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A Novel Approach for Lung Cancer Detection Using Morphological Operations

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ABSTRACT: Lung cancer is a disease of abnormal cells multiplying and growing into a tumour. Early detection of lung cancer can increase the chance of survival among people although the computed Tomography (CT) can be more efficient than X-ray. However, the problem seemed to merge due to time constraint in detecting the present of lung cancer. In this paper, a novel method is introduced based on adaptive k-means clustering and fuzzy c-means threshold. Here the segmentation is done based on the threshold. Then it differentiates between a normal tumour and a cancer tumour. The technique has been used to achieve an impressive speedup of a search process when other efficient search techniques may not be available. The experiments on the ct lung images by the proposed method shows better results compare to the state-of-art of criteria.

KEYWORDS: Computed Tomography (CT), Adaptive k-means, Fuzzy c-means

I. Introduction

Lung cancer is a disease of multiplied abnormal cells and growing into a tumor Cancer cells can be carried away from the lungs in blood, or lymph fluid that surrounds lung tissue. Lymph flows through lymphatic vessels [2], which drain into lymph nodes located in the lungs and in the centre of the chest. Lung cancer often spreads toward the centre of the chest because the natural flow of lymph out of the lungs is toward the centre of the chest. The occurance of metasis when a cancer cell leaves the site where it began and moves into a lymph node or to another part of the body through the blood stream [1]. The lung cancer can be divided into two main group among the different types. These are gives as: Small cell lung cancer and non-small cell lung cancer which has three subtypes: Carcinoma, Adencarcinoma and Squamous cell carcinomas.

According to stage of discovery of the cancer cells in the lungs, the most dangerous and wide spread in the world is lung cancer, so the process early detection of the disease plays a very important and required role to avoid serious advanced stages to reduce its percentage of distribution. The lung CT images [12] having low noise when compared to scan image and MRI image. So we can take the CT images for detecting cancer tumor in the lungs. The main advantage of the computer tomography image [12] is better clarity, low noise and distortion. The mean and Variance can be easily calculated. The calculated value is closer when compared to the original value.

The objective of the proposed method is to detect lung cancer using image processing techniques. CT scanned lung images of cancer patients are acquired from various hospitals. Using image processing techniques [10] like adaptive k-means clustering and by using the FCM threshold for segmentation, feature extraction, area of interest is separated. Developing the algorithm, features like area, eccentricity and perimeter are extracted from all the images.

The parameter values obtained from these features are compared with the normal values suggested by a physician [14]. From the comparison result, cancer stage is detected. This system can help in early detection of lung cancer more accurately. Here it defines the tumor is a normal or cancerous.

The paper is organized as follows. Section II first reviews existing method. Our proposed method is described in Section III. Then experimental results are reported to demonstrate the superior performance of our framework. Finally, conclusions are presented.

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II. Existing Method

In the existing method [14] the Marker Controlled Watershed Transform is used for lung cancer detection. The existing method includes the following steps:

1. Pre-processing
2. Segmentation
3. Feature extraction
4. Classification

The Gaussian filter is used to smooth the input image in preprocessing stage. In the pre-processing stage, Gabor filter [8] is used for enhancement, thresholding and Marker-Controlled watershed transform is used for the segmentation purposes. After image segmentation, the features such as average intensity, area, perimeter and eccentricity are extracted from the detected tumor. Binarzation process is done to decide whether it is cancerous tumor or not. Also, if there is cancerous tumor, the cancer stage is identified.

A. MARKER-CONTROLLED WATERSHED SEGMENTATION

Separation of touching objects in any image is one of the most difficult image processing operation. The watershed transform is often applied to solve this problem.

The watershed transform [6] finds “catchments basins” and “watershed ridge lines” in an image by treating it as a surface where light pixels are high and dark pixels are low. One of the most important drawbacks that are associated to the watershed transform is the oversegmentation [5] that commonly results.

