論 文 の 要 旨

題　目　Design of a Discrete-time Adaptive Output Feedback Control System based on Passivity
（受動性に基づく離散時間適応出力フィードバック制御系の設計）

氏　名　　　関　哲

　This thesis addresses the control problem of design of discrete-time adaptive output feedback control systems based on passivity, and it investigates the passivity property in linear systems as well as in non-linear systems. There are several outcomes to be clarified in terms of successful design of adaptive output feedback control systems and verification of the proposed schemes.

　The notion of passivity is a fundamental concept in control theory, yet the use of the term has varied. For LTI systems, strict passivity is equivalent to strict positive realness (SPR). It is well recognized that SPR property can be certain to stabilize adaptive control systems based on the Lyapunov function. Therefore, adaptive algorithms are able to be built and thus, the performance can be maintained in the presence of either stationary or non-stationary uncertainties. However, for real-world plants, they are hard to satisfy the SPR conditions. An alternative concept almost strict positive realness (ASPR) is emerged, yet the required conditions to be ASPR are very restrictive. As a result, the parallel feedforward compensator (PFC) is utilized to alleviate such restrictions. This thesis establishes the relationship between the PFC and the direct term d, and the causality problem in discrete-time domain is addressed as well. Additionally, a problem is concerned in terms of tracking property since the steady state error emerges when the PFC is introduced. The feedforward input is considered to deal with the steady state error, and this thesis discusses the way of generating feedforward input by only considering an integral action. Furthermore, the fictitious reference iterative tuning (FRIT) approach is introduced to optimize the PFC from the practical perspective. As a consequence, for LTI systems discussed in this thesis, there are four outcomes. The first one is the adaptive output feedback control system is successfully designed; the second one is the steady state error is removed by introducing the feedforward input; the third one is the low-order and simpler adaptive controller can be designed with the output feedback and control the system without priori information; the last one is the FRIT is succeeded in applying to the adaptive control system to optimize the PFC. These outcomes are verified through numerical simulations and experiments, which is discussed in this thesis.

　For non-linear system, the passivity is discussed in designing the adaptive control system. Since the output feedback is considered, the output feedback strictly passive (OFSP) is investigated. It is well recognized that adaptive control systems based on OFSP can achieve asymptotic stability via static output feedback. However, these conditions are very restrictive. Similarly, to the linear case, the idea of introducing PFC to alleviate those restrictions; and the steady state error is removed through the use of feedforward input. At present, researchers are yet to examine a data-driven application adaptive control system based on OFSP. As a consequence, there are two outcomes. The first one is that the steady state error is removed by adding the feedforward input; the second one is that the data-driven approach is successful used in designing an adaptive control system based on OFSP. These outcomes are verified through numerical simulations which demonstrate the effectiveness of the proposed scheme, which is discussed in this thesis.