Activities Report for June — September 1993

David Koester

My activities for the reporting period June — September 1993 has focused on three areas:

1. documenting work in progress,
2. examining ordering techniques for block-diagonal-bordered form sparse matrices,
3. integrating a parallel dense matrix solver into my block-diagonal-bordered sparse matrix solver to factor the nearly dense last block.

All efforts in these three areas support both my Ph.D. research and the NPAC — Niagara Mohawk contract.

In order to document my work in progress, two NPAC technical reports are in the process of being written:

1. *Parallel LU Factorization of Block-Diagonal Bordered Sparse Matrices*,
2. *Ordering Irregular Matrices for Parallel Block-Diagonal-Bordered LU Factorization.*

The first report is awaiting data to be collected in the latest implementation of my parallel block-bordered diagonal sparse matrix solver, while additional editing is required for the second paper. Significant portions of these papers will be used in my thesis.

Direct block-diagonal-bordered sparse matrix solvers exhibit distinct advantages when compared to current parallel direct sparse matrix solvers. Task assignments for numerical factorization on distributed-memory multi-processors depend only on the assignment of independent blocks to processors and the processor assignments of data in the last block. My research into block-diagonal-bordered form sparse matrix solvers has developed a new three-step preprocessing phase that requires special ordering techniques to determine the block-diagonal-bordered form and to perform load-balancing to ensure efficient parallel operations. The applicability of two prospective ordering techniques to order power systems sparse matrices into block-diagonal-bordered form with uniform distribution of work for all processors has been examined using power systems data from the Boeing-Harwell sparse matrix series. These two ordering techniques are based on recursive spectral bisection and node-tearing nodal analysis — a form of diakoptics. Node-tearing nodal analysis has distinct advantages over the technique based on recursive spectral bisection. In order to determine the extent of the applicability of the node-tearing nodal analysis technique to general irregular sparse matrices, node-tearing nodal analysis has been extensively exercised on various sparse matrices in the Boeing-Harwell series, in addition to actual electrical power system network data obtained from Niagara Mohawk.

A poster session covering my matrix ordering research as been accepted at the Scalable Parallel Libraries Conference 6-8 October 1993 at Mississippi State University. The poster and accompanying paper will describe the problems with limited scalability in sparse matrix solvers due to the limited parallelization available in real-life sparse matrices. This phenomenon is clearly visible in animations developed from series of ordered sparse matrix representations.

My last, and most recent task, has been to examine efficient parallel dense LU factorization techniques to be used to factor the last block in a block-diagonal-bordered sparse matrix. Ordering research has shown that the last block will be nearly dense after considering fillin due to factorization, so a dense matrix solver will be the most efficient technique available to factor this portion of the matrix. Previous NPAC research into FORTRAN benchmarks has been utilized to develop an efficient parallel dense matrix solver for the last-block in the sparse matrix. My software implementation is currently under development, although development effort will be significantly decreased because large portions of the code will directly utilize existing SAXPY routines from the LAPACK software library.