

Automatic Detection and Classification of Lung Carcinoma using Image Processing Techniques in LabVIEW



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Abstract: Lung cancer screening saves human lives by detecting cancer earlier, when it may be treated more successfully. The most familiar methods for the diagnosis of lung cancer includes bronchoscope guided BronchoAlveolar Lavage (BAL) samples and the CT scan. In this paper, we propose a technique to automatically analyze the microscopic images of BAL samples and CT scan images in the same platform. This method will help in reducing the manual intervention and provides many useful parameters such as location, size and number of clusters present in the images. We have processed the images using the specialized software in LabVIEW, NI vision Assistance. The detection is done with the microscopic images of BAL and the stages are classified with the analysis of CT scan images. For this, separate algorithms have been developed using Vision Assistant and the common user interface has been designed using LabVIEW.

Keywords: Biopsy, Bronchoscope, BronchoAlveolar Lavage (BAL), Computed Tomography, vision Assistance, LabVIEW, User interface.

I. INTRODUCTION

Lung cancer is the most deadly and second most common cancer in both men and women. Each year, more people die of lung cancer than any other types of cancer [1]. As per the statistics of American cancer society, of the total cancer cases reported, 14% are diagnosed as lung cancer. Almost a fifth of all cancer deaths worldwide is lung cancers. In the beginning of the century in India, lung cancer was considered to be rare. But now it is the leading cause of cancer deaths [2]. The time trends of lung cancer show a significant increase in the metropolitan cities such as Delhi, Chennai and Bangalore in both sexes. Hence there is a need for an efficient tool not only to diagnose lung cancer but also to classify it as earlier as possible.

There are three common steps to diagnose lung cancer namely 1) Physical examination 2) Computed tomography (CT scan) 3) Biopsy [3].

In this paper, the algorithm is developed to automatically analyze the both CT scan and biopsy. Usually, the analysis of BAL samples and CT scan images are done manually which is a time prone task. Also, it is up to the ability of the physicians to perform an exact analysis to find out the count of the cells and the extent of the disease spread. We propose a method for the combined analysis of biopsy and CT images automatically using NI Vision assistant and LabVIEW. A graphical user interface has been designed through which the doctor may interact with the system just by giving the BAL sample images and the CT scan images as input. The necessary parameters such as the presence or absence of cancer, size, location, etc. will be displayed in the user interface.

1. Proposed Methodology

1.1 BAL Image Analysis

We propose the following algorithm for the detection of atypical cells from BAL sample images using NI vision assistant.

a) Image Acquisition

The first step is the acquisition of BAL samples from the patients. The microscopic images of these samples are taken for analysis. Along with the atypical cells (if any) native cells such as squamous cells [4], stratified columnar cells, Carbon laden alveolar macrophages, Epithelial cells can also be seen.

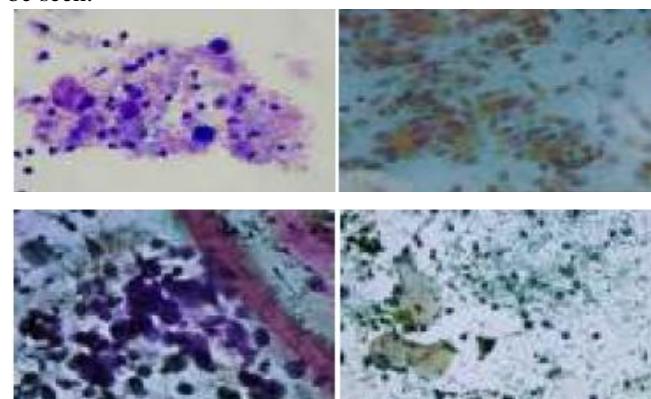


Figure 1. BAL sample Images

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b) Image pre-processing

i) Image enhancement

The quality of the image is adjusted by varying three parameters [5]: Brightness, Contrast and Gamma value. Brightness and contrast are adjusted as per the requirement and gamma which is a numerical parameter that describes the non-linear relationship between pixel value and luminance is set to 0.31.

ii) Color operator

The resultant image is subjected to logical NOR operation with a blue constant to highlight the cells.

