TUMOR DETECTION ON CT LUNG IMAGES USING IMAGE ENHANCEMENT

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Abstract: Last three decades, early cancer detection and researches on early detection solutions play vital role for human health. Computed tomography images (CT) are widely used in radiotherapy planning because they provide electronic densities of tissues of interest which are mandatory to a correct dose computation. Furthermore, the good spatial resolution and soft/hard tissues contrast allow precise target delineation. Also, CT techniques are preferred compared to X-Ray and MRI images. Image processing techniques have started to become popular in use of CT images. In this study, image pre-processing, image erosion, median filtering, thresholding and feature extraction of image processing techniques are applied on CT images in detail. The aim of this study is to develop an image processing algorithm for lung cancer detection on CT Images.

Keywords: CT Lung Cancer Images, Thresholding, Feature Extraction

Introduction

As WHO reported (WHO 2012), all around the world 8.2 million people died because of cancer. According to American Cancer Society (ACS 2012) researches showed that lung cancer mortality rates in men has dropped nearly 30 percent whereas, this rate in women has started to regress in last 10 years.

According to ACS (ACS 2012), the second most common cancer in both men and women is lung cancer, where prostate cancer is more common for men and breast cancer is for women. Lung cancer has very low survival rate after late diagnosis, where it is directly proportional with its growth at its detection time. However, if it can be detected at early stages, people have a higher possibility of survival.

Carcinoma, another name given to lung cancer, is growing of abnormal cells. Lung cancers are broadly classified into two types: small cell lung cancers and non-small cell lung cancers which are abbreviated as SCLC and NSCLC respectively (Rath 2001). As for the stages, there are four stages of carcinoma; I, II, III and IV, where staging is relying on tumor size, tumor and lymph node location (Rath 2001).

In today's world there are different techniques such as Chest Radiography (x-ray), Computed Tomography (CT), Magnetic Resonance Imaging (MRI) scan and Sputum Cytology, for diagnosing lung cancer (Al-Tarawneh 2012), (Chaudhary and Singh 2012). As stated earlier, early diagnoses are important for interfering the cancer, so that new technologies are greatly needed. Researches showed that, with early detection, survival rate of lung cancer patients has been increased from 14% to 49% within last five years (Chaudhary and Singh 2012). Image processing techniques are widely used in different medical fields to guide medical staff for detection of cancer in earlier stages (Al-Tarawneh 2012).

Nowadays multi-disciplinary actions are carried out for effective and efficient solutions for human health and survival. One of the most popular multi-disciplinary work is on image processing techniques that have been used in various medical fields (Ada and Kaur 2013), (Dimililer 2012), (Dimililer 2013). The aim of this paper is to perform image processing techniques and their interrelated methods to Health care, especially to the carcinoma patients. Ultimate research relay on quantitative information for instance, the shape, size and the ratio of the affected cells (Pathan and Sptalkar 2012).

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Proposed Lung Tumor Detection System

In this section, detection of tumors within the lung using Image processing techniques will be proposed. The suggested system will be explained in detail.

Image Acquisition

Computed tomography (CT) scan images are preferred to be used in this research, due to low noise and better clarity compared to X-Ray and MRI images. The lung image database has been chosen from NIH/NCI Lung Image Database Consortium (LIDC) which is an on-line CT image dataset available for the researchers in the field of digital image processing. The images used within this research are in .raw format. Figure 1 shows samples of original CT images.

Figure 1. Original CT lung images.

Image Enhancement on Lung Tumor Detection

Following image acquisition, all the images have gone a few image processing steps; grayscale conversion, thresholding, erosion, median filtering and noise removal, and image subtraction.

Gray Scale Conversion

This step involves conversion of original DICOM images which are in RGB format to grey color. It converts RGB images to grayscale by removing the tint and saturation information while maintaining the luminance.

Normalization

The size of the images has been reduced from 512 x 512 to 256 x 256 pixel values, in order to provide sufficient information while the processing time is low.

