraj used the idea of basic image processing techniques such as Bit-Plane Slicing, Erosion, Median Filter, Dilation, Outlining, Lung Border Extraction and Flood-Fill algorithms are applied to the CT scan image in order to detect the lung region. Then the segmentation algorithm is applied in order to detect the cancer nodules from the extracted lung image. and proposed the idea of Fuzzy Possibility C Mean (FPCM) algorithm for segmentation because of its accuracy. After segmentation, rule based technique is applied to classify the cancer nodules. Finally, a set of diagnosis rules are generated from the extracted features. From these rules, the occurrences of cancer nodules are identified clearly. In 2011 Disha Sharma and Gagandeep Jindal proposed the system generally first segments the area of interest (lung) and then analyzes the separately obtained area for nodule detection in order to diagnosis the disease. Initially, the basic image processing techniques such as Erosion, Median Filter, Dilation, Outlining, and Lung Border Extraction are applied to the CT scan image in order to detect the lung region. Then the segmentation algorithm is applied in order to detect the cancer nodules from the extracted lung image. After segmentation, rule based technique is applied to classify the cancer nodules. Finally, a set of diagnosis rules are generated from the extracted features. For experimentation of the proposed technique, the CT images are obtained from a NIH/NCI Lung Image Database Consortium (LIDC) dataset that provides the chance to do the suggested research. DICOM (Digital Imaging and

Communications in Medicine) has become a standard for medical imaging. Its purpose is to standardize digital medical imaging and data for easy access and sharing. There are many commercial viewers that support DICOM image format and can read metadata. The main objective of the project is to develop a CAD (Computer Aided Diagnosis) system for finding the early lung cancer nodules using the lung CT images and classify the nodules as Benign or Malignant. In 2012 Nikita Pandey and Sayani Nandy present work proposes a method to detect the cancerous cells effectively from the CT scan images by reducing the detection error made by the physicians naked eye for medical study based on Sobel edge detection and label matrix.

3.METHODOLOGY

Overall, there are three main processes used throughout the report; Pre-processing, feature extraction and finally the classification process. MATLAB is used in every process made throughout the project. Process involved in the lung cancer detection system for the project can be view in Figure (a).

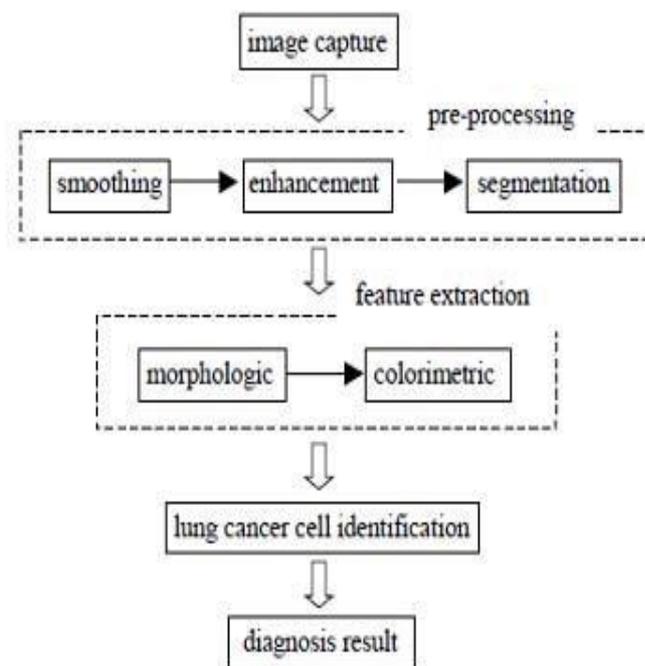


Fig.(a)p: Lung Cancer Detection System

LCDS system uses convolution filters with Gaussian pulse to smooth the cell images. The contrast and color of the images are enhanced. Then the nucleuses in the images are segmented by thresholding. All of those are simple digital image processing techniques. After that, LCDS utilizes morphological and colorimetric to extract feature from image of the nucleuses [3]. The extracted morphologic features include the average intensity, area, perimeter and eccentricity of the nucleuses. On this basis, a lung cancer cell identification nodule is employed to analyze those features to judge whether cancer cells exist in the specimens or not. Moreover, if there are cancer cells, the cancer cell type is identified. The entire diagnosis process of LCDS is shown in Fig.(a)

