Interfaces for Control Components

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Modern software engineering heavily relies on clearly specified interfaces for separation of concerns among designers implementing components and programmers using those components. The need for interfaces is evident for assembling complex systems from components, but more so in control applications where the components are designed by control engineers using mathematical modeling tools and used by software executing on digital computers. However, the notion of an interface for a control component must incorporate some information about timing, and standard programming languages do not provide a way of capturing such resource requirements.

This talk will describe how finite automata over infinite words can be used to define interfaces for control components. When the resource is allocated in a time-triggered manner, the allocation from the perspective of an individual component can be described by an infinite word over a suitably chosen alphabet. The control engineer can express the interface of the component as an omega-regular language that contains all schedules that meet performance requirements. The software must ensure, then, that the runtime allocation is in this language. The main benefit of this approach is composability: conjoining specifications of two components corresponds to a simple language-theoretic operation on interfaces. We have demonstrated how to automatically compute automata for performance requirements such as exponential stability and settling time for the LQG control designs. The framework is supported by a toolkit, RTComposer, that is implemented on top of Real Time Java. The benefits of the approach will be demonstrated using applications to wireless sensor/actuator networks based on the WirelessHART protocol and to distributed control systems based on the Control Area Network (CAN) bus.

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