

SEGMENTATION STRATEGY OF PET BRAIN TUMOR IMAGE

Dipanjan Moitra

Department of Computer Science & Applications, University of North Bengal, Raja Rammohunpur,
Siliguri, West Bengal 734013, India
tataijal@gmail.com
http://www.nbu.ac.in

Dr. Rakesh Kumar Mandal

Department of Computer Science & Applications, University of North Bengal, Raja Rammohunpur,
Siliguri, West Bengal 734013, India
rakesh_it2002@yahoo.com
http://www.nbu.ac.in

Abstract Positron Emission Tomography (PET) is one of the leading medical imaging techniques. It is often used to detect brain tumors. In order to identify proper location and size of a brain tumor, it is highly necessary to correctly identify the Region of Interest (ROI).

Keywords: Positron Emission Tomography (PET), Brain Tumor, Image Segmentation, Region of Interest (ROI).

1. Introduction

Positron Emission Tomography (PET) is a widely used medical imaging technique. It mainly helps radiologists to identify abnormalities in tissues. Unlike other contemporary structural medical imaging techniques like MRI or CT scan, PET works around functional changes in cells [4]. One of the popular variations of PET is ^{18}F -FDG where radioactive glucose is injected in patient's body and uptake values are measured through PET scanner [8]. If there is any abnormality in cells, there will be variations in uptake values. In case of a malignant brain tumor, as the rate of cell division will be too high, the uptake values will also be on the higher side, no matter how small the tumor size is [3]. Thus, both the early stage tumors and post-treatment recurring tumors may be easily identified using PET [7]. Structural medical imaging techniques may not be found very useful in these cases.

2. Image Segmentation

Image segmentation is the process of separating and grouping similar regions of an image [1]. This is very useful to figure out the accurate Region of Interest (ROI) [6]. A correct segmentation not only helps radiologists to identify size and location of the tumor but, in turn, it also helps oncologists to pave the way of effective treatment. Proper segmentation decreases the chance of damaging the tumor adjacent non-cancerous cells which is very common in chemotherapy or radiation treatment.

3. Objective of the Study

Many research works have so far been conducted to formulate algorithms for PET image segmentation. The segmentation algorithms include thresholding (fixed, adaptive, iterative), active contour, region growing, random walk, graph cut, affinity propagation, K-NN, FCM, etc. [2], [5], [9]. These studies have not portrayed the overall strategy to segment PET brain tumor image. PET images have poor resolution than other structural imaging techniques. So, there is a need to properly reconstruct PET images and extract features which will be valuable to carry out further research work. The present study demonstrates the steps to segment PET brain tumor image: image acquisition, image standardization, image enhancement, removal of noise and segmentation & feature extraction.

4. Proposed Segmentation Strategy

4.1. Grayscale Image Thresholding

After reading the concerned image, it is converted to a grayscale image of a standard size, i.e., [256 X 256]. If any algorithm is proved for an $[n \times n]$ matrix, then it is also proved for an $[n \times n \times k]$ matrix. The proposition establishes the need for the grayscale conversion of the concerned image. The image is then enhanced by equalizing the histogram and the Gaussian filter is used to blur the image in order to remove the noise present. The next two steps are edge detection and flood-filling the holes present in the image respectively. The last step is the vectorized approach of thresholding. The threshold value may be determined by using the Otsu's method [10] or its improved version. The proposed equation for thresholding is as follows:

$$O = \text{double}(I > t) - \text{double}(G) \quad (1)$$

Where, O is the output image, I is the original image, t is the desired threshold value and G is the grayscale equivalent of I.

4.2. RGB Image Thresholding

The difference between a grayscale and a RGB image lies in the number of channels present. A binary or a grayscale image is typically a single channel image, whereas, a RGB image is a three channel image. By setting the second and third channel values to zero, the red channel image is obtained. Subsequently, we may also obtain grayscale image by using red channel. Such variations to the original RGB image are found quite useful in image segmentation. The proposed algorithm for RGB thresholding is as follows:

- Step 1: Loop through each channel of the concerned image;
- Step 2: Swap in the channel to a temporary variable;
- Step 3: Search for all the pixel values less than the desired threshold value and set them to zero;
- Step 4: Replace the original channel with the value of the temporary variable;

