JSS30, Summer School, COMP5: Machine learning in inverse and ill-posed problems Course Project

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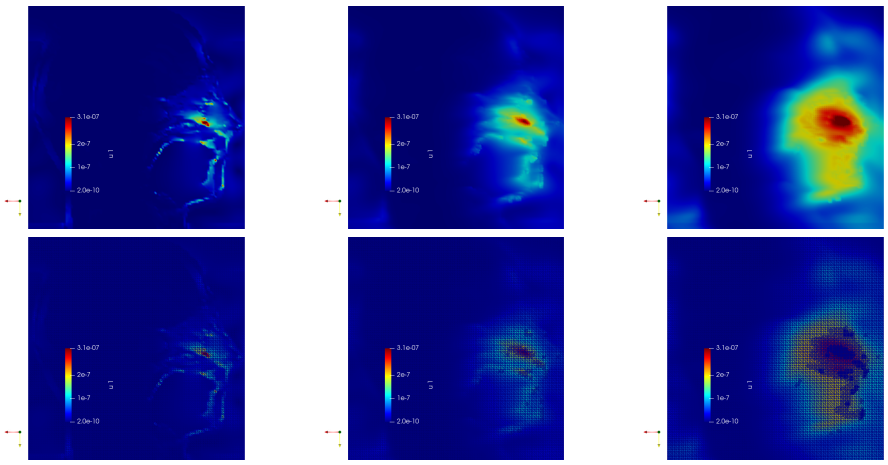
Instructions

- You can work in groups by 2 - 4 persons.
- Sent final report for every computer assignment with description of your work together with Matlab programs to my e-mail.
- Report should have description of used techniques, tables and figures confirming your investigations. Analysis of obtained results is necessary to present in section "Numerical examples" and summarized results - in section "Conclusions". You can download latex or pdf-template for report from the course homepage. Attach also corresponding programs for testing.



coarse mesh | 1 time refined | 2 times refined

Figure 0.1: Reconstructions of the tunour in the Duke model obtained via AFEM in the transverse plane with the regularization term $\frac{\lambda}{2}\|u\|_2^2$. Details about AFEM see in [1].

Course Project

Regularized algorithms for detection of tumours in microwave medical imaging

In this project we will study different regularization strategies for detection of tumours using microwaves. This problem is a typical Coefficient Inverse Problem (CIP) for determination of complex dielectric permittivity function in Helmholtz equation from scattered electric field in frequency domain. Alternatively, the dielectric permittivity function can be determined from the solution of a Fredholm integral equation of the first kind which is an ill-posed problem. The goal of the current project is further development of mathematical methods presented in the recent paper [1] for real-life applications in microwave medical imaging. This project is the joint work with the group of Biomedical Imaging at the Department of Electrical Engineering at CTH, Chalmers.

More precisely, in this project students will:

- Study different regularized formulations of the reconstruction problem presented in the paper [1] which can be downloaded from the link

  `https://doi.org/10.1515/jiip-2020-0102`

- Determine the dielectric permittivity function by solving the regularized linear system of equations (LSE) in 2D and 3D by modifying existing matlab code used for computations in the paper [1] available for download at

  `http://www.math.chalmers.se/Math/Grundutb/CTH/tma265/2021/IPcourse/MatlabCode_MicrowaveImaging.zip`.

- Test different regularization strategies (Morozov's discrepancy principle, Balancing principle) for choosing the regularization parameter as well as for choosing the regularization terms.

References

[1] M. G. Aram, L. Beilina, H. Dobsicek Trefna, Microwave Thermometry with Potential Application in Non-invasive Monitoring of Hyperthermia, *Journal of Inverse and Ill-posed problems*, 2020. `https://doi.org/10.1515/jiip-2020-0102`