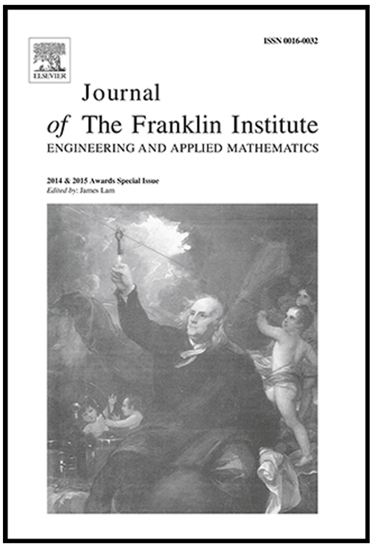

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Gradient based approach for generalized discrete-time periodic coupled Sylvester matrix equations *

Lingling Lv †, Zhe Zhang ‡, Lei Zhang§, Xianxing Liu ¶

Abstract

The paper is dedicated to solving the generalized periodic discrete-time coupled Sylvester matrix equation, which is frequently encountered in control theory and applied mathematics. The solvable condition and a iterative algorithm for this equation are presented. The proposed method is developed from a point of least squares method. The rationality of the method is testified by theoretical analysis, which shows that the algorithm can solve the problem within finite number of iterations. The presented approach is numerically reliable and requires less computation. A numerical example illustrates the effectiveness of the raised result.

Keywords: Generalized periodic Sylvester matrix equations; least squares method; iterative algorithm; heoretical analysis; numerical solutions.

1 Introduction

The linear discrete-time periodic system has received the active attention of researchers from the world over the past few decades[1–7]. The discrete-time periodic matrix equation is an important part of the analysis and design of linear discrete periodic systems, and it has also received extensive attention[8–10]. There are several existed literatures on the computing of linear time-invariant matrix equations and the analysis of linear time-invariant system(one can see [11–16] and references therein). However, there are only a few approaches to the solutions to the linear periodic matrix equations[17–19]. Cai and Hu gave an iterative algorithm in [17] for solving periodic Lyapunov matrix equations. [18] presented parametric solutions to the discrete periodic regulator equations. In addition the problem of solving periodic Sylvester matrix equations is considered in [19].

The research on coupled matrix equation has been extensively studied in recent years, for example, Ding et al consider a pair of linear matrix equations $A_1XB_1 = F_1, A_2XB_2 = F_2$ and give two iterative algorithms in [20] which are proved that the iterative solutions obtained by the proposed algorithms converge to their true values; Feng Ding establishes a gradient-based iteration for solving the coupled matrix equations $A_iXB_i = F_i, i = 1, 2, \cdots, p$ in [21] by constructing an objective function and using the gradient search; a family of iterative methods for linear systems is presented and a least-squares iterative solution to coupled matrix equations are studied in [22] by using the hierarchical identification principle and the star product; by applying a hierarchical identification principle, [23] extend the well-known Jacobi and Gauss–Seidel iterations and present a large family of iterative methods, which are then applied to develop iterative solutions to coupled Sylvester matrix equations. The similar iterative algorithms according to the least-squares principle can also be seen in [24–27].

On the basis of the research of the time-invariant coupled matrix equation, the periodic coupled matrix equation, which is widely applied in control theory and engineering, has also attracted people's attention. Among them, the periodic

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