Element-by-element matrix storage-free subdomain local FE solver for domain decomposition method

†Hiroshi Kawai[1], *Masao Ogino[2], Ryuji Shioya[1], Tomonori Yamada and Shinobu Yoshimura[3]

[1]Toyo University, Japan.
[2]Nagoya University, Japan
[3]The University of Tokyo, Japan

*Presenting author: kawai063@toyo.jp
†Corresponding author: kawai063@toyo.jp

Abstract

Exa-scale supercomputers will appear around 2020–2022. To obtain high intra-node performance, efficient utilization of processor cache memory should be considered. The traditional memory access-intensive approach, which prefers less computing and more storage on main memory, might not be effective for supercomputers in near future. The Domain Decomposition Method (DDM) is one of the effective parallel finite element schemes. We have been developing an FE-based parallel structural analysis code, ADVENTURE Solid, based on DDM, with the Balancing Domain Decomposition (BDD) pre-conditioners. The re-design of the subdomain local FE solver part, which is a performance sensitive kernel in the DDM code, is required. Here in this work, an "on-cache" iterative solver based on the DDM framework is developed. The subdomain local FE solver of the DDM code is implemented using CG solvers with element-by-element matrix storage-free approaches. These iterative solvers are parallelized using OpenMP, so that each subdomain can be solved by multiple cores. By adjusting the subdomain size so that the footprint fits within the last-level cache of a processor, this DDM code can be considered as a kind of an "on-cache" iterative solver". Performance benchmark results are shown on various kinds of HPC platform having many core scalar processors, such as Skylake Xeon, Knights Landing and Fujitsu PRIMEHPC FX100.

Keywords: **Parallel Computing, Domain Decomposition Method, Subdomain Local Solver, Element-By-Element, Many Core**