Image Thresholding

Threshold value is a specific value that turns a grayscale image into a binary image due to thresholding method. The main idea of this method is when multiple levels are selected, determine the threshold value or values (Dimililer, Kirsal-Ever and Ugur 2016). The easiest method for image segmentation is thresholding method, and it is the most common method used in CT images. The images in the proposed system are divided into five, namely low brightness, LB (T1), medium-low brightness, MLB (T2), medium brightness, MB (T3), high-medium brightness, HMB (T4), and high brightness, HB (T5) where ranges are defined as 0-51, 52-103, 104-155, 156-207, 208-255 respectively. These defined threshold values for brightness are classified according to field of applications, as stated in (Khashman and Dimililer 2005).

Figure 2 shows a median filter applied image, whereas figure 2b represents threshold segmentation is applied. This is the area with the consistency values higher than the defined threshold. High consistency areas mostly involve of cancerous tissue. Through the threshold segmentation, the location of cancerous tissue is determined.

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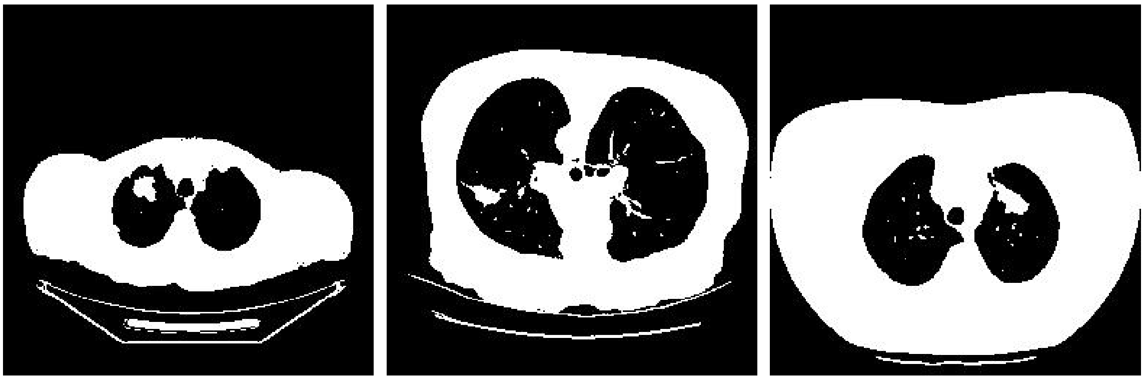

Figure 2. Threshold applied to Median filtered image.

Noise Removal

For removing the noise, erosion and 5 x 5 median filter (Dimililer, Kirsal-Ever and Ugur 2016) are applied to the system respectively. Erosion is one of the basic operators in the morphological image processing. The main effect of the operator on a binary image is to erode away the confines of sites of foreground pixels such as white pixels. Median filtering is applied to reduce the noise within CT images preserving the details and smooth non-impulsive noise. If the aim is to simultaneously minimize noise and conserve edges, a median filter is more impressive (Badrul Alam Miah and Abu Yousuf 2015). Figure 3 represents original CT lung image that erosion applied, where figure 4 shows median filter applied to eroded image.

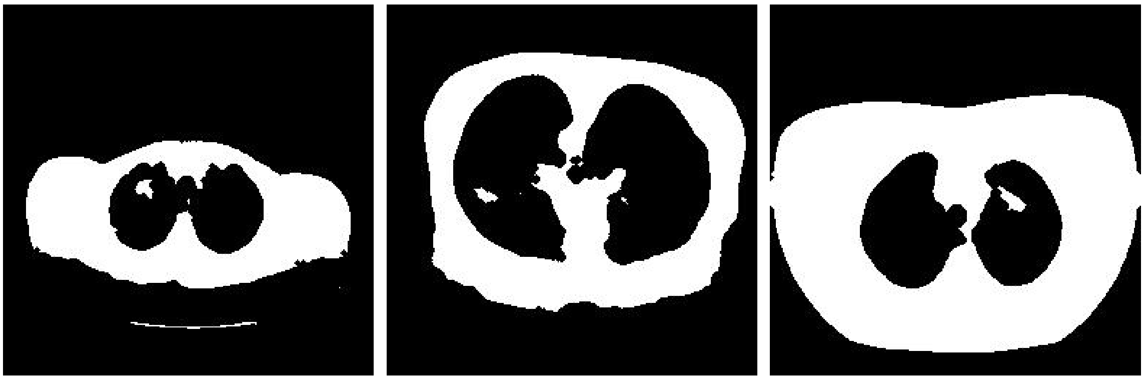

Figure 3. Original CT image with Erosion.

