Tomographic reconstruction for a Quality Assurance dosimetric system

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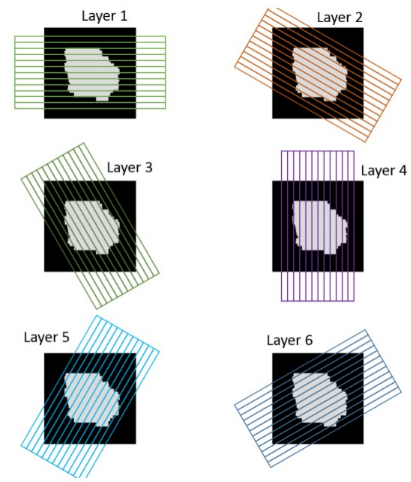

Context. The medical objective of QASys (1D and 2D Quality Assurance dosimetric systems based on prompt-radioluminescence transduction for MRI guided stereotactic radiation therapy) is to develop dosimeters for Quality Assurance (QA) procedures in radiotherapy. The INL (Institut des Nano-sciences de Lyon) in Lyon is developing and testing a novel real time high resolution QA dosimetric system based on prompt-radioluminescence transduction and tomographic field reconstruction. The dosimeter can be roughly modeled as superposed layers of parallel strips or lines covering an area and integrating the radiotherapy photon flux. The mathematical problem to solve is the reconstruction of a slice of the radiotherapy beam from a handful (five to ten) tomographic projections, each projection corresponding to a layer of parallel lines or strip measurements. It is well known that this problem is severely ill posed [Natterer86,Clackdoyle10]. The resolution of the reconstructed image is directly related to the number of projections [Desbat97]. Classical analytical methods like FBP (filtered Back Projection) yield poor results. However, we can model the reconstruction flux slice as a binary function f with $f(x) = 1$ within the flux and 0 otherwise. Iterative techniques like SIRT or Discrete Algebraic Reconstruction Technique (DART) are preferred in this context [Aarle15, Aarle16].

Objectives. The first objective is to study and to benchmark the performance of some reference reconstruction techniques (SIRT/DART, Expectation Maximization, TV-regularized methods...) for the reconstruction of a binary function f (photon flux slice) from few projections. The second objective is to adapt such algebraic reconstruction methods to the context of a multi-leaf collimator (MLC). An MLC is a finite number of parallel tungsten strips. Opposite strips can be controlled in order to produce a rectangular hole where the photon flux is not blocked. The photon flux shape is thus produced by finite number of real parameters describing the MLC. Thus, the reconstruction problem can be reduced to a small number of geometric parameters that could be of the order of measurements collected [Gardner06].

Practical Information. The duration of this PFE or Masters project is 6 months. The primary location is the TIMC laboratory (Grenoble). QASys is funded by INSERM in the context of “Research proposal in physics, mathematics and engineering sciences applied to the cancer research”.

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