

Fully nonlinear FETI method

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We consider the Finite Element approximation of the solution to nonlinear elliptic partial differential equations such as the ones encountered in (quasi)-static mechanics or in thermal diffusion. We focus on non-overlapping domain decomposition methods allowing independent nonlinear computations on the subdomains, sometimes called “nonlinear relocalization techniques” [?]. Nonlinear counterparts to classical non-overlapping DDM have been proposed, see [?] for primal/dual/mixed approaches, [?] for FETIDP/BDDC.

Our objective is to double the intensity of the local independent nonlinear computations by proposing a nonlinear preconditioner to the system [?]. This idea applies particularly easily to the dual approach, under an hypothesis equivalent to infinitesimal strain in mechanics. When applying a Newton algorithm, one alternates a sequence of two independent nonlinear local solves (one Neumann problem and one Dirichlet problem separated by one all-neighbor communication) and an interface tangent solve which exactly has the structure of a linear preconditioned FETI problem. Academic assessments show that the sequence of two local nonlinear solves can reduce the need of global Newton iterations and thus the number of calls to the communication-demanding Krylov solver.

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References

- [1] P. Brune, M. Knepley, B. Smith, and X. Tu. Composing scalable nonlinear algebraic solvers. *SIAM Review*, 57(4):535–565, 2015.
- [2] P. Cresta, O. Allix, C. Rey, and S. Guinard. Nonlinear localization strategies for domain decomposition methods: Application to post-buckling analyses. *CMAME*, 196(8):1436–1446, 2007.

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- [3] A. Klawonn, M. Lanser, O. Rheinbach, and M. Uran. Nonlinear FETI-DP and BDDC methods: A unified framework and parallel results. *SIAM SISC*, 39(6):C417–C451, 2017.
- [4] C. Negrello, P. Gosselet, C. Rey, and J. Pebrel. Substructured formulations of nonlinear structure problems–influence of the interface condition. *IJNME*, 2016.