Comparison of nonlinear reconstruction algorithms for fluorescence diffusion optical tomography

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Fluorophore distributions inside an object can be imaged using fluorescence tomography which injects light at the object's boundary to excite the fluorophore and measures the light emitted by the fluorophore on the sample's surface. From the knowledge of the source and detector locations it is then possible to solve the inverse problem which is the determination of the fluorophore distribution in the inside. Currently, mostly linear inversion methods [1,2] or nonlinear methods with linear regularization terms [3] are applied. In this work, linear and nonlinear inversion schemes together with a linear L^2-penalty and nonlinear total variation (TV) regularization and a method of level-set type were compared. For this comparison, 100 test cases with randomly placed Gaussian-shaped inclusions with random concentrations were generated. As quality criterion, the reconstructed amount of fluorophore inside a 95% region centered at the location of the original inclusions was used. With a linear inversion algorithm the ratio of reconstructed fluorophore amount to the true fluorophore amount was 0.75±0.11. The result was significantly better using the full nonlinear model for the inversion which resulted in a ratio of 0.91±0.13. The best ratio of 1.00±0.13 was obtained by adding an additional TV penalty while the method of level-set type overestimated the amount of fluorophore which was 1.45±0.97 times the true amount. The mesh-size independet algorithms all exhibit similar structure and can be incorporated easily into existing finite element codes, therefore.

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