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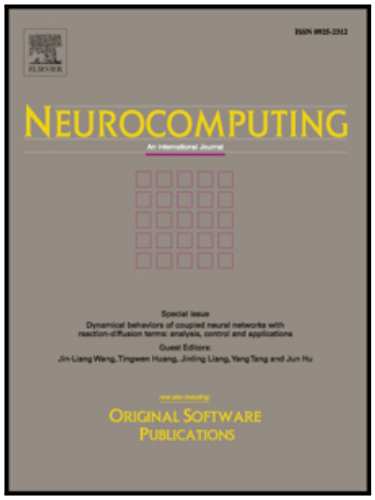

Modified discrete iterations for computing the inverse and pseudoinverse of the time-varying matrix

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Modified discrete iterations for computing the inverse and pseudoinverse of the time-varying matrix

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Abstract

The general discretization scheme for transforming continuous-time ZNN models for matrix inversion and pseudoinversion into corresponding discrete-time iterative methods is developed and investigated. The proposed discrete-time ZNN models incorporate scaled Hyperpower iterative methods as well as the Newton iteration in certain cases. The general linear Multi-step method is applied in order to obtain the proposed discretization rule which comprises all previously proposed discretization schemes. Both the Euler difference rule and the Taylor-type difference rules are included in the general scheme. In particular, the iterative scheme based on the 4th order Adams-Bashforth method is proposed and numerically compared with other known iterative schemes. In addition, the ZNN model for computing the time-varying matrix inverse is extended to the singular or rectangular case for the pseudoinverse computation. Convergence properties of the continuous-time ZNN model in the case of the Moore-Penrose inverse and its discretization are also considered.

Keywords: Zhang neural network; Inverse matrix; Moore-Penrose inverse; Multi-step methods.

AMS subject classifications: 68T05, 15A09, 65F20

1 Introduction

The hyperpower iterative family for computing generalized inverses has been investigated extensively. The most important references are [1, 2, 3, 4, 5]. These iterations possess an arbitrary order $p \geq 2$ and are defined by the standard form

$$X_{k+1} = X_k \left(I + R_k + \cdots + R_k^{p-1} \right) = X_k \sum_{i=0}^{p-1} R_k^i, \quad R_k = I - AX_k, \tag{1.1}$$

where A is the input matrix and X_k is the kth iterate of the generalized inverse.

Gradient neural network (GNN) approach is based on the Frobenius norm of an appropriate error matrix as the performance criterion and exploits a neural network dynamics evolving along the negative gradient-descent direction to force the convergence of the error norm to zero. For the time-varying case, the Frobenius norm of the error matrix cannot decrease to zero even after infinite time due to the inability of GNN models to trace changes of the input matrix in time. For this purpose, the Zhang neural network (ZNN) has been

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