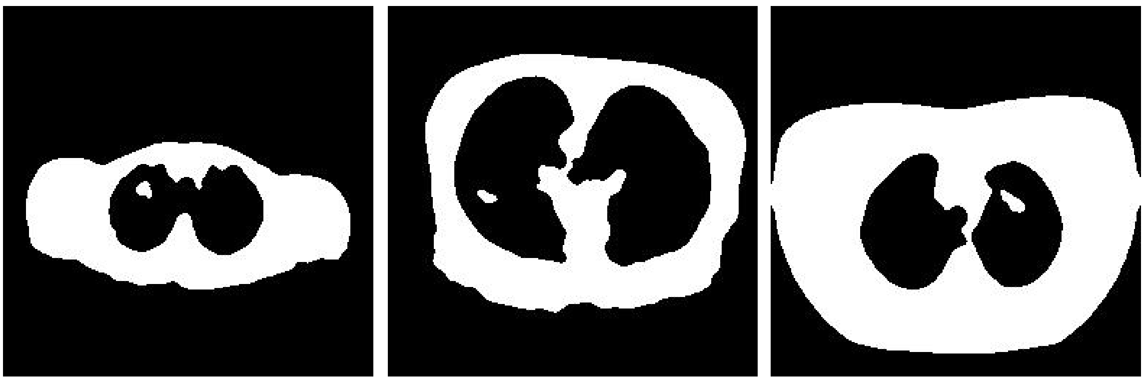

Figure 4. Median filtered applied to eroded image.

Feature Extraction

Image feature extraction stage plays an important role in this project. Image processing techniques are applied to localize and eliminate various desired portions or shapes (features) of an image.

The objects within the lung images having a total pixel numbers less than 1000, has been considered as 0 (black). The number of pixels has been decided upon several experiments for this type of tumors on lung images.

This whole process has been known as segmentation and after performing segmentation on lung images, the features can be achieved and the diagnosis rule can be designed to detect the cancer nodules in the lungs (Sharma and Jindal 2011). Figure 5 represent this information.

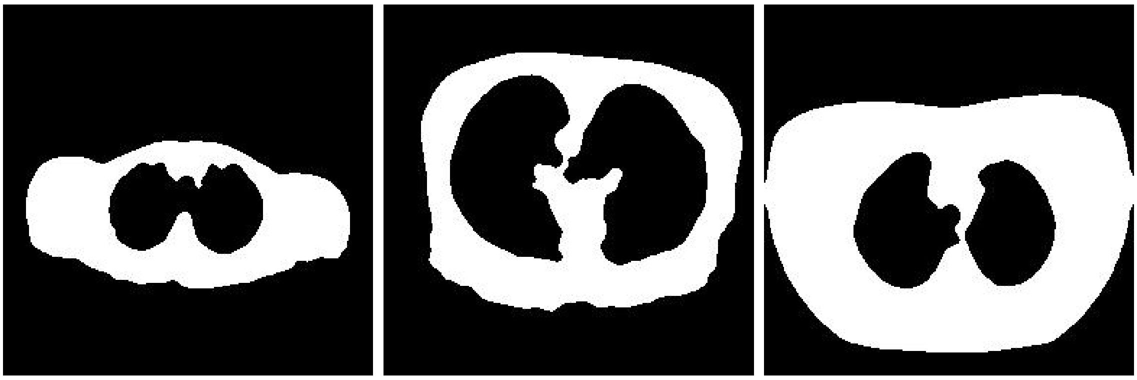

Figure 5. Feature Extraction.

Image Subtraction

In this step, images that have tumor cells are clarified by using filtering and elimination of small objects. Then tumor cells are removed from images. For removing tumor cells from images, objects are eliminated under specific pixel values.

In last step, in order to create tumor cells alone, difference between filtered image and small objects removed from the images are taken into account.

These two approaches are combined and applied successfully. Figure 6 shows the original image with the subtracted image.

Conclusion

In this paper, a tumor detection system using image enhancement is presented. In order to reduce the amount of data with computational and time costs, image processing techniques are used for providing meaningful representations of lung patterns. Relationship between input and output patterns has been created in order to detect the tumors within the images. Input images are obtained in 256x256 raw format, which thresholding are applied in order to clear black and white pixels. Afterwards, erosion and median filtering are used to remove noise. Afterwards, small objects within the image are removed. Last but not the least, small objects removed image is subtracted from median filtered image in order to find the location of the tumor.

