EFFICIENT DOMAIN DECOMPOSITION ALGORITHMS AND APPLICATIONS IN TRANSPORTATION AND STRUCTURAL ENGINEERING

by

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ABSTRACT

Domain decomposition is a divide and conquer strategy. In the first part of this dissertation, a new/simple/efficient domain decomposition partitioning algorithm is proposed to break a large domain into smaller sub-domains, in such a way to minimize the number of system boundary nodes, and to balance the work load for each sub-domain. This new domain decomposition algorithm is based on the network's shortest path solution. Numerical results have indicated that the new Shortest Distance Decomposition Algorithm has outperformed the most widely used METIS algorithm in 21 out of 27 tested (transportation) examples. In the second part of this dissertation, another new/simple and highly efficient shortest path algorithm is described, for finding the shortest path from all-to-all (all source nodes to all destination nodes). This new Domain Decomposition based Shortest Path algorithm basically finds the SP from all-to-all for each sub-domain, and assembles each sub-domains' shortest path solution to correctly obtain the original (un-partitioned) network's shortest path solution. Numerical results for real-life transportation networks have shown the algorithm is much faster than the existing Dijkstra's shortest path algorithm. Finally, the Shortest Distance Decomposition Algorithm has also shown to perform better than METIS when minimizing non-zero fill-in terms of structural engineering stiffness matrices used during the finite element simultaneous linear equation solution process.