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Research Article

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Image Processing used for Lung Cancer Detection in Medical Imaging

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ABSTRACT

This paper deals with formation of a lung cancer detection system. The system formed can take any type of medical image within the three choices consisting of CT, MRI and Ultrasound images. Here the proposed model is developed using the various techniques of image processing. The result of image processing may be either a set of features or parameters associated with the image or an image itself. The system formed accepts any one of medical image within the three choices consisting of MRI, CT and Ultrasound image as input. After preprocessing of image, Canny filter is used for Edge detection. This present work proposes a method to detect the cancerous cells effectively from the CT, MRI scan and Ultrasound images. Superpixel Segmentation has been used for segmentation and Gabor filter is used for Denoising the medical images. Simulation results are obtained for the cancer detection system using MATLAB and comparison is done between the three medical images.

Keywords: Superpixel Segmentation, Image processing, Morphological processing, Dilation, Erosion.

INTRODUCTION

One of the major reason for non-accidental death is cancer. It has been proved that lung cancer is the topmost cause of cancer death in men and women worldwide. The death rate can be reduced if people go for early diagnosis so that suitable treatment can be administered by the clinicians within specified time. Cancer is, when a group of cells go irregular growth uncontrollably and lose balance to form malignant tumors which invades surrounding tissues. Through the blood stream or lymphatic system the cancer cells can also reah other parts of body continuosly spreading from the new location. Cancer can be classified as Non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC).In this paper we confine to Non- small cell lung cancer(NSCLC) as it is more prevalent than small cell lung cancer(SCLC). There's a difference between the diagnosis and treatment of non-small cell and small cell lung cancer. The various ways to detect lung cancer is by the use of image processing , pattern recognition and artificial neutral network to develop Computer aided diagnosis. In this paper we use the techniques and algorithm used in image processing to detect cancer in three types of medical images. In this system first of all the medical images are recorded using a suitable imaging system. The images obtained are taken as input for the system where the image first go through the various steps of image processing like preprocessing, edge detection, morphological processing ,feature extraction. In this paper, CT scan image , MRI scan image and ultrasound images are used. A CT scan or Computerized Axial Tomography (CAT) scan is the most sensitive and specific detection modality produces cross-sectional images of specific areas of scanned object by the use of computer processed combination of many X-ray images taken from different angle. Radio waves and magnetic field is used to form images of a body in an imaging technique known as Nuclear Magnetic Resonance Imaging (NMRI) The aim of this paper is to design a system which can take any one of the three images as input and produces the desired output. The algorithm used are efficient in terms of sensitivity, specificity and accuracy. The proposed model consists of following steps such as: Collection of lung image data set, preprocessing, edge detection, morphological processing and segmentation of CT and MRI images. Every step is described in further sections.

EXPERIMENTAL SECTION

The In this section, the methods used for the proposed model is described. From this, the best method which can detect cancer and extract cancer tissue information from the two images is found. Finally the comparison is done amongst all the images. The steps to classification of lung cancer are given in the Fig.1

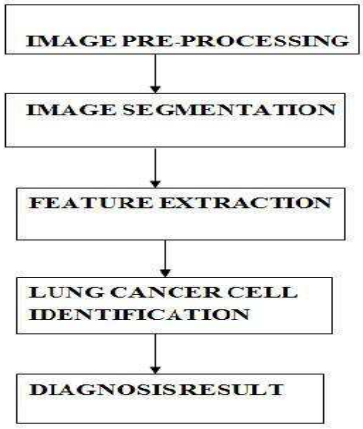

Fig.1. Lung Cancer detection system flowchart

The data used for this paper includes 6 CT and 15 MRI scan images of lungs. The lung's image have a dimension of 512 x 512.

I. Image Preprocessing

Image pre-processing is used to reduce noise and prepare the images for further steps such as segmentation. It diminishes distortion in image and enhances the relevant features. Thus a rectified image is obtained. For this purpose, MATLAB software has been used. The various steps involved in image processing are smoothing, image enhancement, green layer separation and gray level conversion.

