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Lung Cancer Nodule Location Diagnoses Using Linear Vector Quantization Based Morphology Process

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Nodules localization diagnose is a challenging issues since it helps medical personnel to determine the next treatment to lung cancer patients. The purpose of this study is to diagnose the location of nodules in lung cancer using a linear Vector Quantization Based Process Morphology. This research comprises three stages: image preprocessing, determining nodule candidate and determining nodule location. Methods exploited in preprocessing are downscaling, grayscale, and Contrast-Limited Adaptive Histogram Equalization (CLAHE) to normalize the intensity of the image varies. Watershed is exploited to clarify the feature image while LVQ is to classify the present of nodules. We evaluated the proposed method on 73 CT images of The Cancer Imaging Archive (TCIA) Public Access. The results showed 82.19% has been able to show the location of nodules in lung cancer.

Keywords: nodule, lung cancer, LVQ, morphology process

1. INTRODUCTION

There were an estimated 14.1 million cancer cases around the world in 2012. 7.4 million cases of them were in men and 6.7 million in women. This number is expected to increase to 24 million by 2035[1]. Lung cancer is the biggest number then other cancer. There are three main types of lung cancer: Non-Small Cell Lung Cancer, Small Cell Lung Cancer, and Lung Carcinoid Tumor[2]. Non-Small Cell Lung Cancer is the most common type. About 85% of lung cancers are in this type. Squamous cell carcinoma, adenocarcinoma, and large cell carcinoma are all subtypes of non-small cell lung cancer. Small cell lung cancer tends to spread very fast, it also refers to oat cell cancer. Approximately 10%-15% of lung cancer is in this type. Lung Carcinoid Tumor is less than 5% of lung cancers. They are also defined as lung neuroendocrine tumors. Most of these tumors grow slowly and rarely spread.

Lung cancer based image processing has been investigated by many researchers. Computerized System For Lung Nodule Detection in CT Scan[3], proposed a method for detection and diagnosis of lung nodules (malignant & benign) on Computed Tomography (CT) images, the detection comprises two stages: obtaining the lung image from CT-scan image of the chest region and gaining the lung nodules by exploiting landmark and shape features (geometric properties) of lung nodules. Cancer Cells Detection Using Digital Image Processing Methods has employed thresholding and watershed to detect cancer cell[4]. A further researches of cancer detections are statistical feature-based neural Network Approach for the Detection of Lung Cancer in Chest X-Ray Images[5],

Lung Cancer Detection on CT Scan Images: A Review on the Analysis Techniques[6], Lung Detection and

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Segmentation Using Marker Watershed and Laplacian Filtering[7], efficient optimization based lung cancer pre-diagnosis system using feed forward backpropagation neural network[8], Identifying Lung Cancer Using Image Processing Techniques[9], Lung Cancer Detection Using Image Processing Techniques[10], Detection of Lung Cancer Stages on CT scan Images by Using Various Image Processing Techniques[11], Automated detection of lung cancer using statistical and morphological image processing techniques[12], Lung Cancer Detection System on Thoracic CT Images Based on ROI Processing[13], Detection of Lung Cancer Using Marker-Controlled Watershed Transform[14], Lung Cancer Detection from CT Image using Image Processing Techniques[15] and Review about Prediction of lung Cancer Using Image Processing Techniques investigated by[16].

The aim of this research is to design and to implement pre-diagnosis system about the location of nodule in lung cancer. This research proposes the method to find lung cancer location using linear vector quantization (LVQ) based on morphology process. The steps of this research are preprocessing and searching the location. Contrast-Limited Adaptive Histogram Equalization (CLAHE) is applied for preprocessing. It is benefited to normalize the intensity of the image varies. Template matching and downscaling are applied for searching the location and speed up the scanning process. Watershed is exploited to clarify the feature image and row sum graph and center of mass for the final process, LVQ used to classify the present of nodules.

2. METHODOLOGY

In this work, we observed 73 CT images from The Cancer Imaging Archive (TCIA) Public Access. Hardware specification for this research is Dell Inspiron N3010 with Processor Intel(R) Core I5 CPU M430 @2,27 GHz with installed memory (RAM) 2,00 Gb.