c) Image segmentation

i) Colour plane extraction

In this step, the image is converted to HSL luminance plane which is the grayscale representation of an image [5]. HSL stands for Hue, Saturation and Lightness. This model is the simplest way of representing the image in the form of cylindrical coordinates.

ii) Threshold

Thresholding is done mainly to select the range of pixel values in grayscale images. Here, the manual threshold is set to a minimum of 60. Hence, the image is converted to binary, which highlights the typical cells alone.

iii) Basic morphology

The morphological changes include erosion and morphological opening. Erosion [6] is used to remove noise by computing a local minimum over the area of the kernel (that is of the size 3*3 here). By applying this kernel, the brighter areas of the image get thinner whereas dark zones get bigger. A Morphological opening is nothing but preserving the size and shape of other objects. In other words, the opening is the erosion of objects followed by dilation.

iv) Advanced morphology

This performs high-level operations on the particles of the image. Here, tiny particles with unnecessary details are removed by performing the same operation twice.

d) Particle analysis

This operation is used to display the resultant measurements [7] such as the number of cancer cells, mass, area, radius, location, perimeter, etc. of the segmented particles for analysis. These parameters may help the physicians to decide on further diagnosis procedures.

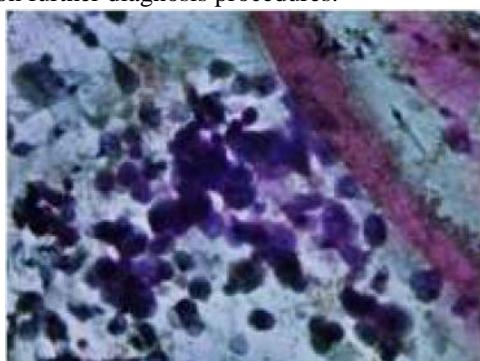


Figure 2. Unprocessed Image

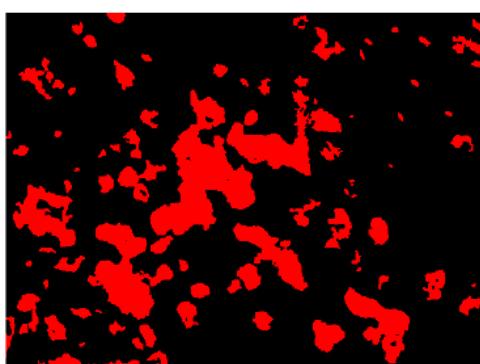


Figure 2.1. Resultant Image

2.2 CT scan Image Analysis

In CT image, overlapping structures are eliminated making the internal anatomy more apparent. So, cancer affected area of the lungs will be clearly visible in CT scan than in X-rays. The following algorithm has been developed to detect lung cancer using CT scan images in NI vision assistant.

a) Image acquisition

In this scan, high-resolution image is obtained from high radiation dosage and noisy, unclear images are the results of low radiation dosage [8]. However, increased dosage results in adverse side effects which are hazardous. Keeping this mind, we have developed an algorithm which can accept the images of any resolution. In short, the CT scan images of any quality are taken as the input.

b) Image pre-processing

i) Resampling

Resampling [9] is done to geometrically transform digital images. This process is mainly done to prepare the image for further processing. Through upsampling and downsampling at suitable places, we convert the input images to the same resolution of 256*256 pixels. For this purpose, bilinear interpolation is used.

ii) Image calibration

Generally, all the measurements such as size, area, etc. will be displayed in the form of pixels. To convert these measurements to real-world units, image calibration is done.

iii) Image enhancement

The three parameters namely brightness, contrast and gamma values are adjusted to highlight even the fine details of the image. Here, the gamma value is set to 1.99.

c) Image segmentation

i) Color plane extraction

Histogram of the CT scan images reveals that red color is more apparent in the images than the other colors in the RGB plane. So, in this step, the image is transformed to RGB red plane.

ii) Threshold

As mentioned in the threshold section of BAL image analysis, thresholding is used to convert a grayscale image into a binary image so that morphological changes can be applied. Here, the manual threshold is set to 200.

iii) Advanced morphology

The resultant image contains some of the border objects which may be the lining of the lungs. These unwanted objects are removed in advanced morphology. Usually, the cancer cells will be larger than the normal cells in the lungs. So, the cells with smaller dimensions are removed.

