Parallel Software for 3D SPECT imaging based on the 2D + 1 approximation of collimator blur

A. Murli* **L. D'Amore**† L. Carracciuolo‡ P. Boccacci§ P. Calvini¶

Unità operativa di Napoli (Prof. A. Murli)
Unità operativa di Genova (M. Bertero)

We describe the activity of the *Unità operativa* in Genova, coordinated by M. Bertero, and the *Unità operativa* in Naples, coordinated by A. Murli aimed at development of methods, algorithms and software for solving inverse and ill posed problems on the advanced computer architectures. More precisely, the activity has been devoted to develop a parallel software for 3D Spect imaging. A fully 3D numerical modeling of collimator blur in SPECT imaging is too time - consuming especially in a clinical environment and cheaper reconstruction techniques are welcome. In [1] the "2D+1 method" [2] is proposed to approximate in an efficient way the collimator blur in 3D SPECT imaging. Basically, the 2D+1 model consists in approximating the actual collimator blur by the combined effect of a uniform axial blurring plus a non uniform transaxial blurring. The implications of the proposed approximation can be better understood on the basis of the slice structure of the data collected during a typical SPECT scan: some tens (say 60, for instance) of sinograms are acquired and each one of them corresponds to the signal coming from a slice of the patient's body being examined. Unfortunately, the collimator blur spreads the signal generated from a particular slice not only within this slice (2D or transaxial blurring), but also over the adjacent sinogram slices (axial blurring).

Among the various solutions of the 2D+1 approximation, the "two-step" method [1] performs the reconstruction in two stages. First, the axial blurring is eliminated by means of a deconvolution and the result is a new set of sinograms which are (practically) free of axial contamination. Each sinogram contains only the signal coming from the corresponding slice of the patient's body and is free of the so called cross-talk effects between nearby slices. Following this approach, the most natural way to introduce parallelism into the 2D +1 method is to distribute the N 2D restoration problems among the *nprocs* processors. More precisely, three different strategies have been developed. The first one is based on data distribution: each processor operates on $N/nprocs$ 2D problems; the second one is based on a domain decomposition approach: each 2D restoration problems is decomposed among processors and each processor operates on the N 2D sub-problems. In the last parallelization strategy, processors are divided in Ng groups and each group performs restoration of the N/Ng 2D problems concurrently.

The parallel software has been developed and performance results on 32 nodes of a Beowulf system will be discussed.

References

[1] P. Boccacci, P. Bonetto, P. Brianzi, P. Calvini, F. Di Benedetto, A.R. Formiconi and A. Passeri, *The 2D+1 method for an efficient modeling of collimator blur in 3D SPECT imaging*, in ANALISI NUMERICA: Metodi e Software Matematico, Ferrara, 19–21 Gennaio 2000.

[2] P. Boccacci, P. Bonetto, P. Calvini, A.R. Formiconi, *A simple model for the efficient correction of collimator blur in 3D SPECT imaging*, Inverse Problems **15** n.4, pp. 907–930 (1999).

*Università degli Studi di Napoli, murli@matna2.dma.unina.it.
†Università degli Studi di Napoli, damore@matna2.dma.unina.it.
‡Centro di Ricerca per il Calcolo Parallelo e Supercalcolatori, CPS - CNR carracci@pixel.dma.unina.it.
§INFM - Dipartimento di Fisica, Università di Genova, boccacci@fisica.unige.it.
¶INFM - Dipartimento di Fisica, Università di Genova, calvini@ge.infn.it.