Approximation and Optimization in Image Restoration and Reconstruction
Ile de Porquerolles, France
June 8–12, 2009

THE ROLE OF IMAGE RECONSTRUCTION ALGORITHMS IN POSITRON EMISSION TOMOGRAPHY

Claude Comtat[1] **and Florent C. Sureau**[2]

[1]CEA, DSV, I2BM, SHFJ, Orsay, F-91401, France
[2]Vrije Universiteit Brussel, Department of Nuclear Medicine, Brussels, Belgium

Positron emission tomography (PET) is a biomedical imaging technique that allows for the visualization and the measurement of biological processes. PET is based on the injection to the patient of a molecular probe for the process of interest. The probe is labeled with radio-isotopes that decay by emitting a positron. The emitted positron annihilates almost immediately with an electron, resulting in the emission of two photons that are detected in detector rings surrounding the patient. In a first approximation, data collected in such a way can be modeled as a Poisson inhomogeneous process, with mean given by the X-ray transform of the probe spatial distribution. PET reconstruction is the inverse problem associated : finding the spatial distribution of the probe from a noisy realization.
The reconstructed images suffer from two main drawbacks : limited spatial resolution and high level of statistical noise due to the low number of photons detected. Spatial regularization during reconstruction is often used, which further degrades spatial resolution. To obtain an optimal trade-off between resolution and statistical noise, it is necessary to accurately model during reconstruction the detection process and the noise in the data. Therefore, the choice of the reconstruction algorithm plays an important role in the quality of the reconstructed images, hence in their diagnostic utility. The development of new reconstruction algorithms for PET is an active field of research.
The various strategies that are used for PET image reconstruction will be presented, with emphasis on iterative techniques. The impact of the modeling approximations will be discussed in regard to the use of the reconstructed images by the physician.