Course Announcement

MECH 603

SPECIAL TOPICS: PARALLEL COMPUTING METHODS IN COMPUTATIONAL MECHANICS

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Fall 1999
Tuesday and Thursday 2:30 – 3:45 pm

Rapid advances in computer technology are changing the way many continuum mechanics problems of engineering importance are solved. Computational mechanics has emerged as an important branch of research and development, along with the more established theoretical and experimental approaches. One of the main factors that limit the accuracy of computational modeling is the speed at which the computations can be performed. Extracting maximum performance out of the single processor, as well as harnessing the power of many processors working together, can lead to crucial improvements in the accuracy of modeling and turnaround time for the analysis.

In this course, the participants will review the discretization approaches commonly used for the analysis of continuum mechanics problems, such as finite difference, finite volume and finite element methods. The emphasis will be placed on a) finite element solution techniques, b) computational fluid dynamics problems and c) engineering applications. The effect of increased resolution of the computational mesh on the accuracy of the solutions and on the time required to obtain the solution will be discussed. These computational demands will be compared with the capabilities of current supercomputers. We will then consider scalar optimization, which can be understood as extracting maximum performance out of a single processor of a single- or multi-processor system. Subsequently, focus will shift to finding and exploiting parallelism, which enables significant reduction in processing time by performing computations concurrently on multiple processors. Parallel programming models such as symmetric multi-processing and message passing will be discussed. The participants will be introduced to compilers and libraries that facilitate parallelization, including High-Performance Fortran (HPF), Message Passing Interface (MPI), and Parallel Virtual Machine (PVM). The remaining portion of the course will center on basic operation blocks encountered in typical implicit finite element codes, such as assembly of the linear system of equations, iterative solution techniques, implementation of boundary conditions and input/output. Placement of the data and parallelization approaches for each of these blocks will be considered.

This course will incorporate numerical exercises, and requires prior familiarity with FORTRAN (preferred) or C programming, and with the UNIX operating system. Because of the finite element focus of this course, the participants may benefit from concurrently attending MECH 554 FINITE ELEMENT METHODS IN FLUID MECHANICS.