Parallel FETI Solver for Modern Architectures

ESPERO Solver – esperso.it4i.cz

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Key Features of the ESPERO Library
- support FEM and BEM (using IBEM library) discretization for: Advection-diffusion, Stokes flow and Structural mechanics
- support for Ansys and OpenFOAM database file format
- Multiphysics benchmark generator for HPC scalability tests
- CAPI allows ESPERO to be used as solver library – tested with CIC ELEMS
- Postprocessing and Visualization is based on VTK library and Paraview (support for real-time visualization using ParaView Catalyst)

Massively Parallel Solver
- based on highly scalable Hybrid Total FETI Method – scales to ~18,000 compute nodes
- Support for symmetric (CG with full orthogonalization) and nonsymmetric systems (ICCG2stab, GMRES)
- supports modern many core architectures – GPGPU and Intel Xeon Phi
- contains pipelined Conjugated Gradient Solver – communication hiding
- supports hybrid parallelization in form of MPI and GIs +

Local Schur Complement Method for FETI
- Schur complement calculation is the main bottleneck of the method
- PARDISO solvers contain efficient algorithms for SC calculation (PARDISO SC and PARDISO MKL exhibit almost identical performance)

CG Solver Acceleration using Schur Complement method on Intel Xeon Phi

Two Intel Xeon Phi 7210P are 2.5 times faster than two 12 core Intel Xeon E5-2680v3 (Symmetric format for SC further improves performance).

References:

Strong Scalability Evaluation of the HTFETI Method

Test performed on ORNL, Titan (18,488 compute nodes)

Weak Scalability Evaluation of the HTFETI Method

Heat transfer (Laplace equation) – up to 124 billion DOF on 17576 nodes

Experience with Knights Landing (KNL)

Intel Xeon Phi Acceleration of the Iterative Solver

Tests performed on TInnovations Salomon Supercomputer

Heat Transfer - CG Solver Runtime w. Lumped Preconditioner solving 7.5 to 2912 million DOF

Real World Problems

Tests performed on TInnovations Salomon Supercomputer

Structure mechanics - 11 billion DOF on up to 17 576 nodes (281 216 cores) and Heat transfer (Laplace equation) - 20 billion DOF on up to 17 576 nodes