Evaluating Parallel Sparse Solvers to Accelerate a Radiofrequency Ablation FEM Application

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***Abstract*—Solving sparse linear systems lies at the heart of many scientific applications, like numerical applications and computer simulations. Such applications can be incredibly time-consuming, demanding lots of computing power to calculate precise results in a feasible amount of time. The Finite Element Method (FEM) is a universal approach to simulating various problems, discretizing the whole system as a finite number of simple-shaped geometric elements. FEM applications are characterized by common steps, like assembling a linear equation system to approximate an unknown function over the discretized domain, leading to a very sparse system of equations that needs to be solved. Hence, the evolution in high-performance computing scenarios through newer parallel hardware and software has been supplying the ever-increasing demand for computational power arising from such applications. An example of a computational simulation application that uses FEM is the Radiofrequency Ablation Finite Element Method (RAFEM), which simulates the radiofrequency ablation procedure, a common treatment for hepatic cancer. We use the RAFEM application in this work as a case study. RAFEM's original version runs sequentially and takes up to 20 hours to produce 15 minutes of simulated results. We use three sparse solvers (MAGMA, cuSOLVER, and QRMumps) among different multicore and GPU architectures to accelerate the application. We investigate the numerical properties of the results provided by each solver using the peak signal-to-noise ratio (PSNR) metric. We also present a detailed performance analysis of the application in different machines using data from application tracing, pointing out the sparse solver role in the overall performance. The acceleration results showed that we managed to reduce the computing time of the original version up to 40 times while keeping numerical results sufficiently close to the original version values.**

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DISCLAIMER

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