Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2013, 4(1):285-290

ISSN: 0976-8610
CODEN (USA): AASRFC

Improvement of contrast using reconstruction of 3D Image by PET /CT combination system

H. A. Ayoub[1], M. H. Dahawy[2], A. Elnadi [3] and Sh. A. El Tammimy[4]

[1]Physics Department, Faculty of Science, Suez Canal University, Egypt
[2]Biophysics Department, Faculty of Science (Boys), Al- Azher University, Egypt
[3]High Technology Institute, Asher of Ramadan, Egypt
[4]NEMROK Center, Faculty of Medicine, Cairo University, Egypt

---

ABSTRACT

Enhancement of the lesion detectability for PET/CT scanner is performed by utilizing the exclusive True X reconstruction algorithm. Evaluation of the optimum contrast ratio is obtained by manipulation of the conventional Iterative program (OSEM) and True X- reconstruction algorithms. NEMA Jaszczak phantom was acquired on biography 64 PET/CT. The five hot spheres of Jaszczak phantom were filled by^{18} Fluoro- Deoxy – Glucose (^{18}FDG) with 2.5: 1 contrast ratio to the background. Image quality was visually assessed and contrast measurements were computed against known phantom activity to determine the quantization accuracy for different size lesions. The enhancement of visibility for hot spheres was done by utilizing the new reconstruction algorithms (True X) . The contrast ratio improved by increasing the hot spheres diameter and by appling more number of iteration for both conventional Iterative program (OSEM) and the reconstruction algorithms True X . The maximum contrast ratio by using OSEM program was 1.8848 for hot sphere of diameter 24 mm and on the other hand when using True X algorithms was 2 . 0525for the same hot sphere. The True X reconstruction – recovery technique improved the accuracy of measured activity values for small hot lesions. The resolution Was improved as explored from center to periphery of lesion, and for either large or off – centered phantom are needed to quantify imaging performance with such PET/CT system. A trail was performed to quantify imaging performance by up to date PET /CT system.

INTRODUCTION

The anatomic image modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI) ,remain the most widely used modalities for target volume delineation and localization. The combined three – dimensional (3D) PET/CT scanner resolved the alignment problem by acquiring both functional (PET) and anatomical (CT) data in a single scan.

The Primary goal of acquiring accurately aligned PET and CT data is to provide accurate anatomical localization of the functional data ,for example, determining the precise location of a focal point of ^{18} FDG accumulation indicative of malignant neoplasm. The CT data can be acquired as a rapid post – injection transmission scan and used to correct the PET data for attenuation correction ,which makes the PET/CT scanner ideal for the estimation of tracer uptake concentration An additional synergistic combination of the PET and CT data includes using the CT data for guiding the reconstruction of whole - body PET data, with the goal of reducing statistical noise, improving quantitation and potentially and potentially improving lesion delectability.

The utilizing of PET in oncology is often limited by high level of statistical noise in the images. Reduction in noise can be obtained by incorporating a priori image smoothness information from correlated anatomical (CT image) information during the reconstruction of PET data.

There has been significant progress during the past few years in image reconstruction method through the introduction of statistically based algorithms into the clinical setting. The ordered – subsets Expectation methods (OSEM) is considered the most usefully reconstruction algorithms in the last 5 years. Further improvement has been achieved by eliminating the rebining step and implementing OSEM fully in 3D with correction for random ,scatter and attenuation incorporated into the system model.

In a recent development termed high – definition (HD) PET, the detector spatial response function has also been included in the reconstruction algorithms model.

Siemens Medical System introduced the True X reconstruction algorithm, which incorporates a direct measurement of the scanner system model, and offers spatial resolution compared with conventional techniques.

Improvement of resolution and lesion delectability for PET scanner by utilizing True X reconstruction algorithm.

The goal of the present work is to improve the contrast ratio by the PET/CT scanner applying two reconstruction algorithms

(a) Conventional Iterative (OSEM)
(b) True X

MATERIALS AND METHODS

All measurements were performed on a Siemens 3D combined Biographer 64 True point PET/CT scanner as illustrated in fig. (1)

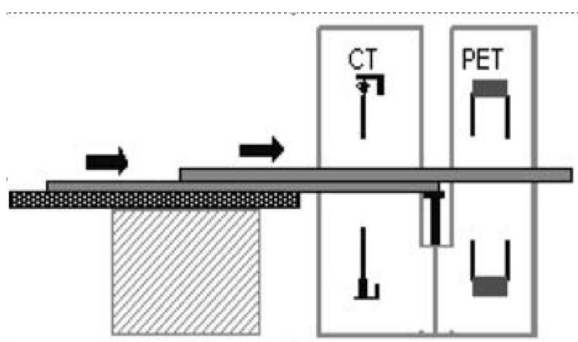

Fig. (1) demonstrates the patient handling system of combination for anatomical (CT) imaging device and Functional (PET) device.

