論文題目 Networked Adaptive Control over Lossy Communication

(損失のある通信を介したネットワークド適応制御)

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This thesis is concerned with an adaptive control of a remote plant across a computer communication network with delays and losses as found in modern factory automation, robot teleoperation, remotely-operated vehicles, and so on. The control systems are assumed to be in such situations as follows: (i) the plants are equipped only with communication micro controller units which relay control signals to and from remote controllers, (ii) the control signals are delayed and sometimes lost by the communication networks, and (iii) the plants have parameter uncertainties that are hard to be known at design phases of the systems. This thesis is devoted to a design of controllers and communication protocols to attain stability of such systems. Stabilizability of the control systems depends on qualities of the communications in addition to the parameter uncertainties. Classical literatures on the adaptive control consider the parameter uncertainties, but neglect effects of the communication network which could easily destabilize the systems. To elucidate the stabilizability, this thesis introduces a measure of the communication quality based on the game theory, called sustainability, which represents temporal and periodic continuity of the communication. Based on this sustainability, we derive sufficient conditions and necessary conditions on the communications quality for the stabilizability.

In the control systems over the lossy communications, plant inputs differ from what the controllers have tried to input due to the input data losses, and the controllers can use only intermittent feedback informations because of the output data losses. These phenomena could make the systems unstable. This thesis approaches this stability problem from the aspect of a game between the controllers and the communications: (a) the uncertainties of the plants are unknown to the controllers but known to the communications, (b) the controllers do their best to identify the uncertainties and stabilize the systems, while (c) the communications try to destabilize the systems by dropping the control signals between the controllers and the plants. In this game, stability conditions correspond to restrictions on the communications. This thesis discusses the restrictions from the standpoint of the sustainability, and clarifies required minimum restrictions for detectability and stabilizability of the systems. Based on the detectability and stabilizability, we derive sufficient stability conditions by developing stabilizing adaptive controllers, and show necessary conditions by giving counter examples where any controllers can not stabilize the systems.