3.1 Image pre-processing

In the image Pre-processing stage we started with image enhancement; the aim of image enhancement is to improve interpretability or perception of information in images for human viewers, or to provide better input for other automated image processing techniques. Therefore, all the image have been undergoing several pre-processing process[4]. Image pre-processing process involved are smoothing, enhancement, and segmentation are done.

3.1.1 Image Enhancement

These techniques are divided into two categories: Spatial Domain method & frequency domain method. Unfortunately there is no general theory for determining what good image enhancement is when it comes to human perception. If it looks good ,it is good! However, when image enhancement techniques are used as pre-processing tools for other image processing techniques, then quantitative measures can determine which techniques are most appropriate. In our image enhancement stage we used three techniques like Gabor filter ,auto enhancement and FFT.

3.1.2. Image Segmentation

It is an essential process for most image analysis subsequent task in particular many of the existing techniques for image description and recognition depend highly on the segmentation result. We used Thresholding & Watershed segmentation techniques Thresholding is one of the most powerful tools for image segmentation. The segmented image

obtained from Thresholding has the advantages of smaller storage space, fast processing speed and ease in manipulation, compared with gray level image which usually contains 256 levels. Therefore, thresholding techniques have drawn a lot of attention during the past 20 years. Watershed segmentation extracts seeds indicating the presence of objects or background at specific image locations. The marker locations are then set to be regional minima within the topological surface (typically, the gradient of the original input image) and the watershed algorithm is applied.

3.2 Feature Extraction

The Image features Extraction stage is very important in our working in image processing techniques which using algorithms and techniques to detect and isolate various desired portions or shapes (features) of an image. Feature extraction is an essential stage that represents the final results to determine the normality or abnormality of an image[7]. These features act as the basis for classification process. Only these features were considered to be extracted; average intensity, area, perimeter and eccentricity. The features are defined as follows: **a) Area:** it is a scalar value that gives the actual number of overall nodule pixel. It is obtained by the summation of areas of pixel in the image that is registered as 1 in the binary image obtained. **b) Perimeter:** It is a scalar value that gives the actual number of the outline of the nodule pixel. It is obtained by the summation of the interconnected outline of the registered pixel in the binary image. **c) Roundness(Eccentricity):** This metric value or roundness or circularity or irregularity index(I):1 only for circular and it is less than 1 for any other shape.

4. PROPOSED WORK

CT image of Lung Cancer have successfully undergo the image pre-processing procedure with four features: average intensity, area, perimeter and eccentricity.

4.1 Enhancement Technique

There are different types of enhancement techniques in image processing shown as below

4.1.1 Gabor filter enhancement technique

The Gabor filter was originally introduced by Dennis Gabor , we used it for 2D images (CT images). The Gabor function has been recognized as a very useful tool in computer vision and image processing, especially for texture analysis, due to its optimal localization properties in both special and frequency domain. Image analysis with Gabor filters is thought to be similar to perception in the human visual system. A set of Gabor filters with different frequencies and orientations may be helpful for extracting useful features from an image. Gabor filters have been widely used in pattern analysis applications.

Gabor Enhancement is the most suitable technique that can be used to have a good quality image.

