Parallel Filtering Algebraic Multigrid for Linear Elasticity Problems

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We present improvements of the Filtering Algebraic Multigrid (FAMG) method applied to Linear Elasticity problems. The FAMG method ([1, 2]) is an AMG method based on minimization of the two-grid correction operator

$$\|(I - PA_H^{-1}P^TA)S\| \leq C \underbrace{\|D^{1/2}(I - PR^{\text{inj}})SD^{-1/2}\|}_{\text{minimize}} \underbrace{\max_{e\neq 0} \frac{\|D^{1/2}A^{-1/2}e\|}{\|e\|}}_{\text{filter}}$$

The construction of the interpolation P is done by performing a minimization over

$$\min_P \|D^{1/2}(I - PR^{\text{inj}})SD^{-1/2}\|_F,$$

incorporating the smoother S, while requiring a filtering condition for all testvectors t_k with $\|Dt_k\| \gg \|At_k\|$ (algebraic smooth vectors):

$$(1 - PR^{\text{inj}})t_k = 0$$

The choice of the testvectors t_k is crucial. For simple diffusion problems, the testvectors only consist of the constant vector, while for linear elasticity, the rigid body modes need to be used. We present parallel results on choosing the appropriate testvector set and coarsening schemes, and a new way of generating local testvectors which combines techniques from [3] and [4].

References

[1] Wagner C.: *On the algebraic construction of multilevel transfer operators.* Computing, Vol. 65, No. 1, pp. 73–95, 2000.

[2] Nägel A., Falgout R.D., Wittum G.: *Filtering algebraic multigrid and adaptive strategies.* Computing and Visualization in Science, Vol. 11, No. 3, pp. 159–167, 2008.

[3] Brandt, A., Brannick, J., Kahl, K., Livshits, I: *Bootstrap AMG.* SIAM J. Sci. Comput., Vol. 33 Issue 2, April 2011, pp. 612–632, 2008..

[4] Henson, Van E. and Vassilevski, Panayot S.: Element-Free AMGe: General Algorithms for Computing Interpolation Weights in AMG. SIAM J. Sci. Comput., Vol. 23 (February 2001), pp. 629-650.