S.-S. Luo, *Reconstruction Algorithms for Single-photon Emission Computed Tomography*, Ph.D. dissertation, Computational Mathematics, Peking University (PKU), Beijing, P.R. China, **2013**.
http://www.dissertationtopic.net/doc/2220625.

Abstract

Single photon emission computed tomography (SPECT), which is widely used in clinical applications, is one of the important nuclear imaging techniques. The variety of existing SPECT reconstruction algorithms can be split into a family of analytical methods and a wide class of iterative techniques. The analytical methods are based on the inversion of the exponential or attenuated Radon transform. The main advantage of them is low computational cost, and the main disadvantage of them is that the reconstructed image is undesired for the noised projection data. The iterative methods take a lot of degraded factors of projection data into system matrix, and the qualities of reconstructed images are higher. However, the computational cost of them is very high. In the third and forth chapters of this thesis, we studied the analytical methods for 180 projection data. It had been pointed out that the weight-differentiated backprojection (WDBP) of projection data of the exponential Radon transform could reduce theSPECT reconstruction to inverting a one-dimensional cosh-Hilbert transform (CHT). Although the uniqueness of the inversion of CHT had been proved under some conditions, there is no analytically and accurately inverse formula of it. Based on the Tricomi inversion formula for Hilbert transform and the characteristics of the Taylor expansion of hyperbolic cosine function, we proposed a moment-based method for the inversion of CHT numerically in the third chapter. Furthermore, Based on the CHT, we proposed a semi-analytical method for SPECT image reconstruction in the forth chapter. Due to the lack of noise immunity, the reconstructed images by the moment-based method have a lot of distortions. In order to suppress the distortions, we proposed a regularization model based on the CHT, in which the balance parameter varies according to the weight function of WDBP. We validated the performances of the proposed methods by numerical simulations. In the fifth chapter of the thesis, we investigated the algebraic methods of SPECT image reconstruction. We studied the convergence of the superiorized EM algorithm, and applied to SPECT image reconstruction. Because the projection data of SPECT obey the Poisson distribution, EM iteration is widely used in the field of SPECT image reconstruction. However, the reconstructed images have a lot of distortions due to the noise of projection data and uncertainty of the system matrix. Regularization methods are the common techniques to improve the qualities of reconstructed images, which implies that we have to solve optimal problems. Due to the large scale of imaging problems, there is no efficient algorithm at present. The superiorization of iterative algorithms is

a new idea to handle the optimal problems. Firstly, we proved the convergence of perturbed EM iteration under some conditions. Secondly, we designed the superiorized EM algorithm based on the convergent conditions, and discussed the details of implementations for total variation and l1-norm minimization problems. Lastly, the numerical experiments were conducted to validate the efficiency of the proposed algorithms.