Efficient solvers based on manycore computers and adaptive techniques for cardiac modeling

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ABSTRACT

Computer models have become valuable tools for the study and comprehension of the complex phenomena of cardiac electrophysiology. However, the high complexity of the biophysical processes translates into complex mathematical and computational models. In this paper we evaluate different parallel and numerical techniques to accelerate these simulations. At tissue level we have used mesh adaptivity and finite volume method, which is a very attractive approach since the spreading electrical wavefront corresponds only to a small fraction of the cardiac tissue. Usually, the numerical solution of the partial differential equations that model the phenomenon requires very fine spatial discretization to follow the wavefront. Therefore, the use of uniform meshes leads to high computational costs. In this sense, the tests reported in this work show that simulations of two-dimensional models of cardiac tissue have been accelerated by 250 times when using an adaptive mesh algorithm together with a time step adaptive algorithm. In addition, we have started to parallelize this new numerical schemes for manycore computers using OpenMP and CUDA. Preliminary results show that these adaptive techniques together with parallel algorithms for manycore computers are a powerful combination for solvers of cardiac models that reduce the execution time of the simulations without significant loss in accuracy.