Table. (1) the specification is for the PET system.

Detector material	Lutetium Oxy-ortho-silicate (LSO)
Crystal dimensions	4.0 x 4.0 x 20 mm
Number of detector blocks	192
Photomultipliertubes (PMTs)	4 per block
Detectors per ring	624
Number of detector rings	52
Total number of detectors	32448
Transaxial FOV	605 mm
Axial FOV	216 mm
Number of image planes	109

Work was done by using a Jaszczazk phantom (NEMA 2007) ,the phantom material is polymethyl methacrylate and it consists of five hot spheres different diameters 8.3,10.1,14,17 and 24mm.Fluorodeoxyglucose (^{18}FDG) was produced by Cyclotron.

Hermes NUD workstation was used for all analysis and processing of raw data images.

The five hot spheres shall be filled with an ^{18}F solution that is 2.5 times hotter than the background ,hot sphere lesion to background = 2.5 : 1 to simulate the tumor with different diameters , i.e with a concentration of 13:25 kBq/ml , where 5.3 kBq/ml could be used for filling the background activity.

The phantom shall be scanned on the CT and PET scanners using a modified version of the standard whole body protocol.

Applying the following reconstruction parameters to the DICOM raw data filed by

(i) Iterative (OSEM) reconstruction algorithm from 1 iteration number to 8 at 8 subsets.
(ii) True X reconstruction algorithm from 1 iteration number to 8 at 8 and 21 subsets.

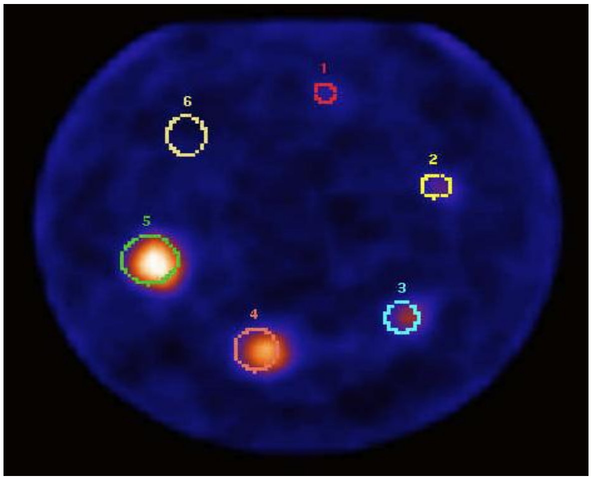

Fig. (2) The drawing of ROI of five hot spheres (1-5) and the 6 represents the ROI drawn on the sphere of background.

Collecting the mean counts for all ROI for hot spheres and background from the Hermes workstation for analysis of data, the images of CT/PET slices are shown in fig. (3).

The contrast ratio $Q_{H,J}$ was calculated by the equation

$$Q_{H,j} = \frac{C_{H,j}/C_{B,j} - 1}{a_H/a_B - 1} * 100\%$$

Where:
a. $C_{H,j}$ is the average counts in the ROI for sphere j,
b. $C_{B,j}$ is the average of the background ROI counts for sphere j,
c. a_H is the activity concentration in the hot spheres, and
d. a_B is the activity concentration in the background.

RESULTS AND DISCUSSION

A. Contrast Ratio by Iterative (OSEM) at 8 subsets. Fig. (3).
- It is clear from Figure (3) that when the diameter of ROI spheres increased the contrast ratio would be enhanced.
- The contrast ratio enhanced by using more numbers of iteratives.
- The maximum obtained contrast ratio was 1.88 from the actual filled hot sphere contrast ratio 2.5 for the largest hot sphere.
- There was a gap in the contrast ratio between the 1st and 2nd iterations Nº.
- The difference between the second and 3rd iteration numbers was lesser.

