IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... September 2016

Editor: Hai Lin
Chair, IEEE CSS Technical Committee on DES
Associate Professor
Distributed Cooperative Systems Research (DISCOVER) Lab
Department of Electrical Engineering
University of Notre Dame
Notre Dame, IN 46556, USA

Phone: (+1) 574-631-3177
Fax: (+1) 574-631-4393
e-mail: hlin1@nd.edu
Website: http://www3.nd.edu/~hlin1/
It is the responsibility of the contributor to ensure that they have the necessary permissions/clearance required for the transmittal of their news item.

Contents:

Editorial

Welcome to the newsletter of the IEEE Control Systems Technical Committee on Discrete Event Systems!

Personal note from the editor:

WELCOME TO THE SEPTEMBER 2016 NEWSLETTER.

HAI

Activities

2.1 Sponsored Activities

2016 Conference on Decision and Control
Las Vegas, United States, Dec 12 - Dec 14, 2016
http://cdc2016.ieeecss.org/

2016 Multi-Conference on Systems and Control
Buenos Aires, Argentina, Sep 19 - Sep 22, 2016
http://www.msc2016.org/

2.2 Technically Co-Sponsored activities

==========

14th International Conference on Control, Automation, Robotics and Vision (ICARCV 2016)
Phuket, Thailand, Nov 13 - Nov 15, 2016
http://www.icarcv.org/2016

20th International Conference on System Theory, Control and Computing (ICSTCC 2016)
Sinaia, Romania, Oct 13 - Oct 15, 2016
http://ace.ucv.ro/icstcc2016/

3rd Conference on Control and Fault-Tolerant Systems (SysTol16)
Barcelona, Spain, Sep 7 - Sep 9, 2016
http://systol16.cs2ac.upc.edu/

The 35th Chinese Control Conference
Chengdu, China, Jul 27 - Jul 29, 2016
http://ccc2016.swjtu.edu.cn/

2016 IEEE Conference on Norbert Wiener in the 21st Century: Thinking Machines in the Physical World
Melbourne, Australia, Jul 13 - Jul 15, 2016
http://21stcenturywiener.org/

Selections of Journal Publications

Contributed by: Xiang Yin (xiangyin@umich.edu)

==========

SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL

VOLUME: 61 ISSUE: 9
SEPTEMBER 2016

(1) On the Equivalence of Observation Structures for Petri Net Generators

Author: Yin Tong, Zhiwu Li and Alessandro Giua

Abstract

Observation structures considered for Petri net generators usually assume that the firing of transitions may be observed through a static mask and that the marking of some places may be measurable. These observation structures, however, are rather limited, namely they do not cover all cases of practical interest where complex observations are possible. We consider in this paper more general ones, by correspondingly defining two new classes of Petri net generators: labeled Petri nets with outputs (LPNOs) and adaptive labeled Petri nets (ALPNs). To compare the modeling power of different Petri net generators, the notion of observation equivalence is proposed. ALPNs are shown to be the class of bounded generators possessing the highest modeling power. Looking for bridges between the different formalisms, we first present a general procedure to convert a bounded LPNO into an equivalent ALPN or even into an equivalent labeled Petri net (if any exists). Finally, we discuss the possibility of converting an unbounded LPNO into an equivalent ALPN.

Full-text available at: http://ieeexplore.ieee.org/document/7315019/

(2) Modeling and Control of Switched Asynchronous Sequential Machines

Author: Jung-Min Yang

Abstract

This note presents a model for switched asynchronous sequential machines (ASMs) and utilizes corrective control to solve their model matching problem. A switched ASM comprising a number of single ASMs or submachines can change its mode or the submachine in which it is operating in an asynchronous mechanism. We obtain a matrix expression for the reachability of switched ASMs, based on which we present the existence condition and design algorithm for a corrective controller that matches the stable-state behavior of the closed-loop system to that of a reference model. The corrective controller for switched ASMs provides not only control input characters but also switching signals to utilize the reachability of each submachine in generating required feedback paths. The constraint on the switching operation caused by the asynchronous mechanism is also discussed.