II. Image Enhancement

The various image enhancement techniques can be categorized as spatial domain methods and Frequency domain methods. Different image enhancement techniques are used for all the different images. This includes smoothing of image and removal of noises, blurring etc. Gabor filter was found to be suitable for both the CT and MRI images .The filtering of image proves to be useful for further steps.

III. Layer Separation

An image is formed of pixels. Each pixel consists of RGB values. In this paper, layer separation is used to eliminate the effect of other two colors i.e. red and blue and represent the image in green color. It reduces the complexity for proper conversion to gray level.

IV. Gray Conversion

This includes conversion of colored image with pixels having RGB level into Gray level. A Gray level image can be easily processed in comparison to colored image. The reason are the pixels to be processed separately which have different RGB values. Therefore Gray conversion is preferred.

V. Lung Region Extraction

Superpixel Segmentation

Separation of objects and regions of interest from the other parts of the image is used so that the image can be properly analyzed. For performing segmentation the techniques used depends upon specific application, imaging modality and other factors etc. For instance ,the image pixels are classified into anatomical region , such as muscles , bones and blood vessels or into pathological regions such as tissue deformities , multiple sclerosis and cancer based on it's usefulness in a particular application [13]. To achieve a better orientation the image segmentation of lung region in all the three type of image is performed. Image slicing algorithm is the first step to the processing of the images of raw data. The best image is chosen from the resulting binary images. This is very in extracting the lung region with certain degree of accuracy and sharpness. Other techniques can be used for different use in a sequential manner resulting in further improvement of chosen image features.

The various morphological processing techniques like, Erosion and dilation steps reduces irrelevant details that may

increase difficulties to the lung border extraction process [13].The aim of the outlining border is to extract the structure's border called as lung border extraction. It is helpful in eliminating useless structures from lungs. [11]

Segmenting Extracted Lung Nodule

Proper analysis of an image can be done after segmentation as it makes the image more meaningful and easier to analyze. It can be used to clear cut the boundaries (lines, curves etc.) and objects in image. More precisely, image segmentation is the process of assigning a label to the pixels with the same visual characteristics in an image [9]. The result of image segmentation is a set of segments that collectively cover the entire image or a set of contours obtained from the image (edge detection).

There is a similarity between the pixels in a given region in the context of some computed property like color, intensity, or texture. The neighborhood lying regions may differ with respect to some characteristic(s).

This has been done using edge detection and the steps for it are:

1. An Edge is a set of allied pixels that lie on the boundary between two regions.
2. Edges are detected by Canny method.
3. Canny method is chosen because of its Accuracy. [13]

VI. Feature Extraction

The image feature extraction stage is an important step which represents the final output and by using algorithms and techniques we can determine the normality and abnormality of an image. The algorithms and techniques detect and eliminate various non-desirable portions or shapes (features) present in an image during image processing. The segmentation is carried out first on lung region followed by steps of feature extraction to get its features. Finally in relevant with some diagnosis rule the cancer nodules can easily be detected in the lungs. To have better diagnosis ,these diagnosis rules can be used to eliminate the false detection of cancers nodules resulted through segmentation . Among the features used in the diagnostic indicators which was found the literature were:

- Area of interest
- Shape
- Size of nodule and
- Contrast Enhancement
- Calcification

To obtain accurate diagnosis we experimentally found the above suitable texture features. As a matter of fact, the first feature (the area of the candidate region or object) is used for:

- Elimination of very small candidate object (Area is less than a thresholding value).
- Elimination of isolated pixels (seen as noise in the segmented image).

By the use of necessary feature, the elimination of the extra candidate regions that probably will not form a nodule can be achieved. Moreover, it's utilization helps in minimizing the computation time required in the upcoming diagnostic steps.

