Automated Detection of Lung Cancer Based on Neuro Fuzzy Technique

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Abstract. Our human civilization has encountered many dangerous diseases and death due to lung cancer is increasing worldwide. The finding of lung cancer cells in the earliest stage is the most challenging process in the medical field. To address the issue, digital image processing techniques, along with neuro-fuzzy logic, has experimented in this current study. The system is aimed to help in the initial stage detection of lung nodules by classifying the existence of abnormalities in the computed tomography (CT) scan image. The critical stages involved in the detection process are preprocessing, image enhancement, image segmentation, feature extraction and neuro-fuzzy algorithm. The proposed system is an entirely functional automatic method which completely avoids physical calculation and this designed system produces a better result with a high accuracy rate.

Keywords: Lung Cancer, Image preprocessing, Image Segmentation, Filtering, Feature extraction, Thresholding, Neural network system.

1. Introduction
Cancer is affecting millions of people worldwide, out of which lung cancer is one of the major causes of the highest mortality rates. In lung cancer, cells abnormally multiply and grow into a tumour. Cancer cells tend to be passing from the lungs to different portions of the body over lymph fluid surrounding lung tissue or blood. Primary lung cancer denotes cancer that starts at lungs. Lung cancer has various stages associated with it as the tumour spreads from the lungs to the different part of the body. Thus, the initial stage finding of lung nodules helps to avoid the complication of the disease. The digital image processing method is the best approaches used to spot the nodules in the lungs[1-2]. The detection method usually consists of a few stages; in the first stage, CT images (normal and abnormal) are procured and recorded. In the second stage, image enhancement is adapted to acquire an enhanced image with superior quality. Next, the third stage deals with the implementation of algorithms for image segmentation and the fourth stage extracts several features from the enhanced segmented image using image feature extraction techniques. These extracted features are passed over the neural network to obtain the reality of the input lung image, whether it is a normal or abnormal lung image.
2. Proposed Methodology

Figure 1 demonstrates the flowchart of the proposed methodology. The primary requirement in digital image processing is the acquisition of lung images. The computerized tomography (CT) images are more efficient than x-ray images to capture the clear pictures of the lungs. The CT images of both normal and abnormal lung images are collected for experimentation purpose of identifying the lung nodules. The total number of collected lung images is 50. The collected CT images are in the file format of jpeg.

Once the lung images are captured, the next step is to implement the preprocessing to improve the quality of input lung images and also to remove the available noise in the input image while retaining the luminance. The transformation from RGB to grey level is achieved. Later the attained image is normalized. With low processing time, adequate data is obtained from the image of processed pixel size. It helps to provide better results in upcoming stages with enhanced effect in image visualization[3-4].

The median filter, which is a non-linear system of digital filtering method plays a major role in the removal of noise content in the input lung image. The output from the median filter generates a noise-free lung image without blurring the clarity of the image, which in turn helps to achieve the smoothing of the image. The selection of median filter is made as it shows better performance over another filter which is called a mean filter. Also, the median value of the filter used here is not disturbed by the unrepresentative pixel of a neighbourhood region in an image. Also, the edges of the image are conserved perfectly for future processing techniques.

Next is the binarization process of transforming the filtered grey level image into an image of only two levels which is called a binary image. The conversion from the grey level image into the binary image is adapted based on a non-linear technique which is known as thresholding which assigns two levels of pixel values. While converting into a binary image, it is essential to eliminate the excessive pixels values from the lung image, which has been filtered by a median filter in the previous step. This method is preferable as it supports the development of the size-independent algorithm.

The next important step in image processing is to increase the contrast level of the preprocessed lung image. The various contrast level of lung image intensities can be adjusted with the help of the histogram equalization method. This method advances the contrast of the images, mainly when close contrast values characterize the usable data of the image. The enhanced lung image of improved contrast level is produced from the histogram equalization technique, which helps smoothen out the histogram of filtered lung images.

