Parallel WIPL-D

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ABSTRACT

This paper describes research work currently being conducted under the Common High Performance Software Support Initiative (CHSSI) sponsored by the DoD High Performance Computing Modernization Program (HPCMO). The work is an on-going development effort to provide a scalable, portable, parallel scene generation tool that will provide the capability to rapidly generate scenes of radiating and scattering structures in realistically complex electromagnetic environments. This effort is leveraging a commercially available tool called WIPL-D (Wires, Plates, and Dielectrics). The benefit of such a tool is that it will provide users with the capability to solve large problems that cannot be currently solved with existing sequential electromagnetic modeling tools. This tool supports a broad range of users including researchers, algorithm developers, analysts, and system developers. This paper will present the parallelization process highlighting the strategies used and will show the results to date.

The parallelization effort has focused on two main areas. The first area is frequency domain parallelization. Linear scaled speedup is achieved by distributing the frequencies among the available processors. The second area is parallelization of the impedance matrix generation and solution. Parallelizing the matrix generation provides speedup, but more importantly also allows for larger problems to be solved. This is achieved by dividing up the impedance matrix among the available processors and allowing for a larger number of unknowns. One of the main objectives for this program is to reach 100,000 unknowns. The parallelization of the matrix solution provides speedup by decreasing the processing time of the major bottleneck of the program. The solution is currently implemented using Scalapack's complex LU decomposition and solution functions, but the code allows for alternative parallel solvers to be used in its place.

Alpha test was conducted in August of 2003. For this test frequency parallelization was implemented and tested. The target application for this test was a simulation of a cellular phone alongside a human head, which required solving 3,549 unknowns. It was tested on two High Performance Computing Machines (HPC's), an IBM SP3 and a Linux Cluster, at the Maui High Performance Computing Center using 32 processors. The worst case linear scaled speedup was 89% and the worst case accuracy was 0.08% error, exceeding the defined optimal requirements. The goal for the next phase of the project is to integrate the parallel matrix generation and solution with the parallel frequency code. This is to take place on the two HPC's listed above, along with the Compaq SC 40/45 at the Aeronautical Systems Center Major Shared Resource Center using 64 processors. A modified version of the previously described target application will be used, which requires solving 5,662 unknowns. The matrix generation and solution are currently implemented and are being tested, showing favorable results. The final results will be presented at Beta test in May of 2004.

The team assembled to conduct this research effort consists of the Air Force Research Laboratory, Naval Research Lab. (NRL), US Army Space & Missile Defense Command (USASMDC), Black River Systems Company, RADC, Syracuse University, University of Toronto, and SUNY Binghamton. Application areas of interest include Foliage Penetration, Synthetic Aperture Radar, Landmine Detection, Re-Entry Vehicles with Chaff, and Antennas on Large Structures.