Full-text available at: http://ieeexplore.ieee.org/document/7336516/

(3) Distributionally Robust Counterpart in Markov Decision Processes

Author: Pengqian Yu and Huan Xu

Abstract

This technical note studies Markov decision processes under parameter uncertainty. We adapt the distributionally robust optimization framework, assume that the uncertain parameters are random variables following an unknown distribution, and seek the strategy which maximizes the expected performance under the most adversarial distribution. In particular, we generalize a previous study [1] which concentrates on distribution sets with very special structure to a considerably more generic class of distribution sets, and show that the optimal strategy can be obtained efficiently under mild technical conditions. This significantly extends the applicability of distributionally robust MDPs by incorporating probabilistic information of uncertainty in a more flexible way.

Full-text available at: http://ieeexplore.ieee.org/document/7308013/

(4) Observability of Boolean Control Networks: A Unified Approach Based on Finite Automata

Author: Kuize Zhang and Lijun Zhang

Abstract

The problem on how to determine the observability of Boolean control networks (BCNs) has been open for five years already. In this technical note, we propose a unified approach to determine all the four types of observability of BCNs in the literature. We define the concept of weighted pair graphs for BCNs. In the sense of each observability, we use the so-called weighted pair graph to transform a BCN to a finite automaton, and then we use the automaton to determine observability. In particular, the two types of observability that rely on initial states and inputs in the literature are determined. Finally, we show that no pairs of the four types of observability are equivalent, which reveals the essence of nonlinearity of BCNs.

Full-text available at: http://ieeexplore.ieee.org/document/7331273/

(5) Stabilization of Nonlinear Systems Using Event-Triggered Output Feedback Controllers

Author: Mahmoud Abdelrahim, Romain Postoyan, Jamal Daafouz and Dragan Ne?i?

Abstract

The objective is to design output feedback event-triggered controllers to stabilize a class of nonlinear systems. One of the main difficulties of the problem is to ensure the existence of a minimum amount of time between two consecutive transmissions, which is essential in practice. We solve this issue by combining techniques from event-triggered and time-triggered control. The idea is to turn on the event-triggering mechanism only after a fixed amount of time has elapsed since the last transmission. This time is computed based on results on the stabilization of time-driven sampled-data systems. The overall strategy ensures an asymptotic stability property for the closed-loop system. The results are proved to be applicable to linear time-invariant (LTI) systems as a particular case.

Full-text available at: http://ieeexplore.ieee.org/document/7332735/

==========

==========

SELECTIONS OF AUTOMATICA
VOLUME: 71
SEPTEMBER 2016

(1) Necessary and sufficient Karush–Kuhn–Tucker conditions for multiobjective Markov chains optimality

Author: Julio B. Clempner

Abstract

The solution concepts proposed in this paper follow the Karush–Kuhn–Tucker (KKT) conditions for a Pareto optimal solution in finite-time, ergodic and controllable Markov chains multi-objective programming problems. In order to solve the problem we introduce the Tikhonov's regularizator for ensuring the objective function is strict-convex. Then, we consider the c-variable method for introducing equality constraints that guarantee the result belongs to the simplex and satisfies ergodicity constraints. Lastly, we restrict the cost-functions allowing points in the Pareto front to have a small distance from one another. The computed image points give a continuous approximation of the whole Pareto surface. The constraints imposed by the c-variable method make the problem computationally tractable and, the restriction imposed by the small distance change ensures the continuation of

the Pareto front. We transform the multi-objective nonlinear problem into an equivalent nonlinear programming problem by introducing the Lagrange function multipliers. As a result we obtain that the objective function is strict-convex, the inequality constraints are continuously differentiable and the equality constraint is an affine function. Under these settings, the KKT optimality necessary and sufficient conditions are elicited naturally. A numerical example is solved for providing the basic techniques to compute the Pareto optimal solutions by resorting to KKT conditions.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0005109816301698