5. Result

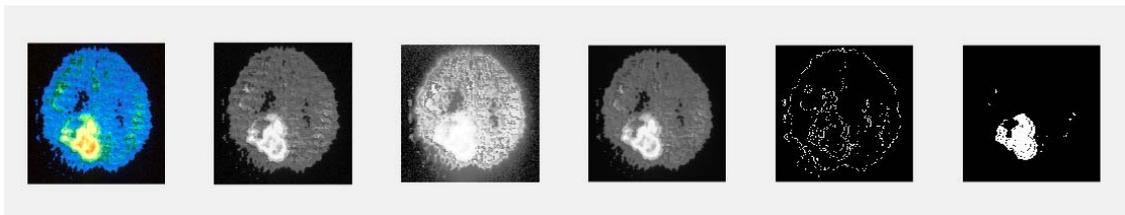


Fig.1.PET Image Grayscale Segmentation (Original Image, Grayscale Image, Enhanced Image, Filtered Image, Edge Detection and Thresholded Image)

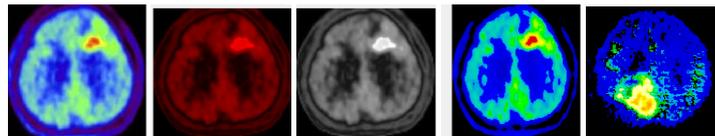


Fig.2.PET Image True Color Segmentation and Reconstruction (Original Image, Red Channel Image, Red Channel Grayscale Image, RGB Thresholded Image of the original images in Fig.2. and in Fig.1. respectively)

6. Conclusion

Fields	Area	MajorAxisLength	MinorAxisLength	Perimeter
17	71	19.4808	12.7999	90.8640
18	2	2.3094	1.1547	1.9600
19	8	3.6515	3.0551	7.2200
20	8	3.6515	3.0551	7.2200
21	3999	87.1589	74.9276	535.6300
22	2	2.3094	1.1547	1.9600
23	5	4.7441	2.6533	9.3620

Fig.3. Extracted Features from Segmented PET Image in Fig. 1.

The features extracted are quite useful for future research work. The results may further assist radiologists to overcome problems of manual segmentation. After successful segmentation only the data regarding the Region of Interest will appear as the most significant entry. The extracted features may help in the determination of exact tumor size and location and in turn it will also help to detect the stage and the growth rate of the tumor. Thus, the PET image segmentation or reconstruction process may give valuable information regarding brain tumor even if there is no prior data available.

7. Running Heads

PET Brain Tumor Segmentation Strategy

References

- [1] Qiao, H. et. al, The study of PET image segmentation using clustering algorithm, World Congress on Medical Physics and Biomedical Engineering, IFMBE Proceedings 39, pp. 1836–1839(2013)
- [2] Meena, A. et.al, Spatial Fuzzy C-Means PET Image Segmentation of Neurodegenerative Disorder, Indian Journal of Computer Science and Engineering (IJCSE), ISSN : 0976-5166, Vol. 4, No.1, pp. 50-55(2013)
- [3] Foster B, Bagci U, Mansoor A, Xu Z, Mollura DJ. A review on segmentation of positron emission tomography images. *Comput Biol Med.*;50:76–96(2014)
- [4] Zaidi H, Abdoli M, Fuentes C, El Naqa I. Comparative methods for PET image segmentation in pharyngolaryngeal squamous cell carcinoma. *Eur J Nucl Med Mol Imaging* 39:881–91.10.1007/s00259-011-2053-0(2012)
- [5] Baâzaoui, A. et. al, A Survey of PET Image Segmentation: Applications in Oncology, Cardiology and Neurology, *Current Medical Imaging Reviews*, Vol. 12, No. 1(2016)
- [6] Elo se Grossiord, Hugues Talbot, Nicolas Passat, Michel Meignan, Pierre Terve, et al.. Hierarchies and shape-space for PET image segmentation. *International Symposium on Biomedical Imaging: From Nano to Macro (ISBI 2015)*, Apr 2015, New York, United States. IEEE, pp.1118-1121(2015)
- [7] Chen, W., Clinical Applications of PET in Brain Tumors*, *J Nucl Med*; 48:1468–1481(2007)
- [8] Mizuho Nishio, M. et. al, Tumor Segmentation on 18F FDG-PET Images Using Graph Cut and Local Spatial Information, *Open Journal of Medical Imaging*, 5, 174-181(2015)
- [9] Layer, T. et. al, PET image segmentation using a Gaussian mixture model and Markov random fields, *EJNMMI Phys.*; 2: 9(2015)
- [10] Otsu, N., "A Threshold Selection Method from Gray-Level Histograms," *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. 9, No. 1, 1979, pp. 62-66