Dicken, Volker

A new approach towards simultaneous activity and attenuation reconstruction in emission tomography. (English) Zbl 0945.65146

Inverse Probl. 15, No. 4, 931-960 (1999).

The author considers some of most challenging problems at the cross roads of mathematics, engineering and medicine arising from the development of tomographic methods for medical diagnosis, especially those involving nonlinear models with very noisy data. A prominent example is the use of single photon emission computed-tomography (SPECT) to examine massive body parts in nuclear medical diagnosis. A mathematical model of the imaging process in SPECT is the attenuated Radon transform. In SPECT one is interested in reconstruction the activity distribution f of some radio-pharmaceutical. The data gathered from attenuation due to the tissue density μ. Each image slice incorporates noisy sample values of the nonlinear attenuated Radon transform:

$$A(f,\mu)(\omega,s) = \int_{-\infty}^{\infty} f(s\omega^{\perp} + t\omega) \exp\left(- \int_{t}^{\infty} \mu(s\omega^{\perp} + \tau\omega) d\tau \right) dt.$$

In practical application, however, μ is not known, but either crudely estimated, determined in costly additional measurements or plainly neglected. The author demonstrates that an approximation of both f and μ from SPECT data alone is feasible, leading to quantitatively more accurate SPECT images. The result is based on nonlinear Tikhonov regularization techniques for parameter estimation problems in differential equations combined with Gauss-Newton conjugate gradient minimization. Some interesting examples are also discussed.

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