# The 2D+1 method for an efficient modeling of collimator blur in 3D SPECT imaging

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In SPECT (Single Photon Emission Computerized Tomography) it has been shown by several authors that an accurate modeling of the acquisition process can help extract most of the information contained in the experimental data [3, 5]. Collimator blur, attenuation and scatter are the main physical effects which deteriorate SPECT data. From a geometrical point of view, their action is genuinely three-dimensional (3D). Unfortunately, the inclusion in an iterative algorithm of a fully 3D compensation for these effects requires computation times which are usually unacceptable for the standard routine in a clinical environment. This fact hinders a widespread use of this accurate approach and leaves the less expensive (but less accurate) Filtered Back-Projection (FBP) as the most popular reconstruction algorithm in the clinical setting. The geometry of data acquisition in SPECT suggests some obvious two-dimensional (2D) approximate descriptions of the above mentioned deteriorating phenomena. Such approximate descriptions are more convenient from the computational point of view, but the results of their inclusion in an iterative reconstruction algorithm (the so called 2D reconstructions) are not quite satisfactory.

An approximate model for collimator blur (the "2D+1 model") has been proposed [1] for a fast and accurate compensation of the deterioration of SPECT data due to the structure of SPECT collimators. Basically, the 2D+1 model consists in approximating the actual collimator blur, which has a very complex behaviour, by the combined effect of a uniform blurring along the tomographic axis plus a non uniform blurring in the planes perpendicular to such an axis. One can compensate for the two kinds of blurring at two different stages (two-step methods) or by means of a reconstruction consisting of a single stage. In both cases the 2D+1 model is shown to yield results which are practically indistinguishable from the ones obtained by a fully 3D modeling of collimator blur. The computational burden is practically equivalent to the one of a 2D reconstruction and can be more easily accepted in a clinical environment. Moreover, such an approach permits, in a quite straightforward way, the inclusion of a modeling of attenuation within the "central ray approximation". The additional computational burden is negligible in the case of uniform attenuation within a convex boundary. Such a hypothesis is reasonable in the case of brain SPECT.

It is also under investigation an alternative discretization approach which allows one to exploit matrix structures arising in the linear system to be solved for computing the reconstruction. The "rotational invariance" of the system yields a sensible spare in that portion of computations involving the angular position of the detector [2].

Appropriate software based on the 2D+1 model and on the Conjugate Gradient has been developed and is presently being tested in the reconstruction of the data acquired by a CERASPECT machine (Digital Scintigraphics Incorporated, Waltham, MA 02154, USA), a brain dedicated SPECT system.

Moreover, the two-step implementation of the 2D+1 approximation proves very suitable for parallelization. In another communication [4] some preliminary results about this problem are presented.

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