SEGMENTATION OF LUNG CANCER PET SCAN IMAGES USING FUZZY C-MEANS

Santhosh T[1]
1M.Tech student,Department of Computer Science & Engineering
Vardhaman college of Engineering,
Kacharam, Andhra Pradesh,India
thonupunurisanthosh@gmail.com

Narasimha Prasad L V [2]
2Professor, Department of Computer Science & Engineering
Vardhaman college of Engineering,
Kacharam, Andhra Pradesh,India
lvnprasad@yahoo.com

***Abstract*—Image segmentation plays a vital role in medical image processing. Eventually, the proposed work is subjected to classify the tumour and non-tumour parts, followed by the segmentation of tumour region in PET scan images. Lung cancer has been the largest cause of cancer deaths. This paper focuses on Fuzzy C means algorithm for Lung tumour part segmentation of PET scan images to diagnose accurately the region of cancer. A PET scan can often detect cellular level metabolic changes at the earliest, whereas a CT or MRI detect changes a little later as the disease begins to cause changes in the structure of organs or tissues. Cancerous tumours are usually more active, have a higher metabolic rate than normal tissue, and appear differently on a PET scan. It has been shown that effective and automatic segmentation can be achieved with this method for lung and area for segmented tumour part is calculated.**

Keywords-Lung Cancer;Fuzzy C Means; PET scan;Segmentation

I. INTRODUCTION

Inorder to reduce diseased rate and number of deaths, early detection of lung cancer is essential. The previous study shows that early detection can effectively reduce the diseased rate caused by lung cancer, and medical image processing is currently the best approach for reliable detection of early no palpable curable lung cancer. However, the appearances of lung cancers are very subtle and unstable in their early stages. Image processing can help doctors and radiologists in getting a more reliable and effective diagnosis. Lung Cancer is a malignant lung tumour characterized by uncontrolled or abnormal growth of cells in tissues of the lung. These cells do not carry out the functions of normal lung cells. These cells will form tumour as they grow up and will be disrupt functions of the lung. At later stage of cancer these cells can traverse to other parts of the body, this process is called metastasis.

Primary lung cancer originates in the lungs and cells are abnormal lung cells. Sometimes cancer cells will traverse to lung from the other parts of body. This is called Secondary lung cancer. Cancer represents 13% of the global deaths and among them lung cancer is number one cancer killer. There are 2 major types of lung cancer exist.

- Non-small cell lung cancer (NSCLC)
- Small cell lung cancer (SCLC)

Medical Image Segmentation is a process of automatic detection of boundaries within a medical image. These images can be obtained from any of these modalities (X-ray, CT, MRI, microscopy, PET, SPECT, Endoscopy, OCT, and many more). Segmentation results can then be used to obtain further diagnostic insights. The main goal is to extract relevant knowledge or information from medical images.Image segmentation is actually the process of dividing image in to multiple parts. Traditionally it can be classified to three categories.

- Threshold Technique
- Region-Based Image Segmentation
- Edge-Based Image Segmentation

Threshold based segmentation is the simplest and easiest method. Pixels are partitioned depending on their intensity values, Say by an appropriate threshold T. Threshold value can be fixed or variable over time. Segmentation is merely depends on the given value.

Region is a group of connected pixels with similar properties. Grouping can be done by principles like similarity and spatial proximity. Completeness, connectedness, disjointness, satisfiability and segmentability are the properties to be met for pixels of each region. Pixel aggregation in region growing starts with seed point and grows with respect to the similar properties of the neighbour pixels. Region splitting starts with the whole image as a region and split it in to regions based on the condition homogeneity. Region merging is the opposite of region splitting. Clustering is also one of the region based technique. Clustering is the process of organizing objects into groups whose members are similar in some way. However in general it can be classified to 2 types. They are Hierarchical clustering and Partition clustering.

In hierarchical clustering number of clusters can be changes during the process. Where as in partitional, Number of pixels need to be fixed before process starts. The proposed algorithm fuzzy c means will come under partitional algorithm. Edge detection uses derivative method to detect edges. It is very sensitive to noise. Derivative method is implemented through first order and second order derivatives. First order and second order derivatives will compute gradient and Laplacian respectively.

II. PROPOSED METHOD

Clustering is the process of organizing objects into clusters whose members are similar in some way and items in different clusters are as dissimilar as possible. Different types of similarity measures are used to place each point to a cluster. Fuzzy C means clustering allows one piece of data to two or more clusters. Membership level is associated with each data point. It indicates the strength of the association between data element and particular cluster. Each iteration updates membership level and cluster centres.

$$\mu_{ij} = 1/\sum_{k=1}^{c}(d_{ij}/d_{ik})^{(2/m-1)} \quad (1)$$

$$v_j = \frac{\sum_{i=1}^{n}(\mu_{ij})^m x_i}{\sum_{i=1}^{n}(\mu_{ij})^m}, \forall_j = 1,2,\ldots c \quad (2)$$

n = number of data points

v_j= jth cluster centre

m= fuzziness index

c = number of cluster centres

μ_{ij} = membership of ith data to jth cluster centre

d_{ij} = Euclidean distance between ith and jth cluster centre

Fuzzy c means algorithm main objective is to minimize

$$J(U,V) = \sum \sum (\mu_{ij})^m ||x_i - v_j||^2 \quad (3)$$

$||x_i - v_j||$ = Euclidean distance between i^{th} data and j^{th} cluster centre.

