Decentralized supervisory system with communication delay

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15 February 2001

Keywords: descrete event system, decentralized supervisory system, communication, delay.

Discrete Event System (DES) is a system in which the state changes when an event occurs asynchronous. Although many researches have been done for the modeling and analysis of DES, there was only a little general methodology for its control.

Ramadge and Wonham proposed the supervisory control scheme which models behavior of systems using formal language theory and automata, instead of using evaluation models which is relatively hard to be analyzed. Ramadge and Wonham proposed the central control scheme in which the system is controlled by one supervisor (*controller*). In addition, they extended the scheme to the distributed control scheme in which the system is controlled by two or more controllers.

In their distributed control scheme, the communication between controller is not taken into consideration. In recent years, a distributed control scheme considering communication between controllers is proposed. The result by Barrett and Lafortune is one of them.

In their model, some events can be observed by a controller, and others cannot be observed. When a controller observes an event, it transmits the event to other controllers and each controller knows its occurrence. Each controller controls a system using the information about occurrences of events. They showed that this model could realize the same control specification as the central control scheme. Moreover, they proposed myopic controllers which uses restricted information on communication as a model between the model with communication and without communication. And they showed a necessary and sufficient condition for the system to realize a given control specification a myopic controller.

In this paper, we propose a model in which delay is introduced into the communication between controllers in distributed control systems, and analyze properties of this model.

In Chapter 2, we describe the central control scheme and the distributed control scheme proposed by Ramadge and Wonham, and show several properties of the estimate for traces computed by controllers, comparing the distributed control scheme with communication and without communication. In Chapter 3, we describe the distributed control scheme with communication proposed by Barrett and Lafortune, and the results of myopic controller with communication. Conditions necessory for the system to satisfy the control specification are controllability and observability. We can easily check controllability comparatively on a system, and can check observability is by computing the estimate for occurring traces. Therefore, we can obtain the necessary and sufficient condition for the system to satisfy a given control specification if the correct estimate is known. In Chapter 4, we propose DELAY_1 system in which communication is delayed for one event occurrence. In Chapter 5, we analyze the system in which communication is delayed for one or less event occurrence, and show that computation of becomes more difficult comparing with DELAY_1 system. Finally, we also show that trace estimates increase exponetially for the system having communication with $\text{DELAY}_{\text{K}(\text{K}\leq 2)}$ in Chapter 6.