DOCTORAL THESIS

Numerical study on some inverse problems and optimal control problems

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ABSTRACT

In this thesis, we focus on the numerical study on some inverse problems and optimal control problems. In the first part, we consider some linear inverse problems with discontinuous or piecewise constant solutions. We use the total variation to regularize these inverse problems and then the finite element technique to discretize the regularized problems. These discretized problems are treated from the saddle-point perspective; and some primal-dual numerical schemes are proposed. We intensively investigate the convergence of these primal-dual type schemes, establishing the global convergence and estimating their worst-case convergence rates measured by the iteration complexity. We test these schemes by some experiments and verify their efficiency numerically. In the second part, we consider the finite difference and finite element discretization for an optimal control problem which is governed by time fractional diffusion equation. The prior error estimate of the discretized model is analyzed, and a projection gradient method is applied for iteratively solving the fully discretized surrogate. Some numerical experiments are conducted to verify the efficiency of the proposed method. Overall speaking, the thesis has been mainly inspired by some most recent advances developed in optimization community, especially in the area of operator splitting methods for convex programming; and it can be regarded as a combination of some contemporary optimization techniques with some relatively mature inverse and control problems.

Keywords: Total variation minimization, linear inverse problem, saddle-point problem, finite element method, primal-dual method, convergence rate, optimal control problem, time fractional diffusion equation, projection gradient method.

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