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Review of Dissertation Thesis

Active Adaptive Control Ing. J. Rathouský

Contents of the Thesis

The dissertation thesis contains 110 pages including 7 chapters and bibliography. It is written in English, very concisely, with a minimum number of typos or errors.

Chapter 1 introduces the notation, models, and types of optimal control strategies. It distinguishes between certainty equivalent, cautious, dual, and active adaptive control.

Chapter 2 comprises cautious LQ control derivation for ARMAX models using Kalman filter design. Parameters and states are stacked together and dynamic programming is employed to derive cautious Riccati equation.

Chapter 3 studies convergence properties of this Riccati equation both in scalar and matrix cases. It is shown that its divergence does not mean divergence of the limit cautious controller.

Chapter 4 applies the previously obtained results and deals with a single-step active adaptive controller for ARX models. Simulation results demonstrate difficulties that arise if multi-step cautious strategies would be considered.

Chapters 5 and 6 concentrate on multi-step active adaptive control where the lowest eigenvalue of the information matrix is maximised. This has influence on persistent excitation of the system and on the optimal control. Several methods are proposed: rank one, Gershgorin circles, orthogonal regressions, and ellipsoid algorithms.

Aims and New Results

The thesis aims to achieve the following goals:

1. To explore and analyse existing methods of stochastic optimal adaptive control, to investigate the current state-of-art in the domain.
2. To derive and to analyse cautious LQ controller for ARMAX models, to discuss its convergence and steady-state properties.
3. To propose novel active adaptive control algorithms.

In my opinion, these goals were fulfilled, contain new scientific results, and contribute to progress in the domain of adaptive control.

Methodology and Significance for Automatic Control

Active adaptive control can improve quality and performance of automatic control systems. Increase of its reliability as well as proofs of its theoretical properties are relevant and are of major interest both for academic community as well as for industry.

Other Remarks

Publication record includes one paper in journal with impact factor and several conference contributions, including two IFAC World congress papers. Their quality stresses the fact that they already have influenced two research groups as it is evidenced by the citations.

Questions and Comments

- Chapter 4.2: Even if the difference between the cost function value between cautious and active controllers is large, the differences between the estimated parameters are negligible both for the speed of convergences as well as for bias. Please discuss.
- Chapter 6: Is it possible that the ellipsoid algorithm removes all admissible input perturbations?
- The thesis deals mainly with singlevariable systems. What are the main obstacles for multivariable systems?

Concluding Remarks

The author of the thesis showed to have ability to formulate and treat scientific problems, and to achieve new results. The thesis fulfils all proposed aims and complies with requirements of committee for scientific degrees. Therefore, I **recommend** it for defence for PhD degree.

Bratislava, October 30, 2014.