SIMULATION OF POSITRON EMISSION TOMOGRAPHY FOR LUNG CANCER ANALYSIS

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Abstract

Geometric models of human body organs are obtained from imaging techniques like computed tomography (CT) and magnetic resonance image (MRI) A new technique is introduced is Positron Emission Tomography (PET) image analysis which useful and versatile to obtain accurate geometric models that can be used in several clinical cases to obtain relevant quantitative and qualitative information. one of the major use PET image is in the diagnoses of tumors. Presently simulation programs such as GATE (Geant4 Application for Tomographic Emission) exist, but they are complicated and more time consuming. This work proposes a new method to simulate the PET image of the Lungs with Monte Carlo simulation in Matlab. For the simulation, a high resolution, MRI and CT based, segmented image, is used as the original image. In MRI segmentation intensity non - uniformity (INU) artefact present. Hence, Adaptive Spatial Fuzzy Center means segmentation is used. It is based on fuzzy C - means that address both INU artifact and local spatial continuity.

***Keywords:**-Lung Cancer, CT, MRI, membership values, clusters, fuzziness factor*

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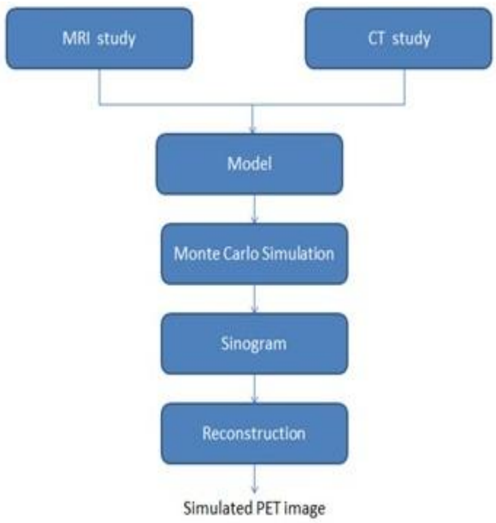
1. INTRODUCTION

Lung tumor is characterized by uncontrolled growth of tissues of lung. Worldwide in 2012, lung cancer occurred in 1.8 million people and resulted in 1.6 million deaths. This makes it the most common cause of cancer-related death in men and second most common in women after breast cancer. The death rate can be reduced if people go for early diagnosis so that suitable treatment can be Advised. A wide range of different image modalities for medical imaging are available at present, which provide view of internal organs of the human body such as brain, kidney, liver etc. Among these medical image modalities, Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) imaging are commonly used for Disease diagnosis. Another technique used in this area is Positron Emission Tomography (PET). Unlike earlier radiotracer techniques PET can quantitatively measure biochemical and physiological processes. PET scans are more accurate in detecting tumors that are smaller or less aggressive than other imaging techniques.

For clinical PET scanning, positron emission radioactive isotopes are injected into the human body. The following are the major drawbacks of this type of scanning: (1) radioactive isotopes have side effects on patients and (2) PET scan is expensive. For these two reasons, PET simulators are needed for physical and clinical research. Here a new method is proposed to simulate the PET tumor image of the Lungs using analytical information from CT and MRI images with Monte Carlo Simulation in Matlab. For the simulation, MRI and CT based segmented image is used as the original image. The main draw back of the MRI scanning is that it cannot provide clear information of hard tissues such as bones and skull while CT scan provides this information. Combination of CT scan and MRI scan is used in this work.

In neuroimaging, Monte Carlo Simulation has been applied in several fields such as the evaluation of reconstruction methods, statistical toolkits, quantification methods, registration algorithms, segmentation methods, etc. Monte Carlo is a numerical calculation method in which random variables play an important role. Random numbers are used to simulate the transport of particles from its emission site for either its detection in the detector or its absorption in the medium in PET simulation.

2. METHODOLOGY



For the simulation of PET image MRI and CT images are used as initial maps. From these attenuation and activity maps are created. all images are required for generate the activity maps. MC code was used to simulate PET image.

To analyze an image it is necessary to separate the objects or regions of interest from the other parts of the image. There are different techniques used for performing segmentation depending upon the specific application, imaging modality and other factors etc. For instance based on the usefulness in a particular application the image pixels are classified into anatomical regions, such as muscles, bones and blood vessels or into pathological regions, such as tissue deformities, multiple sclerosis lesions and cancer.