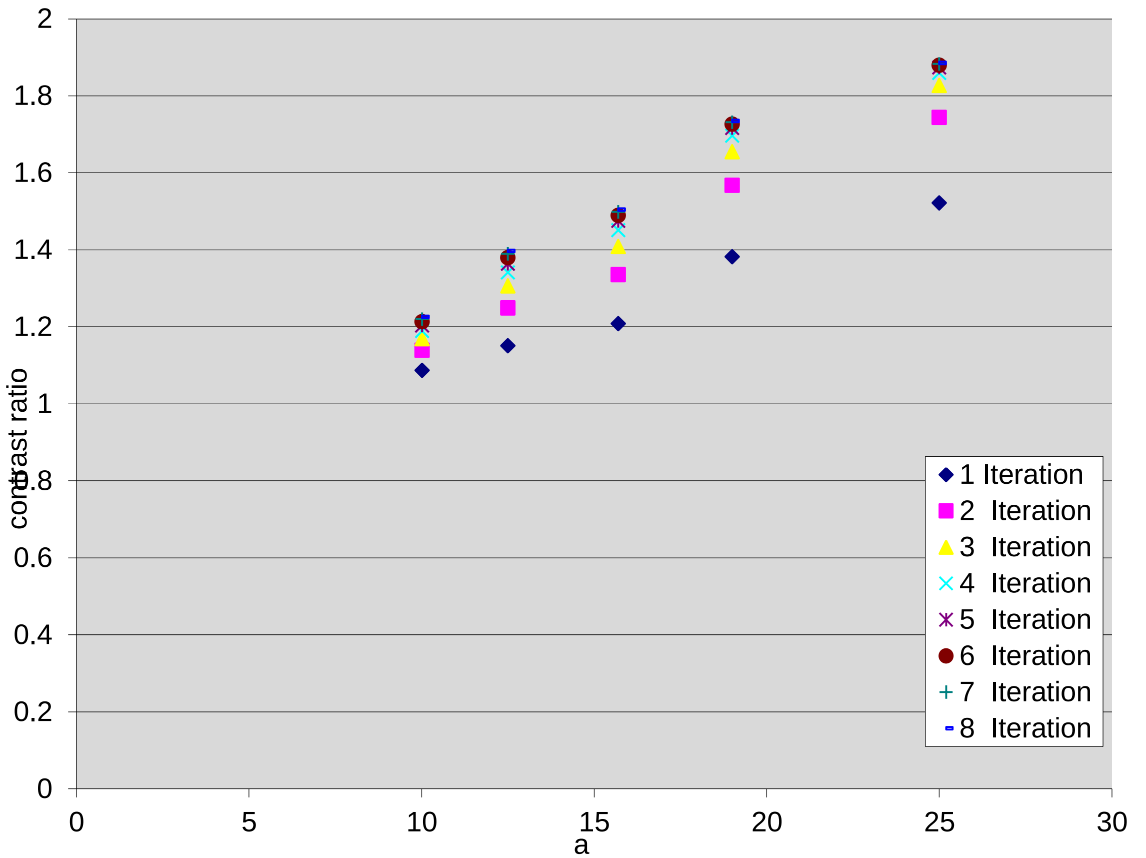

Fig. (3), the contrast ratio for the five hot spheres in the Jaszczak phantom from iteration Nº 1 to 8 when the reconstruction algorithm is at (8) Subsets.

B. Contrast Ratio by True X at 8 subsets
- It is obvious in fig.(4) that by increasing ROI of spheres diameter the contrast would be increased i.e. it is directly proportional to the diameter of the sphere, these findings are in consistence with the results of [Boellaard et al.,2001].
- The contrast ratio increased by using more numbers of True X iterations, these results are identical with the results found by [Luo L. et al., 2005] And [Vorrone et al., 2009].
- The maximum obtained ratio for the reconstruction of True X algorithm by using (8) subsets were 2.052.This in accordance to results obtained by [Aide et al., 2010].

