SPECT imaging with rotating slat collimation

Traditionally, Single Photon Emission Computed Tomography (SPECT) uses parallelhole collimators. These collimators are mandatory to obtain spatial information on the origin of the detected photons and thus to produce images. Nevertheless, they compromise the quality of SPECT images, which are typically affected by noise and blur.

We investigated the performance of an alternative type of collimation, namely rotatingslat collimators, because they impose a lighter sensitivity versus resolution trade-off.The collimation in planes - as opposed to lines for a standard collimator - results in the detection of photons with less information content. Nevertheless, the number ofrecorded photons typically increases by a factor of 40. The question is whether thishigher sensitivity is able to compensate for the lower information content per measuredphoton.

First, we investigated the spatial resolution and sensitivity behavior of the collimator. Measurements with a prototype rotating slat collimator and cross-validation with adetailed Monte Carlo model confirmed the accuracy of our derived model. In a next step, planar image reconstruction was addressed whereafter a new iterative schemewas developed for speeding up both the calculation and the convergence of the slowtomographic reconstruction from plane integral measurements. Compared to MLEMand OSEM, respective speedup factors of 400 and 20 were found. Consequently, imagequality was compared to a traditional parallel hole collimator for both planar andtomographic imaging. For planar imaging, a shorter scan time of a factor of 3 to 12 wasfound for hot lesion imaging, depending on lesion size and contrast. For tomographicimaging, we found a decrease in scan time of a factor 5 and 2.5 for respectively coldand hot lesions. Finally, an attractive application of rotating slat collimators, namelyimaging of isotopes with high energy contaminants like I-123, was investigated. We found that image quality was not affected by the high energy contamination for therotating slat collimator while a contrast drop of more than 10% was found for the parallel hole collimator.

A final conclusion of this work is that it is advantageous to use a rotating slat collimatorin combination with iterative reconstruction including a system model (i) for planar hotlesion imaging, even in large objects and low contrast; (ii) for tomographic hot and coldlesion imaging, when there is limited activity in the neighborhood of the area of interest;(iii) for isotopes with high energy emissions, especially if there is a lot of contaminationarising from these high energy emissions.

References

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