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Enabling real time reconstruction for high resolution SPECT systems

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Single Photon Emission Tomography (SPECT) is mainly limited by the trade-off between spatial resolution and sensitivity. In this context, CdZnTe detectors enable higher spatial resolution compared to previously used scintillators, using sub-pixel positioning and DOI. Consequently, the size of the numerical detector representation increases and SPECT imaging tends to face some of PET imaging issues. Detection data for SPECT is currently computed by bins. This approach implies browsing all detection bins allowed by the system, and storing a huge matrix to link every detecting parameter combination to each voxel in the object. Due to the improvement of spatial resolution, the increasing of the detecting space size made this method no longer practicable.

The aim of the present study is to propose new approaches to deal with this massive amount of information faster than by binning detection events, using algorithms based on the Maximum Likelihood Expectation Maximization (MLEM), which is the most common algorithm in SPECT imaging. The first improvement consists in computing the matrix linking detection events to the object to be imaged on the flight, instead of storing them in a huge matrix for every couple of detector bin / image bin. Moreover, this matrix is sparse; consequently most of couples do not need to be computed. Therefore, it saves memory and time.

Another improvement is achieved by storing input data in list-mode instead of bin-mode. First, it makes the calculation faster, because there is less events in a SPECT acquisition than possibilities of detecting parameters combination. Then, partial updates can be made from groups of acquired events, without waiting the end of the acquisition. In this way, events go into a pipeline, and it is not necessary to store them, since MLEM works on previous updates and there is no iteration on all the events of the acquisition at the same time. Since events can be processed independently, algorithm is parallelizable and computing can be made in real time. Real time processing enables to dynamically adapt acquisition parameters, to make the system more suitable for the particular characteristics of the examination and the patient, and thus improve the result with the same amount of detected photons.

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