Scientific report

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1 Summary of research

Supervisory control was first introduced by people from the automatic community. System were then specified with Finite State Machines (FSM). Some operators over FSM exist to model synchronizations and parallel execution of subsystems. Given a set of FSM modeling subsystems which have to run in parallel, the computation of one unique FSM modeling the global system is needed to perform the computation of a supervisor. Unfortunately this computation is often not feasible in practice because it requires too much time and space. Finding methods in order to tackle this problem is then challenging. An interesting approach consists in finding methods to apply supervisory control, avoiding the computation of one FSM modeling the whole system. I studied this approach during my Ph.D.

During my stay in the Fraunhofer Fokus institute, I have worked to extend and apply supervisory control to a new kind of systems called Autonomic Systems. Autonomic systems are composed of distributed components which are able to self-adapt, autonomously self-organized, and control themselves together. The goal of autonomic systems is to deal with most of problems in order to provide by itself satisfactory services to the user.

Supervisory control seems to be an interesting formal tool to help autonomic systems to reach their goals. In order to be closer to system design models, the previous works were extending to a more powerful model than FSM: Extended Finite State Machines (EFSM). In particular, composition of EFSM permits to model a set of process running in parallel, each possessing a finite set of variables ranging into a possibly infinite domain, which can synchronize together and exchange informations when synchronizing.

We proved that it is possible to extend the previous works to EFSM. There is of course some limitations due to this extension. The first one is that the controlled system obtained may not possess the most permissive behavior. This is mainly due to the infinity of the considered variables domains. The second remarkable limitation concerns the interactions between the system to be controlled and the supervisor. They are indeed assume not to exchange any values. They can synchronize together on events, but the supervisor is not allowed to

take into account the values send by the system. Moreover, the supervisor is not allowed to send values to the system. Theses limitations are regrettable and require more studies in order to be tackled.

2 Publications

Accepted papers

[1] K. Schmidt, H Marchand, B. Gaudin. Modular and Decentralized Supervisory Control of Concurrent Discrete Event Systems Using Reduced System Models. 8th International Workshop On Discrete Event Systems, WODES'06, Ann Arbor, Michigan (USA). (with review comity)

Abstract

This work investigates the supervisor synthesis for concurrent systems based on reduced system models with the intention of complexity reduction. It is assumed that the expected behavior (specification) is given on a subset of the system alphabet, and the system behavior is reduced to this alphabet. Supervisors are computed for each reduced subsystem employing a modular and a decentralized approach. Depending of the chosen architecture, we provide sufficient conditions for the consistent implementation of the reduced supervisors for the original system.

[2] B. Gaudin. Efficient Solution for the State Avoidance Control Problem on Concurrent Systems using a Disjunctive Architecture. 8th International Workshop On Discrete Event Systems, WODES'06, Ann Arbor, Michigan (USA). (with review comity)

Abstract

This work investigates the problem of synthesizing supervisors which ensure some particular states of a Discrete Event System (DES) to be avoided. The systems under consideration are concurrent: they consist of several subsystems running in parallel. In this case, general supervisory control methodologies can not be applied because of complexity. The disjunctive architecture as well as a new controllability definition are here used to efficiently provide a solution to the state avoidance problem on concurrent systems.

Technical reports

[3] B. Gaudin, P.H. Deussen. Supervisory Control on Concurrent Discrete Event Systems with Variables, Research Report of the Technical University of Berlin, ISSN 1436-9915, Mars 2006.

Abstract

This work deals with the supervisory control of Discrete Event Systems (DES). Supervisory control is classically applied to systems modeled by Finite State Machine (FSM). The methods presented in this paper aim at extending previous works in order to efficiently compute supervisors which control systems modeled by concurrent Extended Finite State Machines (EFSM). The link between the classical theory and EFSM is obtained introducing the Parameterized Languages. It is then shown how this can be applied to concurrent systems, whom subsystems exchange information during the synchronizations.

Submitted papers

[4] B. Gaudin, P.H. Deussen. Supervisory Control on Concurent Discrete Events Systems with Variables. 45th Conference on Decision and Control (CDC'05), Ann Arbor (Michigan), December 2006.

Abstract

This work deals with supervisory control of Discrete Event Systems (DES). The method presented aims at extending previous works in order to efficiently compute supervisors which control systems modeled by Extended Finite State Machines running in parallel. Supervisory control is classically applied to systems modeled by Finite State Machine. The link between the classical theory and EFSM is obtained introducing the *Parameterized Languages*. It is then shown how this can be applied to concurrent systems, whom subsystems exchange information during the synchronizations.

3 Workshops and Conferences

During the fellowship, I attended to the following conference:

- 44th IEEE Conference on Decision and Control and European Control Conference ECC 2005, Seville, (Spain). 12-15 December 2005.