Later the segmentation method is done by thresholding. Image segmentation is the technique of dividing the entire region into various parts which in turn will be most helpful for nodule identification. It makes the analyzing process as very simple. Thresholding is an identical prevalent segmentation method, utilized for separating the required region from its background. The process of identifying the
region or object of interest from the enhanced lung image using thresholding is performed by comparing every pixel intensity value of the enhanced lung image to the specified threshold value.

Alteration in the shades and colours of the pixel, the form of the lung image or portion of the lung image is altered in a more identical approach. Filters are adapted to improve the brightness and contrast, which will enhance a range of tones, textures and superior properties to a picture. Filtering image data is used to eliminate the unwanted noise content from the lung image without disturbing the original data present in the lung image. Also, the proper selection of essential filter is subjected to filter behaviour and type of data. Here we can prefer the Sobel filter for filtering. The edge detection is performed using the Sobel filter. The gradient of image intensity at each pixel in the given image is first calculated.

The next step in digital image processing is dilation. In dilation, the pixels are added to the boundaries of objects in the segmented lung image. The erosion process eradicates the pixels which are available on the borders of the segmented object. The total amount of pixels that are removed or added in an object from the segmented lung image depends on the shape and also the size of the element used to process the lung image efficiently. This dilation process is followed by a filling technique to be prepared for feature extraction.

After segmentation, the obtained segmented lung nodule is further processed for feature extraction to understand the various features of the lung image[5]. Characterizing the visual perception of the lung image, multiple features like intensity oriented statistical feature types and geometric oriented feature types can be measured by extracting those features the segmented lung image. The features considered to be extracted from the segmented object of interest are entropy, contrast and energy. The texture of the segmented image is defined by representing the extracted feature[6-7].

The final step is the application of a neural network to identify the accurate result. Neural networks are a collection of interconnected nodes called neurons or perceptron[8-9]. Immediately after required features are extracted from the segmented lung image, the remaining work to diagnose the lung nodules makes use of a well-trained neural network which gives the proficient and consistent result. The neural network-based lung cancer identification module is trained using the various features obtained from the feature extraction process[10-11]. So, the exact computation of cancerous and non-cancerous lung image is done with this approach.

3. Results and Discussion

The computation of lung cancer detection system was implemented using MATLAB a high-performance language used for methodological calculation. MATLAB incorporates programming, conception and computation in a user-friendly background where solution and problems are stated in a simple mathematical expression. For analyzing the proposed system, a total number of 200 images were used. Figure 2 and figure 3 show the lung cancer affected the image and normal image, respectively. The first step in automated lung cancer detection process is to record the CT image. Once the lung image is received, it is fed into the preprocessing block to satisfy the basic requirement of quality improvement of the input lung image. The noise content is filtered with the help of the median filter for better visualization. This steps in image enhancement process, yields contrast-enhanced lung image. After the image is enhanced, image segmentation was carried out to capture the object of interest of enhanced lung image to make it more suitable for upcoming processing approaches. In this proposed model, segmentation is performed based on the thresholding method, which produces the essential output to feature extraction block. The feature extraction process extracts various features such as entropy, Contrast and energy. These features are fed into the neural network unit which utilizes the neuro-fuzzy logic algorithm to generate the result to the user to conclude the status of given input lung image. From figure 2, the computed entropy value is 0.76678. Also, contrast and energy values are 2.931 and 0.59228, respectively. Hence the given input image is a lung cancer affected image. From figure 3, the computed entropy value is 0.67532. Also, contrast and energy values are 2.0248 and 0.66031, respectively. Hence the neuro-fuzzy classifier gives the output as a normal image.
4. Conclusion

The digital image processing system with neuro-fuzzy logic is developed to detect the lung nodules at the earliest stage of lung cancer to reduce the death rate due to the dangerous killing decease of lung cancer. The proposed model functions effectively in preprocessing of input lung images followed by image enhancement, image segmentation to partition the affected area, extracting the needed features such as entropy which can also define the texture of the image. The neuro-fuzzy classifier performs the final process of classifying and detecting the cancerous and non-cancerous cells based on the extracted features. Hence the proposed automated cancer cell detection system with neuro-fuzzy technique provides the accurate result with better performance by avoiding manual errors in identifying the lung cancer from CT images.
5. References

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