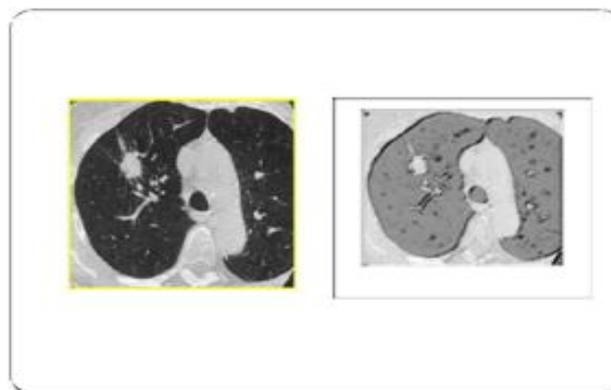


Fig.(a)

Fig.(b)

Fig4.1: Applying Gabor filter enhancement technique

(a)Original image

(b) Enhanced image

4.2. Segmentation

Segmentation divides an image into its constituent regions or objects. The segmentation of medical images in 2D, slice by slice has many application for the medical professional visualization and volume estimation of the object interest, detection of abnormalities (eg.tumor etc.), tissue quantification and classification.

4.2.1 Watershed Segmentation

Separating touching objects in an image is one of the more difficult image processing operations, however it has no smoothing/generalization properties. The marker based watershed segmentation can segment unique boundaries from an image. According to our experimental subjective assessment in the segmentation stage the Watershed Segmentation approach has more accuracy and quality than Thresholding approach [6].

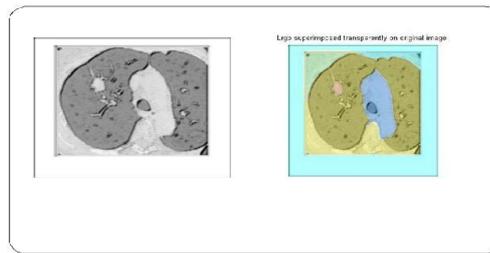


Fig. (a) Fig.(b)

Figure5.1: Normal Enhanced Image by Gabor filter and its Segmentation using Marker-Watershed
Fig.(a) Enhanced Image Fig.(b) Segmented Image

5. CLASSIFICATION

Lung nodule is smallest growths in the lung that measure between 5mm to 25mm in size. Malignant nodules tend to be bigger in size >25mm, and have a faster growth rate. In the normal images nodule size is less than 25mm. And in the abnormal images its size is greater than 25mm. In the segmentation that nodule is detected and then we use feature extraction to extract the features from that segmented image by which we can identify the stages of lung cancer. Lung nodule show up as round, white opacities on chest X-rays and computed tomography scans. Previous scan X-ray or scan and the current X-ray and CT-scan is used to determine if there is any change in shape, size, or appearance of the nodules. If the nodule do not grow larger after monitoring for a 2 year period, no further treatment is necessary.

5.1 Stages of Lung Cancer

The stages of a cancer are a measure of the extent to which a cancer has spread in the body. Staging involves evaluation of a cancer's size and its penetration into surrounding tissue as well as the presence or absence of metastases in the lymph nodes or other organs [7]. Staging is important for determining how a particular cancer should be treated, since lung-cancer therapies are geared toward specific stages. Staging of a cancer also is critical in estimating the prognosis of a given patient, with higher-stage cancers generally having a worse prognosis than lower-stage cancers. Stages from I to IV in order of severity: In stage I, the cancer is confined to the lung. In stages II and III, the cancer is confined to the chest (with larger and more invasive tumors classified as stage III). And in stage IV cancer has spread from the chest to other parts of the body.

6. CONCLUSION

Lung cancer is the most dangerous and widespread in the world according to stage the discovery of the cancer cells in the lungs, this gives us the indication that the process of detection this disease plays a very important and essential role to avoid serious stages and to reduce its percentage distribution in the world. To obtain more accurate results we divided our work into three stages: Image Enhancement stage, Image Segmentation stage and Features Extraction stage. Lung Nodule Detection in CT Scans is an active area of research which is continuously emerging and there are many enhancements that can be included to make more efficient.

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