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A STRUCTURED SCHUR COMPLEMENT METHOD FOR EFFICIENT SEARCH DIRECTION COMPUTATION IN BARRIER METHODS FOR DISCRETE-TIME OPTIMAL CONTROL

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Abstract. This paper presents an efficient numerical algorithm for solving constrained discrete-time quadratic optimal control problems. The proposed method is based on an inverse algorithm that exploits the Schur complement structure of the block matrices arising in the Karush-Kuhn-Tucker (KKT) system. By leveraging this structure, the method enables the computation of the inverse of the augmented KKT matrix without full matrix inversion, significantly reducing computational cost and memory usage. We compare the performance of the proposed algorithm with classical direct methods for solving linear systems, such as Cholesky factorization and LU decomposition, which are commonly employed for large-scale KKT systems. Numerical experiments on test problems with horizon lengths up to N=300 demonstrate that the proposed approach achieves comparable numerical accuracy while substantially improving computational efficiency and memory requirements.

Keywords. Optimal Control, Logarithmic Barrier Method, Schur Complement, Linear System, KKT System.

AMS (MOS) subject classification: 49M25, 90C51, 49M37, 65F10, 15A09.

1 Introduction

Solving linear systems is a core operation in numerous scientific and engineering disciplines. In the field of optimal control, linear systems often arise as subproblems within larger optimization frameworks. A particularly important example is the Karush-Kuhn-Tucker (KKT) system, which encapsulates the optimality conditions for constrained optimization problems, such as those encountered in logarithmic barrier methods. These methods play a critical role in interior-point algorithms used to solve constrained optimal control problems.