Efficient non-negative constrained model-based inversion in optoacoustic tomography.

Abstract:
The inversion accuracy in optoacoustic tomography depends on a number of parameters, including the number of detectors employed, discrete sampling issues or imperfectness of the forward model. These parameters result in ambiguities on the reconstructed image. A common ambiguity is the appearance of negative values, which have no physical meaning since optical absorption can only be higher or equal than zero. We investigate herein algorithms that impose non-negative constraints in model-based optoacoustic inversion. Several state-of-the-art non-negative constrained algorithms are analyzed. Furthermore, an algorithm based on the conjugate gradient method is introduced in this work. We are particularly interested in investigating whether positive restrictions lead to accurate solutions or drive the appearance of errors and artifacts. It is shown that the computational performance of non-negative constrained inversion is higher for the introduced algorithm than for the other algorithms, while yielding equivalent results. The experimental performance of this inversion procedure is then tested in phantoms and small animals, showing an improvement in image quality and quantitativeness with respect to the unconstrained approach. The study performed validates the use of non-negative constraints for improving image accuracy compared to
unconstrained methods, while maintaining computational efficiency.