The next aspect is calcification in which we discover that Diffuse, central, laminated or popcorn calcifications are benign patterns of calcification. in hematomas and granulomatous disease , the above mentioned calcification has been spotted. As a signal of benignity, the other remaining patterns should not be considered. For patients known to have a primary tumour, this rule proves to be a failure. In patients having osteosarcoma or chondrosarcoma there was evident diffuse in calcification pattern. Similarily, in patients who suffered from GI- tumours and previously had chemotherapy, central and popcorn pattern was observed. The 3rd feature which was carried out in shape Japanese that proved a polygonal shape as well as a three-dimensional ratio > 1.78 and a peripheral sub pleural location as a sign of benignity through the screening. A polygonal shape is a lesion having multiple facets.

Maximal Transverse dimension divided by maximal vertical dimension gives three dimensional ratio. A large three-dimensional ratio shows that the lesion is proportionately flat, which is a benign sign. Solitary pulmonary nodule (SPN) which is the 4th feature is a single intraparenchymal lesion less than 3 cm in size and not associated with atelectasis or lymphadenopathy. Mass is basically a nodule which is greater than 3 cm in diameter.

An analysis/ distinction is made stating thats lesions greater than 3 cm are usually malignant, while smaller lesions can be either benign or malignant.

Swensen et al observed the relationship between the size of a SPN and the chance of malignancy in a cohort at high

risk for lung cancer. For smaller lesions it was concluded that benign nodule detection rate is high. Of the over 2000 nodules that were less than 4 mm in size, none was malignant.

The 5th feature which was contrast enhancement was taken and it provided the resukts that less than 15 HU possess a very high predictive value for begnignity(99%).

After a baseline scan, 4 consecutive scans are performed at an interval of 1 minute after a baseline scan. [13]

This applies only for nodules with the following selection criteria:
1. Relatively spherical
2. Nodule > 5mm
3. Homogeneous, no necrosis, fat or calcification

RESULTS AND DISCUSSION

In this paper Lung CT, MRI AND Ultrasound images used were obtained from a specialist medical imaging center. The image enhancement is done using Gabor filter. After enhancement step, the images were passed from layer separation step and then converted to Gray level image. For segmentation Superpixel segmentation algorithm was used thus lung region or (ROI) is extracted. The steps applied on CT, MRI and Ultrasound images as shown in Fig. 3.1 , Fig. 3.2 and Fig. 3.3 respectively.