The usual way of predetermining the number and approximate location of the regions provided by the watersheds technique consisted in the modification of the homotopy of the function to which the algorithm is applied. This modification is carried out via a mathematical morphology operation, geodesic reconstruction [13], by which the function is modified so that the minima can be imposed by an external function (the marker function). The catchment basins that haven’t been marked are filled by the morphological reconstruction [7] and so transformed into non-minima plateaus, which will not produce distinct regions when the final watersheds are calculated.

Segmentation using the watershed transform works well if we can mark, or identify, foreground objects and background locations. Marker-controlled watershed segmentation [11] follows this basic procedure:

1. Compute a segmentation function, which is an image whose dark regions are the objects trying to segment.
2. Compute foreground markers. These are connected blobs of pixels with in each of the objects.
3. Compute background markers. These are the pixels that are not part of any object.
4. Modify the segmentation function so that it only has minima at the foreground and background marker location.
5. Compute the watershed transform of the modified segmentation function.

Morphological operations are performed on the watershed segmented image [8] to get final segmented image. Here the method to use is morphological operations called opening by reconstruction and closing by reconstruction to clean up the image. These operations will generate flat maxima inside each object which is located using image regionalmax. In this approach, the total number of black pixels & white pixels are counted. If the total number of black pixels of input image is more than threshold [5], then the tumor is normal tumor. Otherwise, if the total number of the black pixels is less than the threshold then the tumor is cancerous tumor.

B. DRAWBACKS

1. over segmentation
2. under segmentation
3. Accuracy is low
4. Time of execution is more.

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III. PROPOSED METHOD

In the proposed method first the input image is acquired and then the pre-processing is done. Clustering is done by the adaptive k-means and for the segmentation fuzzy c-means threshold [4] is applied. The morphological operations are applied to get the features. At last the classification is applied.

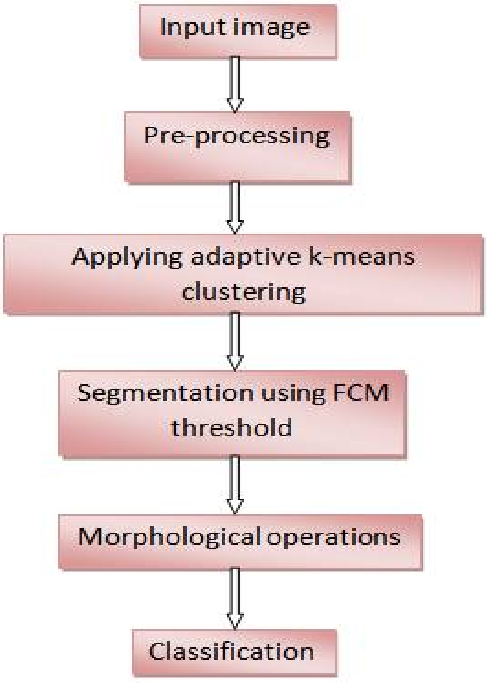

Fig1: The proposed block diagram

In this research, to obtain more accurate results we divided our work into the following three stages:

1. Image pre-processing stage:

To make the image better and enhance it from noise, corruption or interference, the following three methods are used for this purpose: median filter is applied for getting the noise-free image [7]. The median member a_m, according to the minimum-distance definition, is the member whose distance to all other members in the set is smallest. This definition can be expressed as

$$a_m = argmin \sum_{i=1}^{N} \|a_m - a_i\|_L \qquad (1)$$

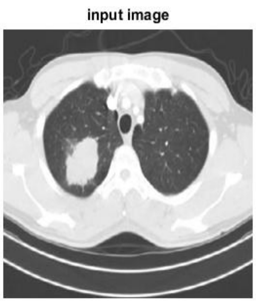

Fig.2: Input image

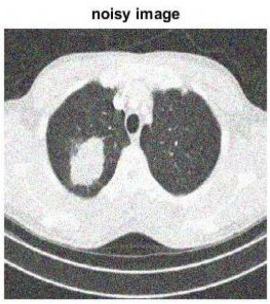

Fig.3: Noisy Image

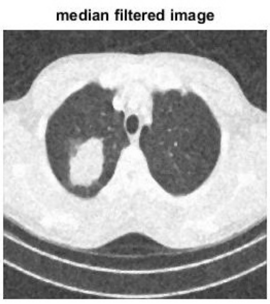

Fig.4: Median Filtered Image

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2. Clustering stage:

The adaptive K means clustering [3] algorithm starts with selection of K elements from the input dataset. These K elements form the seeds of clusters and are randomly selected. The properties of each elements also forms the properties of cluster that is constituted by the element. The algorithm [4] is based on the ability to compute distance between a given elements and cluster. In most cases, the Euclidean distance may be sufficient. For example, in the case of spectral data given by the n-dimensions, distance between two data elements.

$$E_1 = \{E_{11,}E_{12,} \dots ..E_{1n}\} \tag{2}$$

$$E_2 = \{E_{21,}E_{22,} \dots ..E_{2n}\} \tag{3}$$

Then $\sqrt{(E_{11} - E_{12})^2 + (E_{12} - E_{22})^2 + \cdots + (E_{1n} - E_{2n})^2}$ (4)

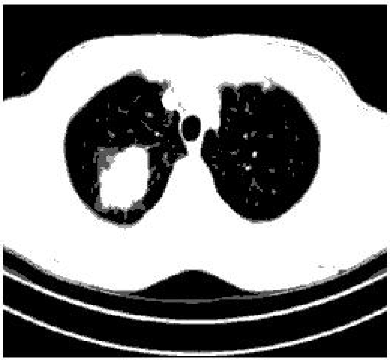

Fig.5: Adaptive K-Means Clustered Image

Compute the distance of each cluster from every other cluster and stored as a triangular matrix in a 2D array. Minimum distance D_{min} between any two clusters Cm1 and Cm2 and also identification of these two closest clusters is noted down[4] . For each non clustered element E_i, distance of E_i from every cluster is to be computed. For assignment of this element to a cluster, there may be following three cases:

a. If the distance element and the cluster is 0, assign the element to that cluster, and begin working with the next element.

   If the distance between the element and cluster is less than the distance D_{min}, assign this element to its nearest cluster. As a result of this assignment, the representation of cluster or centroid[4] , may change. The Centroid is recomputed as an average of properties of all elements in the cluster. In addition to the distance of the affected cluster from all other cluster, as well as, the minimum distance between any two clusters and the two clusters that are closest to each other is recomputed [5] .

b. When the distance D_{min} is less than the distance of the element from the closest cluster, select the two closest clusters Cm1 and Cm2, and merge Cm2 into Cm1. Demolish the cluster Cm2 by removing all the elements from the cluster and by deleting its representation and add the new element into this empty cluster, successfully creating a new cluster. The distances between all clusters are recomputed and the two closest clusters identified over again.

3. Image segmentation stage:

The observations showed that FCM [4] works well for making rough clustering of pixels which can further be used to get better threshold values for image segmentation.

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$$Q = \sum_{i=1}^{c} \sum_{j=1}^{N} (u_{ij})^m \|z_j - v_i\|^2 \quad (5)$$

In addition to this, if the threshold image is used as initial estimate for segmentation [9], it can result in more accurate segmentation as compared to existing methods and region based active contours. We, hereby presented a technique, based on combining these methods to achieve higher accuracy in segmentation of CT lung images.