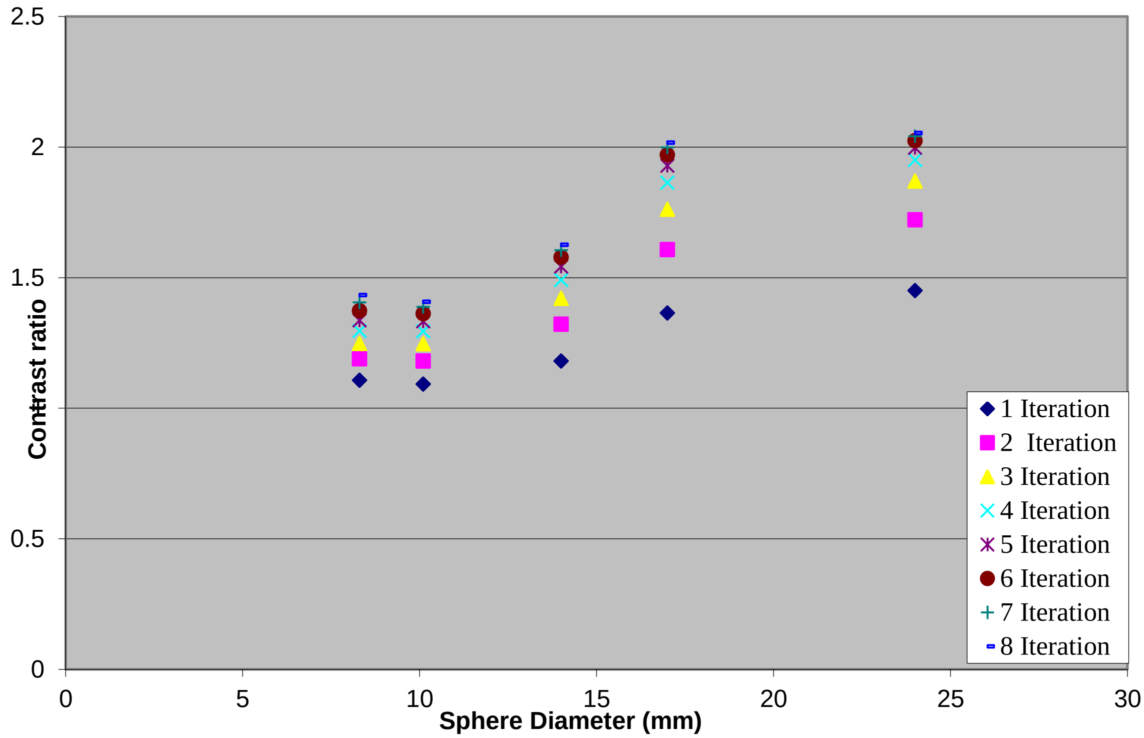

Fig. (4), demonstrates the contrast ratio for the five hot spheres in the Jaszczak phantom from True X Nº 1 to 8 as a reconstruction algorithm at (8) Subsets.

Table. (2) clarifies the maximum achievable contrast ratio for the five hot spheres in Jaszczak phantom reconstructed by both algorithm Iterative (OSEM) and TrueX.

This table shows that, the maximum value at contrast ratio by OSEM algorithm is 1.88, this value is greatly increased to 2.05 in case when using True X algorithm.

sphere Diameter (mm)	Reconstruction algorithm OSEM	Related Iteration Nº	Reconstruction algorithm TrueX	Related Iteration Nº
8.3	1.225920125	8th	1.433126294	8th
10.1	1.397024276	8th	1.407246377	8th
14	1.504111198	8th	1.62505176	8th
17	1.734338293	8th	2.016563147	8th
24	1.884886453	8th	2.052587992	8th

CONCLUSION

In case of OSEM algorithm
- When the diameter of ROI spheres increased the contrast ratio enhanced by using more iterative numbers.
- The maximum achievable contrast ratio is 1.88

In case of True X algorithm
- The contrast ratio enlarged by using more numbers of True X algorithm until the 8th iterative number.
- The maximum obtained contrast ratio is 2.05
- The visual assessment for the five hot spheres was recording an augmentation in the images sharpness and has more details by increasing the number of iterations and the diameter of studied hot spheres for both algorithms.

REFERENCES

[1] Aide N, Desmonts C, Mathieu J, et al: High throughput static and dynamic small animal imaging using clinical

PET/CT. Springer, **2010**.
[2] Boellaard R, Lingen V, Adriaan A, et al: Experimental and Clinical Evaluation of Iterative Reconstruction (OSEM) in Dynamic PET. *Eur.J.Nucl.Med*.**2001**.
[3] Luo, L, Toumoulin, C, Christine M, et al: Image Analysis by Discrete Orthogonal Hahn Moments, Springer, **2005**, (524-531)
[4] Perkins A, Stearns C, Chapman J, et al : NEMA (National Electrical Manufacturers Association) Standards Publication Performance Measurements of Positron Emission Tomography, **2007**.
[5] Siemens Biograph True Point PET/CT Service Manuals, **2009**,(3-10)
[6] Varrone A, Sjöholm N, Eriksson L, et al: Advancement in PET quantification using 3D-OP-OSEM point spread function reconstruction with the HRRT. Eur J. Nucl. Med. Mol. Imaging, **2009**