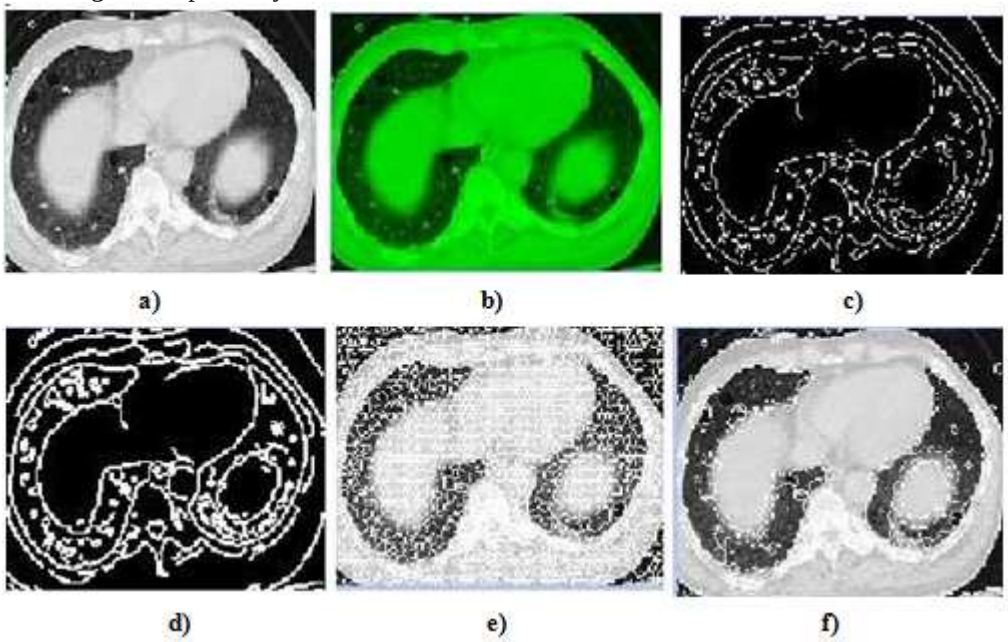

Fig.2: Segmentation steps for CT Image a) input denoised image, b) green layer separation, c) gray level intensity, d) edge detection, e) morphological processing f) segmentation, g) superpixel segmentation

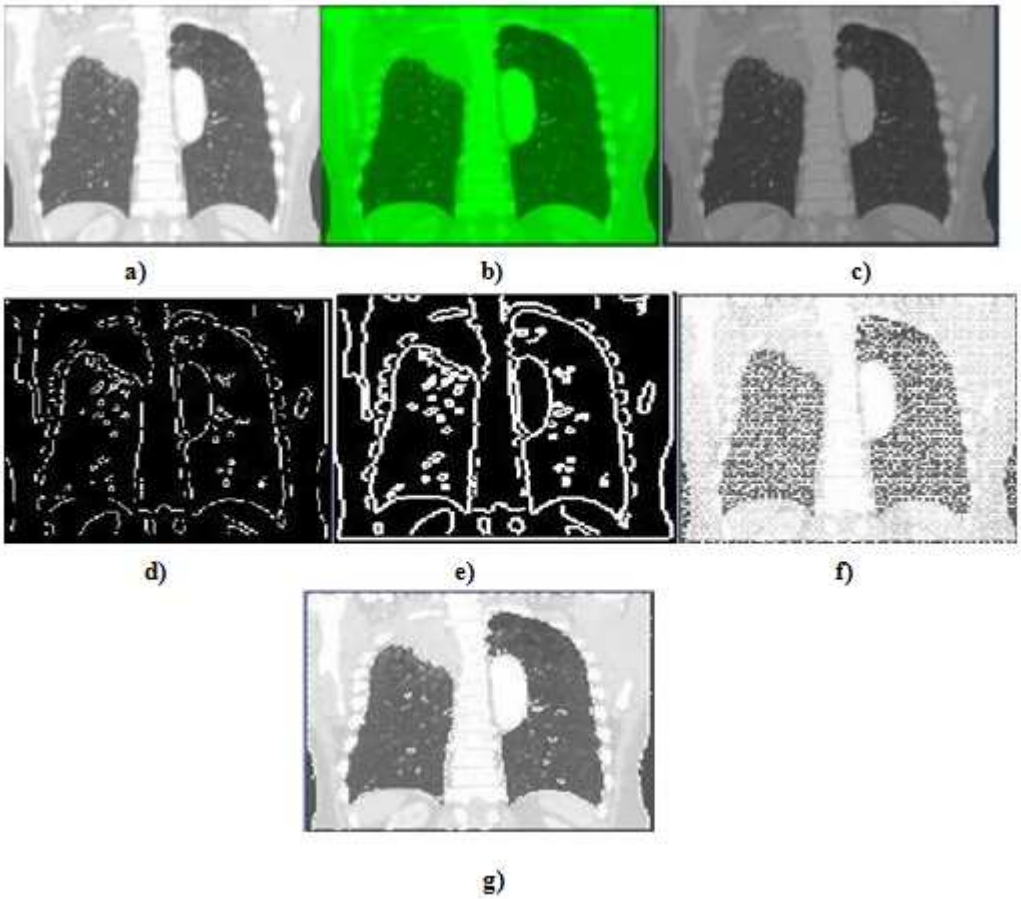

Fig.3: Segmentation steps for MRI Image a) input denoised image, b) green layer separation, c) gray level intensity, d) edge detection, e) morphological processing, f) segmentation, g) superpixel segmentation

