Solving discontinuous collocation equations for a class of brain tumor models on GPUs [1]

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Abstract

Brain tumor models, that incorporate brain's heterogeneity, have been well developed in the last decades. The core PDE, that models tumor's cell diffusion and proliferation properties, is being characterized by a discontinuous diffusion coefficient, since tumor cells migrate with different rates in brain's white and gray matter. In recent years, working towards the development of high order approximation methods, we have introduced and studied Discontinuous Hermite Collocation (DHC) methods coupled with traditional as well as high order semi implicit and strongly stable Runge-Kutta (RK) time discretization schemes. In this work the problem at hand is the efficient solution of the linear model tumor invasion problem in 1+2 dimensions. Tensor product formulated fourth order DHC method is used as spatial discretization to produce a system of ODEs, to be solved, in the sequel, by third order Diagonally-Implicit RK (DIRK) schemes. Therefore, in each time step a large linear system of order $O(N^2)$, where N is the number of elements in each dimension, has to be solved demanding quite intense computational effort. Its efficient solution by incomplete factorization preconditioned BiCG stabilized iterative method (as the eigenvalue topology suggests) in GPU computational environments is presented and several numerical experiments are used to demonstrate its performance.