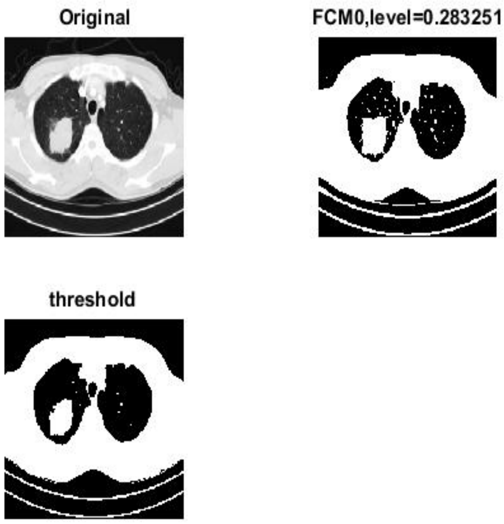

Fig.6: original, FCM, Thresholding Images

4. Morphological operations:

Two basic morphological operators are: erosion and dilation. Directional versions of them have structuring element consisting of only one neighbor of each pixel in given grid. Dilation (erosion) is described as a non-linear supremum[7] (infinimum) filter. Same duality for the dilation:

Fig.7: Dilated Image

We consider supremum (infinimum) [7] of only two points: center point and one of its neighbors, so that the image properties from one direction are considered. All possible locations of the neighbor are strictly depending on the grid type. As a consequence of that not all directions can be taking under consideration - only these which describe location of neighbors in given grid.

$$I \oplus H = (\bar{I} \Theta H^{*})^{1} \quad (6)$$

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Because of number of directions is equal to the connectivity of the grid [7] e.g. for grid with 6-connectivity (hexagonal grid) only 6 directions are available for use. Erosion can be computed as a dilation of the background:

$$I \Theta H = (\overline{I} \oplus H^{*})^{1} \quad (7)$$

Fig.8: Eroded Image

5. Classification:

After the feature classification is done. The classification reveals that the tumor is a normal tumor or it is a cancerous tumor. This can be done by classifying cells using binarization [5] method. Counting of total number of black pixels and white pixels are done.

If the total number of black pixels of input image is more than threshold, then the tumor is normal tumor. Otherwise, if the total number of the black pixels is less than the threshold then the tumor is cancerous tumor.

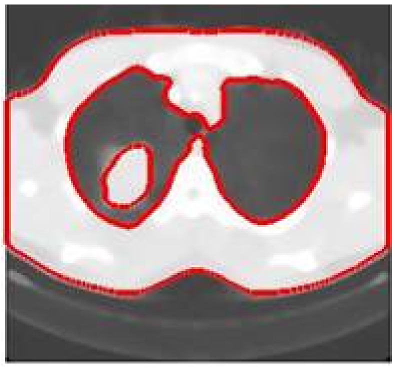

Fig. 9: Segmented Image

Fig. 10: Dialog Box

By using this result, sensitivity and accuracy are calculated [14]. To find these parameters, first calculate some of the conditions like true positive, true negative, false negative and false positive.

$$Sensitivity = \frac{TP}{(TP + FN)} \quad (8)$$

$$Accuracy = \frac{(TN + TP)}{(TN + TP + FN + FP)} \quad (9)$$

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Here, TP is True Positive, TN is True Negative, FN is False Negative and FP is False Positive [14]. Sensitivity is defined as amount of true positives that are correctly recognized by a diagnostic test. Accuracy is defined as amount of true results, which is either true negative or true positive. It measures the degree of reliability of a diagnostic test on a condition.

	Image from medscape.com		Image from medicalxpress.com	
Parameters	**Existing method**	**Proposed method**	**Existing method**	**Proposed method**
Accuracy	**90.52**	**98.02**	**91.3188**	**98.89**
Elapsed time	**4.211 (sec)**	**1.458 (sec)**	**3.917 (sec)**	**0.366 (sec)**
TP	**0.8297**	**0.9609**	**0.8468**	**0.9780**
FN	**0.8855**	**1**	**0.8855**	**1**
TN	**1.0520**	**1.9520**	**0.2641**	**1.1641**
FP	**0.0072**	**0.0195**	**0**	**0.0116**

Table I: Comparison Table of Accuracy for Different Images

IV. CONCLUSIONS

In this paper we used an adaptive k-means clustering which clusters the pixels very accurately. Then we used the fuzzy c-means [4] algorithm for the segmentation [9] process based on the threshold. Then we applied morphological operations using a mask and we calculated the regional properties like area. At finally, we obtained the accurate segmentation along with which type of tumor whether it is a normal or cancerous. By the observation of the experimental results the proposed method is better compared to the existing algorithms.

