What Life Scientists Should Know About Molecular Imaging

Optical Imaging, Ultrasound, Photoacoustics

Image reconstruction methods: The principles of Diffuse Light Propagation. From datasets to 3D tomographic images

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Learning Objectives:

- Optical Imaging
- Forward-Inverse problem
- Techniques for image reconstruction
- Fluorescence molecular tomography
- Shape based methods
- Matrix-Free methods

When whole animal or human optical imaging is concerned, the existence of high scattering in the biological tissue is hindering the simple image reconstruction methods used for the cases where light is considered ballistic. In the presence of scattering, model-based methods have to be employed to reconstruct for three dimensional tomographic images of the distributions of the optical properties under investigation (absorption, scattering, fluorescence concentration and so on). During this seminar we will discuss the procedures followed from experimentally acquired datasets to the 3D Tomographic images. The bases of the definition for the Forward and Inverse problems will be examined and techniques for the successful solution of the inverse problem in some applications of interest, such as Diffuse Optical Tomography (DOT) and Fluorescence Molecular Tomography (FMT), will be analysed. Finally, we will conclude with a brief introduction to some of the more advanced techniques for the solution of the inverse problem such as, inclusion of priors, shape-based methods and Matrix-Free methods.

Relevant Publications:

1. Zacharopoulos, M. Schweiger, V. Kolehmainen, S. Arridge, “3D shape-based reconstruction of experimental data in Diffuse Optical Tomography”, Opt. Express 17, 18940-18956 (2009)
2. D. Zacharopoulos, P. Svenmarker, J. Axelsson, M. Schweiger, S. R. Arridge, and S. Andersson-Engels, “A matrix-free algorithm for multiple wavelength fluorescence tomography,” Opt. Express 17, 3042-3051 (2009)
3. Zacharopoulos, S. Arridge, O. Dorn, V. Kolehmainen, and J. Sikora, ”Three dimensional reconstruction of shape and piecewise constant region values for Optical Tomography using spherical harmonic parameterisation and a Boundary Element Method”, Inverse Problems. 22, No 5, 1509-1532 (2006)

References:

1. S.R. Arridge, 1999, “Optical Tomography in Medical Imaging”, Topical Review, Inverse Problems, 15, R41-R93.
2. J. Ripoll and V. Ntziachristos, “Imaging Scattering Media from a Distance: Theory and Applications of Non -Contact Optical Tomography”, Modern Physics Letters B, 18 (2004).
3. Image Reconstruction in Diffuse Optical Tomography , TOAST++ http://web4.cs.ucl.ac.uk/research/vis/toast/install.html