Multi-frontal multi-thread direct solver with GALOIS system for adaptive finite element method

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ABSTRACT

In this paper we present a new multi-thread multi-frontal solver desigined with the help of graph grammars and implemented in the GALOIS system [1]. The multi-frontal solver algorithm has been expressed a sequence of basic undividable tasks called graph grammar productions [2]. Next, we identify dependency relation between these tasks, and construct a dependency graph. By coloring the graph we obtain sets of tasks that can be executed in parallel over the shared memory machine. The input to the solver algorithm is an elimination tree defined on the level of mesh elements. We obtain the optimal elimination trees from dynamic programming algorithm [3] as well as from heuristic algorithm [4]. The efficiency of our multi-thread solver has been tested on a number of two and three dimensional meshes, with h refinements towards point, edge and face singularities. We also compare our solver with state of the art MUMPS solver [5, 6] interfaced with different ordering algorithm, such as nested-dissection, Approximate Minimum Degree (AMD), Approximate Minimum Fill (AMF), quasi-AMD, PORD, METIS. We also compare our solver with parallel version of the MUMPS solver. In all the considered cases we outperform MUMPS solver both in execution time, number of floating point operations (FLOPs) as well as parallel efficiency and speedup.

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