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A modified Shift-splitting method for nonsymmetric saddle point problems *

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Abstract

To solve large sparse saddle point problems, based on modified shift-splitting (denoted by MSSP) iteration technique, a MSSP preconditioner is proposed. We theoretically verify the MSSP iteration method unconditionally converges to the unique solution of the saddle point problems, compute the spectral radius of the MSSP iteration matrix and estimate the sharp bounds of the eigenvalues of the corresponding iteration matrix. Numerical experiments show that the MSSP iteration method is effective and accurate.
Key words: modified shift-splitting; Krylov subspace methods; spectral property; preconditioning technique; convergence rate

1 Introduction

Consider a given, nonsymmetric, large sparse saddle point system $Ax = b$ in the following form

$$Ax = \begin{pmatrix} B & E \\ -E^T & 0 \end{pmatrix} \begin{pmatrix} u \\ v \end{pmatrix} = \begin{pmatrix} f \\ g \end{pmatrix}, \tag{1.1}$$

where $B \in \mathbb{R}^{n\times n}$ is symmetric positive definite, $E \in \mathbb{R}^{n\times m}$ $(n \geq m)$ has full column rank, $u, f \in \mathbb{R}^n$ and $v, g \in \mathbb{R}^m$. Here, E^T denotes the transpose of E.

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