==========

==========

SELECTIONS OF SIAM JOURNAL ON CONTROL AND OPTIMIZATION
VOLUME: 54 ISSUE: 3
JULY 2016

(1) Distributed Linear Programming with Event-Triggered Communication

Author: Dean Richert and Jorge Cort&#65533;s

Abstract

We consider a network of agents whose objective is for the aggregate of their states to converge to a solution of a linear program in standard form. Each agent has limited information about the problem data and can communicate with other agents at discrete time instants of their choosing. Our main contribution is the synthesis of a distributed dynamics and a set of state-based rules, termed triggers, that individual agents use to determine when to opportunistically broadcast their state to neighboring agents to ensure asymptotic convergence to a solution of the linear program. Our technical approach to the algorithm design and analysis overcomes a number of challenges, including establishing convergence in the absence of a common smooth Lyapunov function, ensuring that the triggers are detectable by agents using only local information, accounting for asynchronism in the state broadcasts, and ruling out various causes of arbitrarily fast state broadcasting. Various simulations illustrate our results.

Full-text available at: http://epubs.siam.org/doi/abs/10.1137/140967106

==========

==========

SELECTIONS OF THE IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY
VOLUME: 24 ISSUE: 5
SEPTEMBER 2016

(1) Polynomially Complex Synthesis of Distributed Supervisors for Large-Scale AMSs Using Petri Nets

Author: Hesuan Hu, Rong Su, MengChu Zhou and Yang Liu

Abstract

Due to the competition for limited resources by many concurrent processes in large-scale automated manufacturing systems (AMSs), one has to resolve any deadlock issue in order to reach their production goals without disruption and downtime. Monolithic resolution is a conventional approach for optimal or acceptable solutions, but may suffer from computational difficulty. Some decentralized methods are more efficient in finding approximate solutions, but most are application dependent. By modeling AMSs as Petri nets, we develop an innovative distributed approach, which can create a trajectory leading to a desired goal and is adaptable to different kinds of applications. Control strategies are applied to processes locally such that they can proceed concurrently and efficiently. Global goals are always reachable through the local observation, control, and execution of processes without knowing external and extra information. Polynomially complex are designed to find distributed controllers.

Full-text available at: http://ieeexplore.ieee.org/document/7360905/

(2) Symbolic On-the-Fly Synthesis in Supervisory Control Theory

Author: Sajed Miremadi and Bengt Lennartson

Abstract

This paper presents an efficient synthesis algorithm and its proof of correctness for computing the controllable, nonblocking, and minimally restrictive supervisor in the supervisory control theory. Conventional synthesis algorithms are based on backward reachability computations, where blocking and uncontrollable states are

iteratively found by searching the entire state space several times until a fixed point is reached. Many unnecessary states may be visited in this kind of searching. In this paper, we present an alternative synthesis algorithm based on forward reachability, where a number of synthesis steps are performed during the reachability computations. This approach is inspired from the search techniques in Artificial Intelligence (AI) planning. To handle large-scale problems, the algorithm performs the computations symbolically based on binary decision diagrams. The algorithm has been developed, implemented, and applied to several large-scale benchmarks. It is shown that, on average, the on-the-fly algorithm is more efficient than the conventional synthesis algorithms, in particular for problems with many uncontrollable states.

Full-text available at: http://ieeexplore.ieee.org/document/7374684/

==========

==========

SELECTIONS OF THE IEEE TRANSACTIONS ON SYSTEMS, MAN AND CYBERNETICS: SYSTEMS
VOLUME: 46 ISSUE: 9
SEPTEMBER 2016

(1) Value Function Discovery in Markov Decision Processes With Evolutionary Algorithms

Author: Martijn Onderwater, Sandjai Bhulai and Rob van der Mei

Abstract

In this paper, we introduce a novel method for the discovery of value functions for Markov decision processes (MDPs). This method, which we call value function discovery (VFD), is based on ideas from the evolutionary algorithm field. VFDs key feature is that it discovers descriptions of value functions that are algebraic in nature. This feature is unique, because the descriptions include the model parameters of the MDP. The algebraic expression of the value function discovered by VFD can be used in several scenarios, e.g., conversion to a policy (with one-step policy improvement) or control of systems with time-varying parameters. The work in this paper is a first step toward exploring potential usage scenarios of discovered value functions. We give a detailed description of VFD and illustrate its application on an example MDP. For this MDP, we let VFD discover an algebraic description of a value function that closely resembles the optimal value function. The discovered value function is then used to obtain a policy, which we compare

numerically to the optimal policy of the MDP. The resulting policy shows near-optimal performance on a wide range of model parameters. Finally, we identify and discuss future application scenarios of discovered value functions.