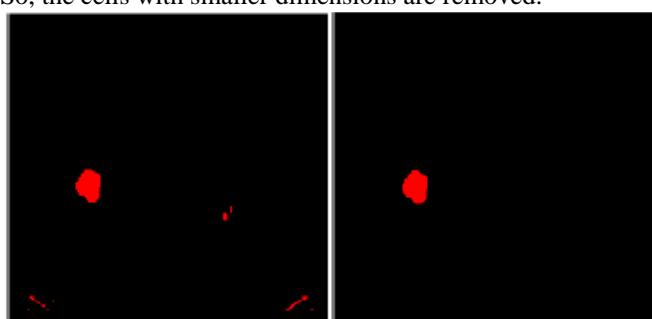


Figure 3. Before applying morphological changes

Figure 3.1. After applying the morphological changes**d) Particle Analysis**

Finally, the required measurements for the classification of the cancer stages are displayed. The stages are classified using LabVIEW.

1.2 LabVIEW**a) Overview**

Laboratory Virtual Instrumentation Engineering Workbench is a graphical programming language developed by National Instruments which is now being used widely by engineers for various purposes [10]. One of its important applications is in the field of image processing. Input images of various file formats such as JPEG, TIFF, GIF, PNG, BMP, etc. can be processed and the output can be displayed in the form of graphs, numeric data, texts, etc [11]. Added to these, the user interface can also be designed according to the needs of the end-user [12].

b) Elements of LabVIEW

- 1) The programs developed in LabVIEW are named as Virtual Instruments (VI).
- 2) The window which displays the controls and indicators alone are referred to as a front panel.
- 3) The back panel-Block diagram contains the graphical source code.

c) Creating subVI

The scripts developed for BAL sample images and CT scan images are exported to LabVIEW individually using ‘create LabVIEW VI’ option in Vision Assistant. This operation creates a front panel and block diagram for the BAL sample algorithm and CT scan algorithm separately. A common front panel can be designed for the analysis of both the images which will be beneficial to the physicians.

d) Merging the VIs

The case structure option in the function palette of the block diagram is used for this purpose. It has one or more sub diagrams exactly one of which executes first when the structure executes. The value wired to the selector terminal of the case structure determines which case is to be executed first. Here, we use two cases (0 and 1). Case 0 is assigned to the BAL image analysis and case 1 is for the CT scan image analysis. A Ring control connected to the selection terminal of the case structure enables the user to switch among the cases. In addition to this, common input and output blocks are connected to the case structure.

II. RESULTS AND DISCUSSIONS**3.1 Classification**

Depending upon the diameter of the cancer lump(x), it can be classified into four stages:

Stages	Diameter (cm)
T1a	$X \leq 2$
T1b	$2 < X \leq 3$
T2a	$3 < X \leq 5$
T2b	$5 < X \leq 7$
T3	$7 < X \leq 9$
T4	Any other Size

Along with these details, additional information whether the cancer lumps are present on carina (centre part of the lungs) or not is also displayed in the front panel.

3.2 Front panel design**a) Controls**

- 1) File path: This option in the front panel is included to specify the location of the input image. It is the complete path including the drive, directory and the file name.
- 2) Ring: Ring is the button which is used to specify the case (BAL or CT).

b) Indicators

- 1) Image display: Two image displays are used-one for the input and another for the output.
- 2) Particle measurements: The necessary parameters regarding the dimensions of the cancer lumps such as diameter, mass, location, etc. are displayed in the particle measurements array.

III. CONCLUSION

BronchoAlveolar Lavage (BAL) method is being practiced since the 1970s. Although it is seldom used as a stand-alone technique for diagnostic purposes, it provides better results with Computed Tomography (CT scan). There is also a great interest in applying image processing techniques for the analysis of microscopic images. Also, the vision assistant tool kit of LabVIEW is specifically designed for image processing applications. So, we have used this platform for the combined analysis of both the images.

ACKNOWLEDGEMENT

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