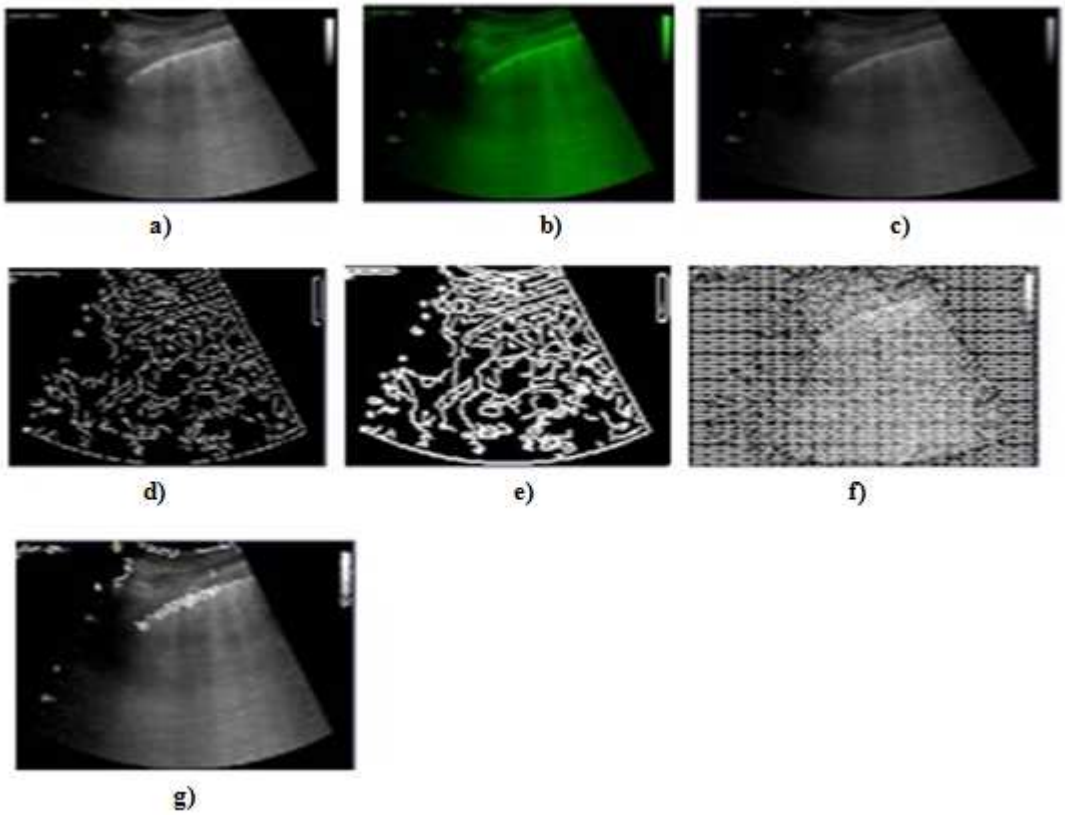

Fig.4:Segmentation steps for Ultrasound Image a) input denoised image, b)green layer separation c)gray level intensity , d) edge detection , , e) morphological processing, f) segmentation, g) superpixel segmentation

CONCLUSION

The major image modalities have been studied in this survey of cancer detection through image processing ued on CT, MRI and Ultrasound images. We proposed a method for segmentation of both MRI ,CT and Ultrasound images. Correct identification of cancer cell is done by studying the necessary features extracted for the two images. Ultrasound images as well to detect the validity of this system.

FUTURE SCOPE

By the process used the complexity is reduced in the system and diagnosis confidence is enriched.. We have used Gabor filter for noise reduction for the two images. Canny filter is used for edge detection and finally we go for superpixel segmentation. Further we can do the classification through Pearsons and Spearman algorithm to detect the cancer prone region in all the three images. We can go for different algorithms like particle swarm optimization, SVM algorithm for further classification and for reducing false positive results.

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