Quantitative study of clinical SPECT: image reconstruction and sensitivity

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Introduction
- Single Photon Computed Tomography gamma camera is a useful device in nuclear medicine,
- Quality controls and evaluations are required to maintain good performance.

Aim
- Evaluate quantitative characteristics:
  - Sensitivity variation with the source-detector distance,
  - Image reconstruction, by investigating the tomographic non-uniformity and contrast

Materials and methods

Question 1: Experimental set-up
- Double headed Symbia T6 SPECT/CT, Siemens (table 1) [1],
- 99mTc radioisotope, 15 % energy window centered at 140 keV gamma peak

Question 2: Sensitivity in air
- 1 ml syringe filled with 44.59 MBq of 99mTc,
- 2 minutes acquisition, at different source-detector distances: 10, 20, 30, 40, 50 and 60 cm,
- Sensitivity calculated as:

\[
  \text{Sensitivity (cpm/µCi)} = \frac{\text{counts (acquisition time (min))}}{\text{activity (µCi)}}
\]

Question 3: Tomographic Sensitivity in air
- Same source as for static sensitivity,
- Source-detector distance: 19.5 cm,
- 30 seconds acquisition for 8 projections over 180° per head,
- Acquisition using a 128x128 matrix with a 1.7959 mm pixel size,
- Tomographic sensitivity calculated as the mean of sensitivities calculated for each projection
- Image reconstruction
  - Jaszczak phantom, filled with water mixed with 485.09 MBq 99mTc,
  - Distance center of the phantom/surface of the collimator: 23 cm ,
  - 64 projections over 180° per head, 35 seconds each,
  - Images acquisition with a 128x128 matrix and a 2.3976 mm pixel size,
  - Six spheres of 31.8, 25.4, 19.1, 15.9, 12.7 and 9.5 mm diameters are inserted in the phantom for contrast evaluation,
  - A uniform part in the phantom, where no inserts are added, is used to evaluate the tomographic nonuniformity.

Question 4: Simulation set-up
- GATE (Geant 4 Application for Tomographic Emission) [2], Monte Carlo based platform,
- GATE models: experimental set-up,
- A glass back-compartment used [3], instead of photomultiplier tubes
- Moroccan Grid computing "MaGrid" [4] was used and jobs split to reduce the total simulation time and increase the statistics.

Question 5: Table 2: contrast values for different visual spheres diameters for reconstruction considering scat ter correction

<table>
<thead>
<tr>
<th>Sphere's diameters</th>
<th>31.8 mm</th>
<th>25.4 mm</th>
<th>19.1 mm</th>
<th>15.9 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAPM contrast range</td>
<td>0.53-0.73</td>
<td>0.35-0.56</td>
<td>0.21-0.38</td>
<td>0.11-0.27</td>
</tr>
<tr>
<td>Measured value of contrast</td>
<td>0.85</td>
<td>0.71</td>
<td>0.42</td>
<td>0.25</td>
</tr>
<tr>
<td>Experimental value of contrast with attenuation correction</td>
<td>0.71</td>
<td>0.58</td>
<td>0.42</td>
<td>0.25</td>
</tr>
<tr>
<td>Simulated value of contrast</td>
<td>0.68</td>
<td>0.65</td>
<td>0.36</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Conclusion
- A quantitative study was held for a clinical SPECT/CT, experimentally and by simulation,
- Our interest goes here to two quantitative parameters: sensitivity and the image reconstruction,
- The sensitivity value decreases, as expected, versus the source-detector distance,
- The obtained results, concerning contrast and the tomographic non-uniformity, are within the range of report 52 AAPM recommended values,
- Next, we are investigating scatter effect in tomographic acquisitions, to enhance our simulation results.

Acknowledgment
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References