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FAST CONVERGENT IGMRES(M) ALGORITHM BASED ON FM-BEM FOR ELASTIC AND ELASTO-PLASTIC NONLINEAR SYSTEMS

Chunxiao Yu[1] and Yunfeng Mu[2]

[1]College of Science
[2]College of Information Science and Engineering
Yanshan University
Qinhuangdao 066004, P. R. China
{chxy; yfm}@ysu.edu.cn

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Abstract. *By using the truncation technology, a new fast Incomplete Generalized Minimal Residual (IGMRES(m)) algorithm based on the Fast Multipole Boundary Element Method (FM-BEM) is proposed. The convergence theory of the IGMRES(m) algorithm is well established and the related convergence theorem is presented with proof. In addition, a novel convergence analysis method that combines theoretical proof with numerical experiments is presented. Through the analysis of the influence of truncation index on the computational efficiency and precision, the IGMRES(m) algorithm has been proved to be rapidly convergent with stable process and high precision. Compared with the GMRES(m) algorithm in other related papers, the newly presented IGMRES(m) algorithm has much more excellent convergence condition and computational performances. The new IGMRES(m) algorithm and the convergence analysis method are especially suitable for the simulations of elastic and elasto-plastic frictional contact systems and other nonlinear computing systems with complicated and time-consuming iterations.*
Keywords: IGMRES(m) algorithm, Convergence, FM-BEM, Truncation index, Nonlinear system

1. **Introduction.** For the discrete elastic and elasto-plastic problems in engineering, they are usually reduced to solve the large-scale asymmetric linear equations

$$Ax = f \tag{1}$$

where A is a nonsingular coefficient matrix, x is an unknown vector of displacements and tractions, and f is a known vector formed by displacements, tractions, contact gaps, frictions, plastic stresses(for elasto-plastic systems), and other nonlinear factors. The Generalized Minimal Residual (GMRES(m)) algorithm in Krylov subspace is the most successful method to solve Eq.(1). Because of the high computing precision and efficiency, it has been widely applied in engineering [1-7]. However, it is inconvenient in the construction of Hessenberg matrix elements and Krylov vectors, because some long recursion formulations are needed. So it is necessary to establish a truncation [8,9] type GMRES(m) algorithm with excellent convergence. It is hoped that this method is easy to take measures to accelerate the convergent speed and quickly obtain the final results.

To solve the elastic and elasto-plastic problems with complicated and time-consuming iterations [10-12], the IGMRES(m) algorithm based on the FM-BEM is proposed, which could accelerate the convergence process by using the Fast Multipole Method (FMM)