Brain imaging with FreeFem++

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Teaser: Microwave tomography is a novel imaging modality holding great promise for medical applications and in particular for brain stroke diagnosis. We demonstrated on synthetic data the feasibility of a microwave imaging technique for the characterization and monitoring of strokes. Using high performance computing, we are able to obtain a tomographic reconstruction of the brain in less than two minutes.

Our work demonstrates on synthetic data the feasibility of a microwave imaging technique for the characterization of CVAs, and won our research team the Bull-Joseph Fourier Prize in 2015. The numerical framework is based on high-performance computing open-source tools developed by our research team: the HPDDM library[1](L1) is an efficient parallel implementation of Domain Decomposition Methods (DDM) and is interfaced with the finite element software FreeFem++[2](L2). Our work was carried out in collaboration with EMTensor, an Austrian innovative SME dedicated to biomedical imaging and is based on their BRain IMaging Generation1 (BRIMG1) prototype[3].

In this colloquium, I will present this problem and how to solve it, and I make a short overview of FreeFem++ with some real time tests on classical PDE (Poisson, Navier-Stokes, Elasticy, ...).

References

[1] P. Jolivet, F. Hecht, F. Nataf and C. Prud'homme, "Scalable Domain Decomposition Preconditioners for Heterogeneous Elliptic Problems", International Conference on High Performance Computing, Networking, Storage and Analysis, 2013

[2] F. Hecht, "New development in FreeFem++", J. Numer. Math. 20, 2012

[3] S. Semenov, B. Seiser, E. Stoegmann, and E. Auff, "Electromagnetic tomography for brain imaging: from virtual to human brain", IEEE Conference on Antenna Measurements & Applications (CAMA), 2014

Links

[L1] https://github.com/hpddm/hpddm

[L2] http://www.freefem.org/ff++

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