REFERENCES

[1]W. Wang , S. Wu, " A Study on Lung Cancer Detection by Image Processing", proceeding of the IEEE Conference on Communications Circuits and Systems, pp. 371-374, June 2006.
[2]A. Sheila and T. Ried, "Interphase Cytogenetics of Sputum Cells for the Early Detection of Lung Carcinogenesis‖", Journal of Cancer Prevention Research, vol. 3, no. 4, pp. 416-419, March, 2010.
[3]D. Kim, C. Chung and K. Barnard, "Relevance Feedback using Adaptive Clustering for Image Similarity Retrieval", Journal of Systems and Software, vol. 78, pp. 9-23, Oct. 2005.
[4]Ajala Funmilola A, Oke O.A, Adedeji T.O, Alade O.M, Oyo Adewusi E.A, "Fuzzy k-c-means Clustering Algorithm for Medical Image Segmentation‖", Journal of Information Engineering and Applications, ISSN 2224-5782 (print) , ISSN 2225-0506 (online), Vol 2, No.6, 2012 .
[5]Fatm Taher, Naoufel Werghi and Hussain Al-Ahmad, "Extraction of Sputum Cells using Thresholding Techniques for Lung Cancer Detection", International Conference on Innovations in Information Technology , pp.31-41, March 2012.
[6]QinghuaJi ,Ronggang Shi, "A Noval Method of Image Segmentation Using Watershed Transformation", International Conference on Computer Science and Network Technology , DOI: 10.1109/ICCSNT.2011.6182269, ISSN 12688993 , December 2011.
[7]Pinaki Pratim Acharjya, Santanu Santra, Dibyendu Ghoshal , "An Improved Scheme on Morphological Image Segmentation using the Gradients" , (IJACSA) International Journalof Advanced Computer Science and Applications , Vol.4, No.2 , 2013.
[8]FAN Li-nan , LI Dao-jing , SUN Shen-shen, CHANG Chao-hai, "Applied Research on the Automatic Detection of Lung Nodules ROI based on Top-hat and Gabor Filter", Third International Symposium on Information Processing, IEEE, ISSN 11698998 , October 2010.
[9] Rahil Garnavi, Ahmad Baraani-Dastjerdi, Hamid Abrishami Moghaddam2 , MasoomehGiti, Ali Adjdari Rad,"A New Segmentation Method for Lung HRCT Images", Proceedings of the Digital Imaging Computing Techniques and Applications (DICTA 2005), IEEE, 2005.
[10]Disha Sharma, Gagandeep Jindal , "Identifying Lung Cancer using Image Processing Techniques", International Conference on Computational Techniques and Artificial Intelligence (ICCTAI') , 2011.
[11] K. Parvati, B. S. Prakasa Rao, and M. Mariya Das, " Image Segmentation using Gray-Scale Morphology and Marker Controlled Watershed Transformation", Hindawi Publishing Corporation Discrete Dynamics in Nature and Society , Volume 3, 2008.
[12] Anita chaudhary , SonitSukhraj Singh , "Lung Cancer Detection on CT Images by using Image Processing", 2012 International Conference on Computing Sciences Final Watershed Segmentation.
[13]Sayani Nandy, Nikita Pandey , " A Novel Approach of Cancerous Cells Detection from Lungs CT Scan Images'', International Journal of Advanced Research in Computer Science and Software Engineering , Volume 2, Issue 8, August 2012.
[14]Sayali Satish Kanitkar, N.D. Thombare and S.S.Lohande , "Detection of Lung Cancer Using Marker-Controlled Watershed Transform", International Conference on Pervasive Computing, 976-4799-6277-3/15, 2015 IEEE.