Asynchronous Iterative Solvers and Preconditioners

Edmond Chow [1]

Massive parallelism poses challenges to the efficient execution of preconditioned iterative solvers that rely on global synchronization or a bulk synchronous parallel model of computation. This is because any load imbalance or non-uniformity in hardware performance will cause processing units to idle at synchronization points. For example, in GMRES and other Krylov subspace iterative methods, the inner products are global synchronization points that generally involve every single processing unit in the computation.

In this talk, we will discuss using an asynchronous approach to address the above issues. One idea is to replace the outer Krylov subspace solver by an asynchronous optimized Schwarz (AOS) method, thereby removing the global synchronization and bulk synchronous requirements. Subdomain solves in the optimized Schwarz method use a preconditioned Krylov subspace method. Thus the Krylov subspace method is moved to an inner level, acting on subdomains whose sizes are chosen such that performance non-uniformities are small or can be tolerated.

Another idea is to use the distributed Southwell method as a preconditioner or a multigrid smoother. This method adaptively performs communication when necessary, and an advantage of this method is that it is naturally implemented in asynchronous fashion, in particular, with remote memory access operations.

[1]Georgia Institute of Technology, USA (echow@cc.gatech.edu)