論文の要旨

Online optimization based control methods for enhancing tracking and disturbance attenuation performance of constrained systems
（制約システムの目標値追従および外乱抑圧性能向上のための実時間最適化制御手法）

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Control problems of multi-input multi-output systems under input and state constraints arises in various industrial fields. One typical way to deal with such problems is to use a linear time-invariant feedback control law which is designed so that the input and state satisfy the constraints for all possible reference signals. However, in this case, when the magnitude of the reference signal is small, control performance would be conservative, since only the small control signal is used. Similar problems arise in the case of disturbance attenuation problem. As for the control problem, various control strategies that can achieve desirable tracking and disturbance attenuation performance for a wide class of reference signals and disturbances have been proposed. The model predictive control and the reference governor are most well-known techniques to deal with control problems with constraints. In the model predictive control, an open-loop optimal control problem with constraints is resolved at each sampling time. In this approach, the computational effort required to solve the online optimization problem tends to increase rapidly with increasing the dimensions and/or the number of inputs of the controlled object. A similar problem occurs in the reference governor. The objective of this study is to develop computationally efficient control methods that achieve higher tracking and disturbance attenuation performance under input and state constraints. The contents of this thesis is summarized as follows:

In Chapter 2, we will explain definition and features of a linear matrix inequality which will be utilized as a tool for controller synthesis in this thesis.

In Chapter 3, we will present a tracking control law for a linear parameter-varying system with input constraints. Firstly, a design condition of a controller parameterized by a single scheduling parameter is introduced. The proposed controller includes an integrator to achieve the zero steady-state error in the case where a step reference signal is applied.

In Chapter 4, we will apply the control method in Chapter 3 to a torque control problem of a permanent magnet synchronous motor under input voltage limitation. We show that setpoint tracking control is achievable under the time variation of the rotor speed.

In Chapter 5, we will extend the control method in Chapter 4 so that the motor torque tracks a time-varying reference signal under input voltage limitation and the time variation of the rotor speed. The effectiveness of the method is shown by a numerical example and an experimental result.

In Chapter 6, we will show a model predictive control law for constrained linear systems in the presence of l_2 disturbances. In the proposed control method, the feedback gain and the controller state are updated online so that the l_2 gain of the system is minimized.

In Chapter 7, we will show a method for reducing computation time required to solve the optimization problem in the control algorithm of Chapter 6.

Finally, in Chapter 8, we will summarize this thesis.