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Inversion, Estimation and Control of Uncertain Distributed Dynamical Systems

Stable sequential Pontryagin maximum principle as a tool for solving unstable optimal control and inverse problems for distributed systems

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Abstract: The report is devoted to studying the dual regularization method (see, for example, Sumin, M.I. Parametric dual regularization for an optimal control problem with pointwise state constraints. Comput. Math. Math. Phys. 2009. Vol.49. No.12, pp.1987-2005.) as applied to the parametric convex optimal control problem for controlled third boundary-value problem for parabolic equation with boundary control and with equality and inequality pointwise state constraints understood as ones in the Hilbert space L_2. Due to the presence of the parameters in the constraints of the original problem, it can be studied by applying the perturbation method. As a result, the convergence of the dual regularization method can be analyzed depending on the parameters: the relation to the differential properties of the value function, to the solvability of the dual problem, to the Lagrange principle, and to the Pontryagin maximum principle. A major advantage of the constraints in the original problem understood as ones in L_2 (or in L_p with $1 < p < 2$) is that the resulting dual regularization algorithm is stable with respect to errors in the input data and leads to the construction of a minimizing approximate solution in the sense of Warga. Simultaneously, this dual algorithm yields the corresponding necessary and sufficient conditions for minimizing sequences, namely, the stable sequential (or regularized) Lagrange principle in nondifferential form and Pontryagin maximum principle for the original problem. The main difference of the regularized Lagrange and Pontryagin maximum principles from their classical analogues is that, first, they are written in terms of minimizing sequences (rather than in terms of optimal controls) and, second, they hold for any problem of a considered kind having a solution (see, for example, Sumin, M.I. Stable sequential convex programming in a Hilbert space and its application for solving unstable problems. Comput. Math. Math. Phys. 2014. Vol.54. No.1, pp.22-44.). We underline that these regularized principles expand the applicability of their classical counterparts and discuss the expediency of their application to the analysis and solving ill-posed optimal control and inverse problems. We discuss also the relation between the regularized maximum principle and the classical one in the case when the pointwise inequality constraint of the problem (without pointwise equality constraint) are understood in the space of continuous functions C.