Numerical Evaluations of Parallelization Efficiencies of Communication Avoiding Krylov Subspace Method for Large Sparse Linear System

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Abstract: In this study, an improvement technique of convergence property of Communication Avoiding (CA) Kyrlov subspace method is proposed, and parallelization efficiencies of CA Krylov subspace method is numerically investigated. As is known that most of all the procedures of the Krylov subspace method are constituted by addition of vectors, inner products and multiplication of matrices and vectors. These operations are very easy to derive a parallelization efficiency. However, the candidate coefficient matrices of linear system obtained from the numerical analysis such as Finite Element Method are large sparse matrices, and communications occur between Processing Units at short intervals in parallel calculation of inner products of vectors and multiplication of matrices and vectors. These communication times often consume more time than ordinary calculations and become a major cause of deterioration of parallelization efficiency. Although these communications have to be avoided to improve parallelization efficiency, the communication avoiding technique degrades the convergence property of the method. To improve this degradation, reorthogonalization of bases of Krylov subspace is proposed. Results of computation show that a convergence properties of the proposed method are improved. In addition, the parallelization efficiency of the proposed method is about four times faster than that of the serial method.

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