Coordinator를 이용한 이산사건시스템의 분산관리제어

Decentralized Supervision with Coordinator of Discrete Event Systems

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Abstract— **In this paper, we introduce a conservative control approach using a full feedback map and suggest a switching control between the conservative and default control. For the conservative control, we use the coordinator which performs the conjunction operation of the full feedback map information of local supervisors. Since the switching control with the coordinator extends the ability of local supervisors in the decentralized supervisory control, we can solve the problem in case the coobservability condition can not be satisfied.**

Keywords—**conservative control, coordinator, full feedback map, decentralized control**

I. Introduction

The concept of the decentralized supervisory control has been developed in [3]-[9] within the supervisory control framework of discrete event systems introduced in [1], [2]. It is an effective control scheme for the computational complexity, the convenience of supervisor maintenance and the redesign flexibility[3]. In the decentralized supervisory control framework, control objectives are divided into several subtasks for which local supervisors are designed. Global and local specification problems have been studied under partail observation of local supervisors[3]-[6] and the fully decentralized supervisory control has been investigated in [7]-[9]. However, all these results are based on the default control[4] which is a basic control rule for the concurrent action of local supervisors. The controllability and coobservability of the given specification are the necessary and sufficient condition under the default control. In this paper, we consider the case that coobservability is not satisfied. For this problem, we introduce a conservative control of local supervisors using the full feedback map and switching control between the conservative and default control.

II. Preliminaries

The plant to be controlled is modeled by an automaton $G = (\Sigma, Q, \delta, q_0, Q_m)$ where Σ is an alphabet of event labels, Q is a set of states, $q_0 \in Q$ is an initial state, $Q_m \in Q$ is a set of marker states and $\delta : \Sigma \times Q \longmapsto Q$, a transition function, is a partial function defined at each state in Q for a subset of Σ. The language $L(G)$ and $L_m(G)$ are defined such as $L(G) := \{s | s \in \Sigma^* \text{ and } \delta(s, q_0) \text{ is defined}\}$ and $L_m(G) := \{s | s \in \Sigma^* \text{ and } \delta(s, q_0) \in Q_m\}$ respectively[1].

We consider the decentralized supervisory control with n local supervisors and let $I = \{1, 2, \cdots, n\}$ be a index set of them. Assume that $\Sigma = \Sigma_c \cup \Sigma_{uc} = \Sigma_o \cup \Sigma_{uo}$ where Σ_c (Σ_o) is a controllable(observable) and Σ_{uc} (Σ_{uo}) is a uncontrollable(unobservable) event set respectively. Σ_c is decomposed into n subsets $\Sigma_{i,c}$ $(i \in I)$ which are not necessarily pairwise disjoint. The set $\Sigma_{i,c}$ consists of events controlled by the ith local supervisor S_i. Let $P_i : \Sigma \to \Sigma_{i,o}$ $(i \in I)$ be the corresponding projection from the event set to the locally observed event set. Then the projection P_i is generalized to $P_i : \Sigma^* \to \Sigma_{i,o}^*$ as follows: $P_i(\epsilon) = \epsilon$, $(\forall s \in \Sigma^* \text{ and } \forall \sigma \in \Sigma)$ $P_i(s\sigma) = P_i(s)P_i(\sigma)$. The basic control for the concurrent action of local supervisors is the default control defined as follows[4]: S_i permanently enables all events with labels $\sigma \in \Sigma_c - \Sigma_{i,c}$. Therefore, there is no local supervisor which has priority over other local supervisors under the default control. If S_i is a local supervisor such that $S_i = ((\Sigma_{i,o}, X_i, \xi_i, x_{i,0}, X_{i,m}), \phi_i)$ then its global extension is $\tilde{S}_i = ((\Sigma, X_i, \xi_i', x_{i,0}, X_{i,m}), \phi_i')$ where $\xi_i'(\sigma, x) = \xi_i(\sigma, x)$ if $\sigma \in \Sigma_{i,o}$, $\xi_i'(\sigma, x) = x$ otherwise and $\phi_i'(\sigma, x) = \phi_i(\sigma, x)$ if $\sigma \in \Sigma_{i,c}$, $\phi_i'(\sigma, x)$ =enable otherwise [6]. Then it is known that there exist local supervisors, S_i's $(i \in I)$, which ensure to achieve the specification K such that $L(\bigwedge_{i\in I} \tilde{S}_i/G) = K$ if and only if K is controllable w.r.t. G and coobservable w.r.t. G and P_i for all $i \in I$ under the default control. Moreover, for an event $\sigma \in \Sigma_{i,c} \cap \Sigma_{j,c}$, if S_i disables it and S_j enables (permits to occur) it then σ is considered to be disabled. Hence, the coordinator which performs the conjunction operation of the feedback map information $\{0, 1\}$ received from each local supervisor is needed for the realization of the decentralized supervisory control scheme as shown in Fig. 1. We will construct a full feedback map, i.e., a feedback map of Σ_c (not only $\Sigma_{i,c}$) for each local supervisor S_i. Hence, if S_i disables all events in $\Sigma_c - \Sigma_{i,c}$ in the full feedback map (though S_i can not disable events in $\Sigma_{j,c}$ directly) then S_i can prevent other local supervisors, S_j $(i \neq j)$, from enabling events $\sigma \in \Sigma_{j,c}$ by the conjunction operation of full feedback maps between ϕ_i and ϕ_j in the coordinator. Therefore, it is possible that $\sigma_j \in \Sigma_{j,c}$ may be disabled even if S_j enables σ_j. From this point of view, we suggest a conservative control and a switching control between the