This work comprises 3 stages: image preprocessing, determining nodule candidate and determining nodule location. The three stages are simply listed in Table 1. Methods exploited in preprocessing are downscaling, grayscale, and Contrast-Limited Adaptive Histogram Equalization (CLAHE) which are employed to normalize the intensity of the image varies. Furthermore, watershed is applied to clarify the feature image while LVQ is employed to classify the present of nodules. The algorithm for this work is illustrated in Fig. 1.

Table.1 Process of Lung Cancer Nodule Diagnose Using LVQ Based Morphology

PROCESS	METHODS
Preprocessing	Dimension normalization using downscaling Grayscale Process Intensity normalization using CLAHE
Determining nodule candidate	Otsu Connected component 8 pixel Labelling
Determining nodule location	Watershed LVQ

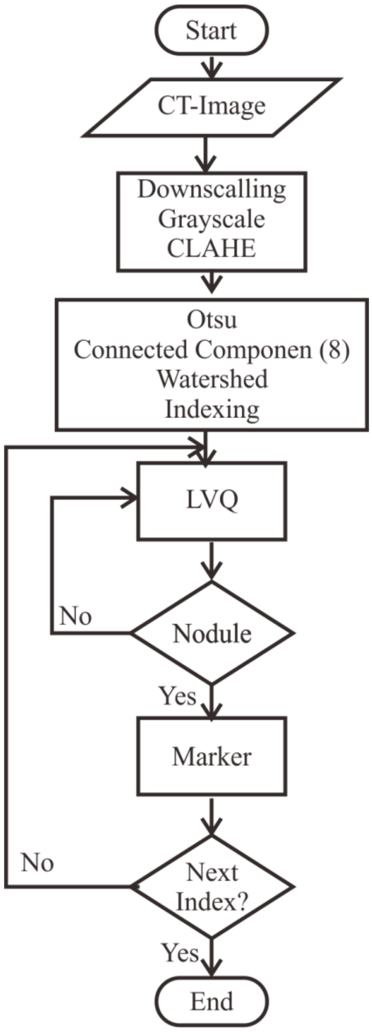


Fig.1 Algorithm of Lung Cancer Nodule Location Diagnoses

3. RESULT AND DISCUSION

We evaluated our proposed method for Lung cancer images. The first step is preprocessing which aims to standardize the dimensions of the image and the intensity of the entire original image. Standardizing the dimensions used comparative method while CLAHE is implemented to standardize the intensity. CLAHE steps are explained as follows:

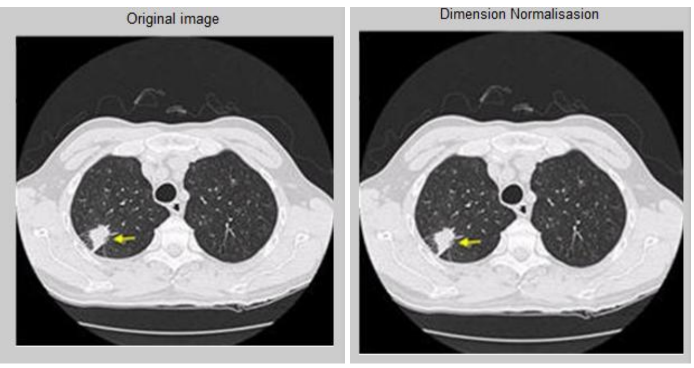
Step 1: Each cell-image is divided into 2×2 non-overlapping contextual region.
Step 2: Histogram of every contextual region is calculated.
Step 3: Setting the threshold parameter (the contrast of the cell-image) which is adjustable.
Step 4: Each histogram which less than the threshold parameter is distributed.
Step 5: The transformation function to modify all histograms using probability density of the input image grayscale value
Step 6: The cell-image grayscale values is changed based on modified histograms.

The histogram of a digital image with gray levels in the range [0, *L*-1] is a discrete function which is formulated in equation (1).

