Recent advances for numerical simulation in brain research

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Numerical simulation is a widely used tool to investigate the function and dysfunction of the human brain. One area of interest is the use of source analysis using Electro- and Magnetoencephalography (EEG, MEG) to non-invasively localize electrical activity within the brain. In order to solve the EEG and MEG inverse problem, an accurate solution of the forward problem using numerical simulation is needed. A challenging problem in the simulation of these signals is the discretization of the singular source distribution. A different area of research is the reciprocal simulation of brain stimulation. The latter introduces an electrical current to the brain using electrodes on the head surface. In order to understand the current flow and to plan and compute optimal stimulation protocols, numerical simulation is used. Both applications share the problem of constructing an appropriate discrete head geometry due to the complex shape of the computational domain. We will present recent advances for numerical simulations in these areas of bioelectromagnetism. Several different finite element methods have been investigated, including discontinuous Galerkin methods as well as cut-cell methods. These discretizations make use of the Dune framework and employ multigrid techniques to solve the resulting linear systems.