Fast Realization of Eikonal Equation Solvers on Tablet Devices

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The Eikonal equation describes the arrivel times of an expanding potential in a given domain Ω. This equation can be considered as a reduced model of the bidomain equations describing the time dependent development of the intercellurar potential in a heart simulation after some excitation.

$$\begin{aligned} |\nabla u(x)| &= F(x), & x \in \Omega \\ u &= 0, & x \in \Gamma \subset \partial\Omega \end{aligned}$$

The Eikonal equation is a special case of the Hamilton-Jacobi partial differential equations (PDEs), encountered in problems of wave propagation.

The solution algorithm bases on the Fast Iteration Method (FIM) algorithm from [1] with special focus on thetrahedral elements [2]. We will present our achievments on implementing the code with OpenMP, MPI and CUDA on a wide variation of hardware ranging from cluster computing with very recent ARMv9 processors to tablets with the Tegra X1 processor. A special focus will be on the domain decomposition approach for parallelizing FIM and on a very sophisticated implementation such that the memory footprint will be significantly reduced in comparison to [Fu, Kirby and Whitaker, 2013].

References:

[1] W.-K. Jeong and R. T. Whitaker, *A fast iterative method for Eikonal equations.* SIAM J. Sci. Comput., vol. 30, pp. 2512-2534, 2008.
[2] Z. Fu, R. M. Kirby, and R. T. Whitaker, *Fast iterative method for solving the eikonal equation on tetrahedral domains.* SIAM J. Sci. Comput., vol. 35, no. 5, pp. C473–C494, 2013.

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