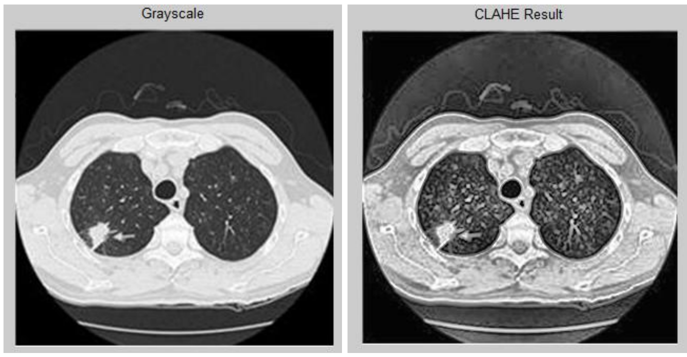
$$p(r_k) = \frac{n_k}{n} \quad (1)$$

where r_k is the kth gray level, n_k is number of pixels in the gray level image, *n* is total pixel number, and $k = 0, 1, 2, \ldots, L-1$. Basically $p(r_k)$ is an estimate the occurrence probability of gray level r_k [17].

Figure 2(a)-(b) are original image of the patient's lung and the result of normalization process, respectively. Image is then converted to grayscale as depicted in Figure 2(c). Grayscale process results is exploited as input for a CLAHE process. The result is depicted in Figure 2(d). Results obtained from the preprocessing is furthered providing information about the characteristics of the nodule.



(a) (b)



(c) (d)

Fig. 2 (a) Original image (b) Dimension normalization (c) Grayscale image (d) CLAHE process result

Otsu process is employed to find nodule candidates. Figure 3(a) is the result of Otsu process. In these pictures, some nodule candidates are present. However, some of objects are not nodule. It is therefore necessary to identify the actual nodule using LVQ. Otsu method is performed by further experiencing the distribution of grayscale, which is then classified to two classes. The formulation of this method is as follows.

$$\sigma^2_{within}(T) = n_B(T)\sigma^2_B(T) + n^2_o(T) \quad (2)$$

σ^2_{within} and T

where

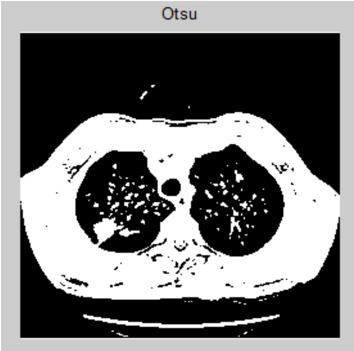
$$n_B(T) = \sum_{i=0}^{T-1} p(i) \quad (3)$$

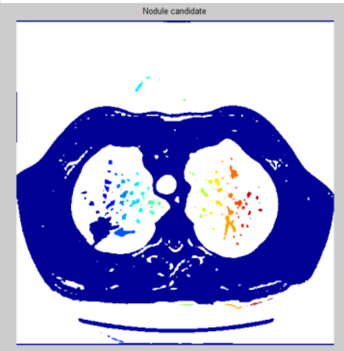
$$n_o(T) = \sum_{i=T}^{N-1} p(i) \quad (4)$$

$\sigma^2_B(T)$ is the variance of the pixel-value below the threshold value

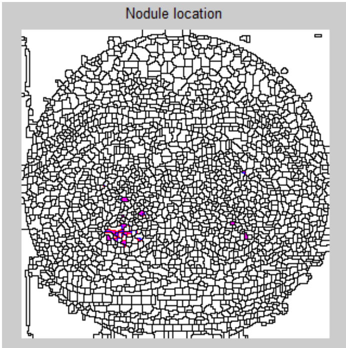
$\sigma^2_o(T)$ is the variance of the pixel-value below the threshold value and [0,N − 1] is intensity level

Indexed object is shown in Figure 3(b), all candidates nodules were classified using LVQ. When an object is detected as a nodule will be given marker. Conversely if the object is not identified as nodules then it will not be given marker. The results of the identification LVQ depicted in Figure 3 (c). After testing 73 data, the results obtained 82.19% can detect the location of nodule.





(a) (b)



(c)

Fig. 3 (a) Otsu process results (b) Nodule candidate (c) Nodule location

4. CONCLUSIONS

This research consists of three procedures: image preprocessing, determining nodule candidate and determining nodule location. Methods exploited in preprocessing are downscaling, grayscale, and Contrast-Limited Adaptive Histogram Equalization (CLAHE) which are used to normalize the intensity of the image varies. Watershed is applied to clarify the feature image and LVQ is to classify the present of nodules. Data studied 73 CT images from The Cancer Imaging Archive (TCIA) Public Access. The results showed 82.19% has been able to show the location of nodules in lung cancer. This result is a good result because up to now determining the location nodule is complex. It is therefore necessary to develop methods to determine nodules location more accurate.

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