

A level set method for structural inversion in medical imaging

Oliver Dorn^a

^a School of Mathematics
University of Manchester
Oxford Rd Manchester M13 9PL
Oliver.Dorn@manchester.ac.uk

Many image reconstruction tasks for medical diagnostics and biomedical imaging are severely ill-posed, and suffer from the fact that only few noisy data can be obtained for the given imaging modality. Therefore, a high resolution tomographic image in the classical sense is out of reach for these applications. Nevertheless, often not such an overall high resolution image is needed, but the extraction of very specific information regarding the imaging task at hand would be sufficient.

For example, in microwave imaging for breast screening the goal is to extract from relatively few microwave data of the female breast sufficient information in order to determine whether a small tumor is present or not. If such an anomaly can be detected in its early stage of development, an additional task would be to verify as precisely as possible from the given data whether it is a benign or a malignant tumor. Unfortunately, classical reconstruction techniques are typically not able to provide this important information, due to the way they are typically constructed: the ill-posedness is here in most cases addressed by applying smoothness assumptions on the final image, which has the positive effect of regularizing the inversion. Unfortunately, exactly this smoothing process makes it almost impossible to detect the correct size and contrast of small tumors embedded in the breast.

Similar situations can occur in other medical imaging applications, for example in fluorescence optical tomography. In these applications, novel reconstruction techniques might be of advantage which allow for the direct reconstruction of images which are composed of several regions of a priori unknown size and topology and having some interior profiles which follow some region-characteristic models. Here, both, the topologies and shapes of the regions as well as the region specific profiles need to be reconstructed from the data.

In the talk we will present a level set technique which is designed to solve this task of structural inversion. We will present numerical examples in 2D for microwave medical imaging and for fluorescence optical tomography which outline the general idea of such a structural inversion technique.