Algorithmic steps

Let X as set of data points such that X= {x_1, x_2, x_3 ..., x_n} and V as set of data centres such that V = {v_1, v_2, v_3 ..., v_c}.

- Select 'c' cluster centres randomly.
- Calculate the value of Fuzzy membership μ_{ij}.
- Compute fuzzy centres v_j.
- Repeat step 2) and 3) until minimum *'J'* value is achieved or $||U^{(k+1)} U^{(k)}|| < \beta$.
  where,

K = iteration step

B = termination criteria

U = fuzzy member ship matrix

J= Objective function

III. RESULTS AND DISCUSSION

The proposed method has been implemented in MATLAB 7.2.0. The experiment is conducted over several PET scan images to extract the tumor part. Statistical parameters such as iteration count, objective function value and execution time are calculated. Extracted tumor part is further evaluated to find number of pixels to define the area. The tumor part which traversed to other parts of the body can also be segmented using the proposed method.

PET scan images and the number of clusters are given as input to the algorithm. Initially cluster centres are selected based on proximity and these will change over the iterations. This process will be continued until changes between 2 successive iterations is minimal. Extracted tumor image is saved and the dimensions are noted. Image and dimensions can be given to the area code to calculate number of pixels. Results of the sample images are depicted below and statistical data is tabulated to represent the processing time and knowledge extracted using algorithm. PET scan images and segmentedtumor partswhich are generated through proposed method are shown below.

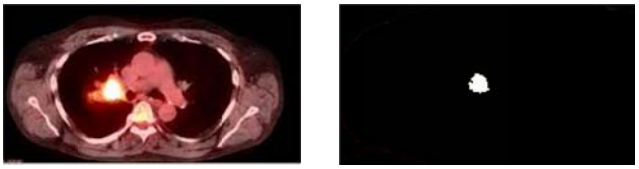

Figure 1. PET scan image1 and its tumor part after extraction

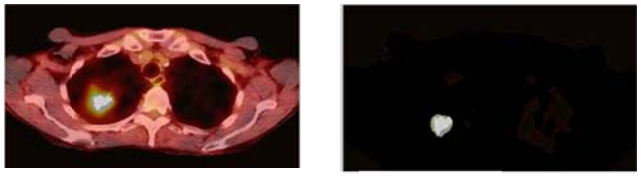

Figure 2. PET scan image 2 and its tumor part after extraction

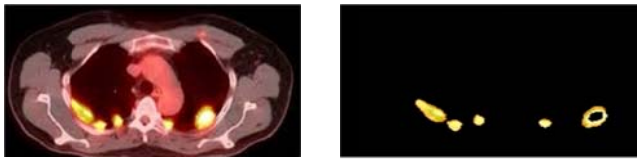

Figure 3. PET scan image 3 and its tumor part after extraction

Table 1 describes statistical measures calculated at iteration count 100. The proposed method execution time will vary according to the number of iterations. If we reduce the number of iterations to 50 execution time approximately will drop to half of its previous value. The objective function value is also varies according to the number of iterations. It will decrease as the number of iterations increase.

Table 1. Statistical measures

Image s.no	iteration count	obj function value	Execution time in seconds	area
1	100	352206.67	3.304	697
2	100	342153.37	7.202	284
3	100	217942.39	6.435	546

IV. RELATED WORK

R. Harrabi and E. Ben Braiek [1], they worked on color image segmentation using fuzzy c means algorithm. They proved colour feature hue is more efficient than RGB color feature. The proposed method calculated feature vector and fuzzy c means is used to cluster the feature vectors in to several regions. Xiao Ying Wang, Jon Garibaldi, TurhanOzen [2], their research demonstrated fuzzy c means will give significantly better performance over Hierarchical Cluster Analysis (HCA). HCA and FCM methods are used on cancer cell data instead of pre-processing.

Juliet R Rajan, Jefrin J Prakash [3], they worked on attributes of lung cancer to identify cancer at an early stage. Training datasets are normalized to generate learning data sets.Suchita Yadav, Sachin Meshram [4], they worked on tumor segmentation from MRI data. K means algorithm is used and several statistical measures like global consistency error, area, elapsed time and rand index have been measured.

Pereyra, M. ; Dobigeon, N. ; Batatia, H. [5], they discussed regarding PET scan image segmentation using Bayesian algorithm. The method correctly segmented the small and large tumor parts. HuitingQiao, Mengqi Mei, Qi Zhang, Nian Liu, Xin Li,Qiaoyang Huang, Deyu Li [6] ,Here PET scan images are segmented for

clinical diagnosis. K means and improved method which is based on ISODATA are compared. Mahesh Yambal, Hitesh Gupta [7] , they presented a survey on medical image segmentation using fuzzy c means algorithm. FCM yielded successful results for noisy images also.

V. CONCLUSION

The proposed method segmented the tumour part of lung cancer images effectively. Soft segmentation done using fuzzy c means algorithm and area of the tumour part is calculated in terms of number of pixels. The experiment is conducted on Lung cancer metastasis images also and multi tumour parts are extracted. Noise is having less impact on the proposed method. In future stage of the cancer can also predicted using the calculated area of tumour. The area can be compared with research data to predict the stage of the cancer. PET scan is used to diagnose the cancer effectively. The growth or decrease of the tumor part can be monitored effectively with the proposed method.

VI. REFERENCES

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