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Soft-Computing and Learning-Based Methods for Model Predictive Control of Complex Dynamic Systém

Supervisor: Assoc. Prof. Ing. Pekař Libor, Ph.D.

Consultant: ---, ---

Department: Department of Automation and Control Engineering

Programme: Information Technologies

Abstract:

Model predictive control (MPC) represents a family of modern system optimization-based control methods. The basic principle is to solve finite horizon open-loop optimal control problems online repeatedly. Feedback is generated implicitly by only implementing the initial part of the optimized input trajectory and repeating the online optimization in the next step. MPC is widely used in practice and has many advantages, such as direct consideration of state and input constraints, applicability to nonlinear systems, or optimization of general performance criteria. However, MPC problems may be restrictive due to the computational burden when solving nonlinear optimization problems to get a control law. As an alternative, explicit MPC (eMPC) pre-computes control inputs to avoid online optimization for specific prespecified parameters. Data-driven predictive control solutions have become crucial for solving the eMPC problems during the last few years. Learning-based MPC methods use the learned system dynamic model from trajectory measurements based on adaptive MPC frameworks. When using learning-based methods, several uncertainties and robustness conditions have been added to the design. The goal of the dissertation thesis should be to investigate the use of various soft-computing and learning-based methods for their implementation in the MPC framework. The proposed techniques should overcome the computation burden when computing the optimal control action and simultaneously adjust identification for nonlinear dynamics of the controlled system model. For instance, a neural network model of the controlled plant can be combined with a metaheuristics-based solution of the constrained optimization problem of the control action computation. Sufficiently fast computation techniques can also be used in an online MPC strategy for large-scale, time-delay, or other complex systems in practice.

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