THE SUMMARY OF Ph.D. DISSERTATION

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Title

A Study of Plug-in Adaptive Control for Servosystem Design

Abstract

Disturbance rejection and reference tracking problems arise frequently in many engineering fields. For such problems, servosystem design method has been generally used. The most major way to construct servomechanism for linear systems is based on the Internal Model Principle (IMP), that is, the controller has to have the poles corresponding to the frequencies of external signals and stabilize the entire feedback system.

On the other hand, new concept for servosystem design method has been proposed recently, and this method is based on Plug-in control scheme, that is, the disturbance and/or reference signal model are placed outside the existed feedback loop. Thus the disturbance rejection and the tracking are achieved in feedforward manner. Compared with IMP, the servosystem design by using Plug-in control scheme has some advantages with respect to reconstruction and maintenance of servomechanism.

In this thesis the goal is to reveal the design strategy to construct servosystems in terms of Plug-in control scheme for both linear and nonlinear systems. Moreover, in order to cope with the case that the transfer function, which describes the transmission process of disturbance, is unknown or the parameters of exosystem, which generates disturbance and reference signal, are unknown, the adaptive system is added to Plug-in control systems.

Chapter 1 says the background of this study and explains briefly the outline of adaptive control system.

Chapter 2 shows the design method of Plug-in adaptive control system for linear systems. In here, Linear Time Invariant (LTI) representation of adaptive structure is introduced. This makes it possible to combine the classical IMP with the Plug-in control scheme and then creates new servosystem design method. As a result, the complex analysis that has been needed in conventional Plug-in scheme does not appear in this method.

The design method of Plug-in adaptive control system for nonlinear systems is discussed from Chapter 3 to 5. First, the tools for stability analysis in nonlinear systems and some technical terms are briefly reviewed in Chapter 3. This chapter also explains the Nonlinear Separation Principle by which the independent design of control and estimation in nonlinear systems gets to be possible. Chapter 4 states the design method of Plug-in adaptive control system for nonlinear systems with relative degree one. Such controller is designed by reforming our problem to Error Feedback Regulation (FR) Problem, solving it and applying Nonlinear IMP, which is expansion of linear one. Chapter 5 deals with more general case, i.e. the nonlinear systems with arbitrary relative degree. The design steps are the same of the previous case until Nonlinear IMP is applied. The major difference is that the controller of this chapter is designed through the recursive design procedure. This controller, however, needs higher derivatives of the tracking error. So estimating these derivatives by using Nonlinear Separation Principle, the controller can be implemented with the tracking error only. Furthermore, Chapter 5 also proposes the design method for the situation where the matching condition, in which the disturbance comes into the system through the same channel of control input, is not assumed.

Finally, Chapter 6 summarizes what each chapter has claimed and concludes this study.