3. SEGMENTATION

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. Lungs tissue segmentation is done by Adaptive Spatial Fuzzy centre mean algorithm (FCM)[16]. Adaptive Spatial Fuzzy C-means clustering is a data clustering method .In which each data point belongs to a cluster to a degree specified by a membership value.

3.1 Adaptive Spatial Fuzzy C-Means Clustering

- Membership matrix U randomly select according to the size of the image.

  U=[U_{ij}],1 ≤ i ≤ c,1 ≤ j ≤ n

  It satisfies the following condition:

$$\sum_{i=1}^{c} U_{ij} = 1 \quad \forall j = 1,2, \dots \dots, n$$

  Where U_{ij} - membership grade ,n- number of samples c-number of clusters

- Then calculate the Cluster center

$$c_i = \frac{\sum_{j=1}^{n} U_{ij}^m \cdot x_i}{\sum_{j=1}^{n} U_{ij}^m}$$

  Where m ∈ [1,∞] is the weighting exponent xi is the data point

- Calculate distance between the pixel and center

$$d_{ij}^2 = \|x_i - c_j\|^2$$

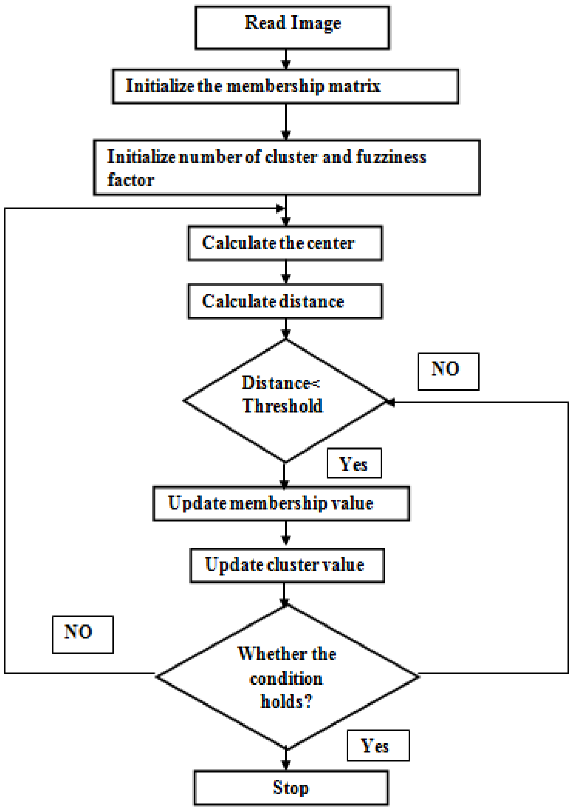
- If the distance is less than the threshold 1e-5 then update the membership matrix

- The new membership matrix is

$$U_{ij}^m = \frac{1}{\sum_{k=1}^{c} (\frac{d_{ij}}{d_{ik}})^{\frac{2}{m-1}}}$$

- Terminating condition: Aims at minimizing the desired function

$$J_{ASFCM} = \sum_{i=1}^{c} \sum_{j=1}^{n} U_{ij}^m \, d_{ij}^2$$



SFCM Segmentation algorithm:
(1) Read the MRI image
(2) Assign number of clusters
(3) Assume the fuzziness factor
(4) For i=1:max_iter
  i) Distance between pixel and centroid is calculated
  ii) Membership values are calculated
  End for
(5) If distance less than threshold
  i) Membership values are updated
  ii) Update cluster centroid
(6) Do the Segmentation

4. EXPERIMENTAL RESULTS

MRI studies were Lungs extracted and segmented to obtain the image set 1) extracted Lungs image, 2) segmented image, and 3) Lungs threshold image, various tissue structures was extracted from the MRI image by thresholding. To generate the activity maps, information from all images was taken into account.

