Comment on “Bisimilarity control of partially observed nondeterministic discrete event systems and a test algorithm” 1

Ratnesh Kumar, Shengbing Jiang and Changyan Zhou

Iowa State University (Ames, IA), General Motors R&D (Warren, MI), and Magnatech Inc. (East Granby, CT)
rkumar@iastate.edu, shengbing.jiang@gm.com, and changyan.zhou@gmail.com

Abstract
An article on bisimilarity enforcing supervisory control of discrete event systems was published recently in 2011, Issue 4, Volume 47, pages 782-788, of Automatica. The article introduced a certain definition of composition of plant and supervisor to define a controlled system, so as to come up with an existence condition of bisimilarity enforcing control. Such definition changes the semantics of event-based control to transition-based control, selectively disabling nondeterministic transitions. Any results reported in the paper thus raise question about practical value and applicability.

1. Definition of controlled system of [1] and its Problem

The following definition of controlled system was introduced in [1, Definition 7]: Given plant and control specification automata $G = (X, \Sigma, \alpha, x_0, X_m)$ and $R = (Q, \delta, q_0, Q_m)$, respectively (where, standardly, the 1st component is states, 2nd the events, 3rd the transition function, 4th the initial state, and 5th the final states), such that $R$ is simulated by $G$ under a simulation relation, say, $\Phi \subseteq (Q \times X)$, and a supervisor $S : L(G) \rightarrow 2^\Sigma$ that maps plant traces to event-based controls, the controlled system, $S^\Phi/G = (Y, \Sigma, \beta, y_0, Y_m)$, is defined as follows (see [1, Definition 7]):

- $Y \subseteq Q \times X$,
- $Y_m = (Q_m \times X_m) \cap Y$,
- $y_0 = (q_0, x_0)$,
- $(q, x) \in \beta(y_0, \epsilon) \iff (q, x) \in \Phi, q \in \delta(q_0, \epsilon)$
- $(q, x) \in \beta(y_0, \sigma) \iff (q, x) \in \Phi, q \in \delta(q_0, \sigma), \sigma \in S(\epsilon)$,
- $(q, x) \in \beta(y_0, s) \Rightarrow (q', x') \in \beta((q, x), \sigma)) \iff (q', x') \in \Phi, q' \in \delta(q, \sigma), \sigma \in S(s)$,

where $\sigma \in \Sigma, s \in \Sigma^*$.

To see how the above definition alters the semantics of event-based controls, suppose a plant $G$ has transitions $\{(x_0, a, x_1), (x_0, a, x_2), (x_2, b, x_3)\}$, i.e., $G$ is simply a nondeterministic choice between $a$ and $ab$. Next suppose a specification $R$ has transitions $\{(q_0, a, q_2), (q_2, b, q_3)\}$, i.e., $R$ simply is a deterministic subautomaton of $G$ that executes $ab$. Then clearly $R$ is simulated by $G$, with a simulation relation $\Phi = \{(q_0, x_0), (q_2, x_2), (q_3, x_3)\}$. Now consider a supervisor $S$ that initially enables $a$ and next enables $b$. Note as

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per the simulation relation $\Phi$, no state in $Q$ is simulated by the state $x1$, and so the controlled system cannot include any state of type $(\cdot, x1)$. Then according to the above definition of composition, the controlled system $S^\Phi/G$ has transitions $\{((q0, x0), a, (q2, x2)), ((q2, x2), b, (q3, x3))\}$, i.e., the controlled system is deterministic and identical to $R$ (expect for the state labels). Thus although $G$ has an initial nondeterministic choice on the event $a$, which is initially enabled by the supervisor $S$, the controlled system $S^\Phi/G$ no longer has the nondeterministic choice on the event $a$.

Clearly, the control is no longer event-based, rather transition-based, and able to selectively disable nondeterministic transitions (in the example, the $a$-labeled transition from $x0$ to $x1$ is disabled while the $a$-labeled transition from $x0$ to $x2$ is enabled). This is even more problematic if the event $a$ is uncontrollable since by definition any uncontrollable transition cannot be disabled.

2. Conclusion

The aim of this communique is to demonstrate that the definition of controlled system introduced in [1, Definition 7] alters the semantics of event-based control to become transition-based control, selectively disabling nondeterministic transitions (rather events). Consequently, any results about the event-based control existence and realization presented in that paper raise question about their practical value and applicability. In fact it is known that, in general, under event-based controls the complexity of bisimilarity control is doubly exponential [2], yet authors of [1] report algorithms of lower complexity.

References