Future work will include the modification of the system to recognize images that have scattered tumor on the lung cells.

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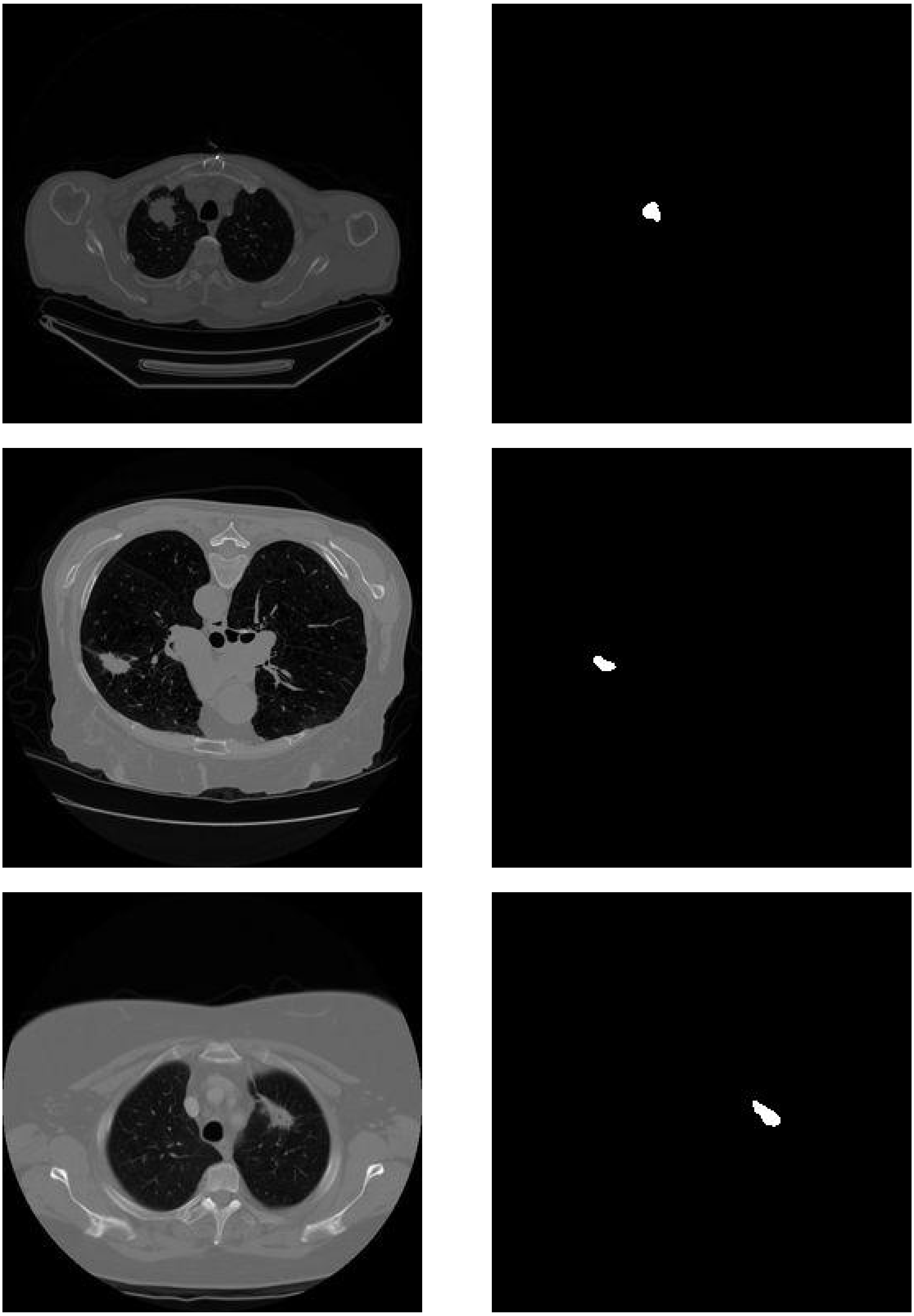

Figure 6. Image Subtraction.

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