Fig 4.1 Input CT image

Fig 4.4 Threshold image from MRI

Fig 4.2 Input MRI

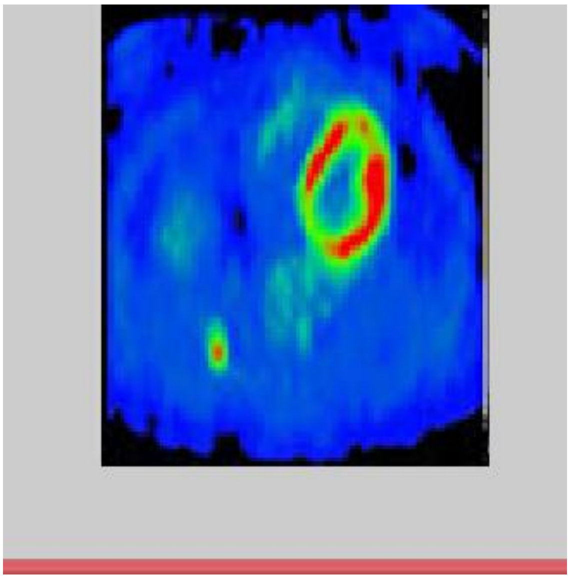


Fig 4.5 Simulated PET

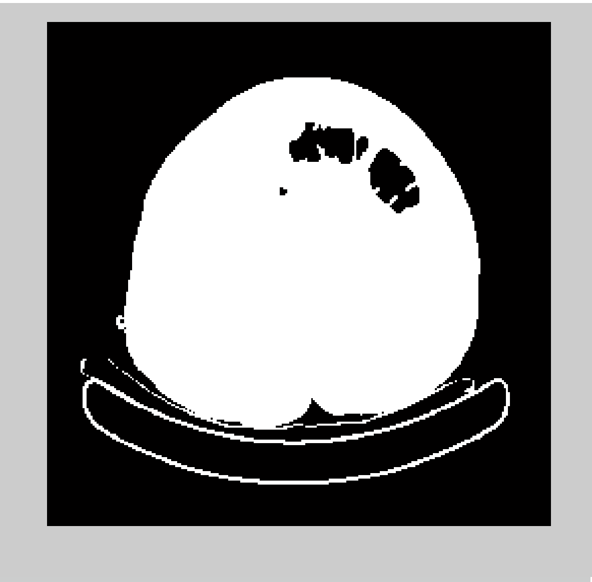


Fig 4.3 segmented image from CT

5. CONCLUSION

Lung cancer is one of the serious disease due to this more people are tends to death so it is essential to identify lung cancer cell and serious stages. It is necessary to get proper treatment on time, to reduce death rate of people in the world. In this work, the efficiency of the PET simulation is demonstrated by segmentation. In this method first assign the membership matrix and fuzziness factor. From these values update the membership value according to the distance. Hence Lungs tissue segmentation is obtained correctly.

REFERENCES

[1] Nooshin Hadavi, Jan Nordin, Ali Shojaeipour, Lung Cancer Diagnosis using CT- Scan images based on Cellular Learning Automata, IEEE, 2014.

[2] Magesh B, Vijaylakshmi P, Abhiram M, Computer aided Diagnosis System for identification and

classification of Lessions in Lungs, International Journal of Computer Trends and Technology, 2011.
[3] Linda G, Shapiro, and Stockman G.C, Computer Vision: Theory and Applications, Prentice Hall, 2001.
[4] Anita chaudhary; Sonit Sukhraj Singh, International Transaction on Computing Sciences, **2012** .
[5] B.V. Ginneken,;B. M. Romeny and M. A. Viergever, IEEE transactions on medical imaging, 2001 ,20(12)
[6] Antony Judice A. ;K. Parimala Geetha, **2013**, 1-8.
[7] Vijay A.Gajdhane ;Deshpande **, 2014**, 16(5), 28-35.
[8] Buvat, I. Castiglioni, 'Monte Carlo Simulation in SPECT and PET', Q J Nucl Med, 2002; 46:48-61.
[9] Karine Assie, Vincent Breton, Irene Buvat, Claude Comtat, Sebastien Jan, Magalie Krieguer, Delphine Lazaro, Christian Morel, Martin Rey, Giovanni Santin, Luc Simon, Steven Staelens, Daniel Strul, Jean-Marc Vieira, Rik Van de Walle, 'Monte Carlo Simulation in PET and SPECT Instrumentation Using GATE', Nuclear Instruments and Methods in Physics Research, A 527 (2004) 180-189.
[10] G. Santin, D. strul, D. Lazaro, L. Simon, M. Vieira Martins, V. Breton, C. Morel, 'GATE: A Geant4-Based Simulation Platform for PET and SPECT Integrating Movement and Time Management', IEEE Transactions on Nuclear Science, VOL. 50, No. 5, October 2003.
[11] Fatma Taher, Naoufel Werghi and Hussain Al-Ahmad,2012. "Bayesian Classification and Artificial Neural Network Methods for Lung Cancer Early Diagnosis", IEEE, pp: 773-776.