Full-text available at: http://ieeexplore.ieee.org/document/7274364/

(2) A Continuous-Time Markov Decision Process-Based Method With Application in a Pursuit-Evasion Example

Author: Shengde Jia, Xiangke Wang and Lincheng Shen

Abstract

This paper presents a novel method—continuous-time Markov decision process (CTMDP)—to address the uncertainties in pursuit-evasion problem. The primary difference between the CTMDP and the Markov decision process (MDP) is that the former takes into account the influence of the transition time between the states. The policy iteration method-based potential performance for solving the CTMDP and its convergence are also presented. The results obtained by MDP-based method demonstrate that it is a special case of CTMDP-based method involving the identity transition rate matrix. To compare the methods, a well-known pursuit-evasion problem, involving two identical cars, is solved as a benchmark. The CTMDP-based method can provide a discretization solution that is close to the analytical solution obtained by the differential game method. Besides, it shows strong robustness against changes in the transition probability, as compared with the traditional MDP-based method. To the best of our knowledge, this is the first attempt to validate the influence of the transition time between the states in such a pursuit-evasion scenario, or in a similar application, solved by an MDP-related model. The CTMDP-based method offers a new approach to solving the pursuit-evasion problem and can be extended to similar optimization applications.

Full-text available at: http://ieeexplore.ieee.org/document/7295622/

==========

==========

SELECTIONS OF CONTROL ENGINEERING PRACTICE
VOLUME: 54
SEPTEMBER 2016

(1) Petri-net-based robust supervisory control of automated manufacturing systems

Author: Hao Yue, Keyi Xing, Hesuan Hu, Weimin Wu and Hongye Su

Abstract

Supervisory control that ensures deadlock-free and nonblocking operation has been an active research area of manufacturing engineering. So far, most of deadlock control policies in the existing literature assume that allocated resources are reliable. Additionally, a large number of methods are for systems of simple sequential processes with resources (S3PRs), where a part uses only one copy of one resource at each processing step. In contrast, we investigate the automated manufacturing systems (AMSs) that can be modeled by a class of Petri nets, namely S*PUR. S*PUR is a generalization of the S*PR Petri net model, while S*PR is a superclass of S3PR. This work addresses the robust supervision for deadlock avoidance in S*PUR. Specifically, we take into account unreliable resources that may break down while working or being in idle, and the considered AMSs allow the use of multiple copies of different resources per operation stage. Our objective is to control the system so that: 1) when there are breakdowns, the system can continue producing parts of some types whose production does not need any failed resources; and 2) given the correction of all faults, it is possible to complete all the on-going part instances remaining in the system. We illustrate the characteristics of a desired supervisor through several examples, define the corresponding properties of robustness, and develop a control policy that satisfies such properties.

Full-text available at:
http://www.sciencedirect.com/science/article/pii/S0967066116301034

==========

==========

SELECTIONS OF ASIAN JOURNAL OF CONTROL
VOLUME: 18 ISSUE: 4
SEPTEMBER 2016

(1) Abstraction-Based Verification and Synthesis for Prognosis of Discrete Event Systems

Author: Misato Yokotani, Tetsuya Kondo and Shigemasa Takai

Abstract

In this paper, we develop a theoretical framework for abstraction-based failure prognosis of partially observed discrete event systems. The purpose of using abstraction is to verify prognosability and synthesize a prognoser based on the abstracted models with fewer states and transitions. We present conditions under which prognosability can be verified and a prognoser can be synthesized based on the abstracted models of the system and the specification.

Full-text available at:
http://onlinelibrary.wiley.com/doi/10.1002/asjc.1210/full

==========

==========

SELECTIONS OF FORMAL METHODS IN SYSTEM DESIGN
VOLUME: 48 ISSUE: 1-2
APRIL 2016

(1) Decentralised LTL Monitoring

Author: Andreas Bauer and Yli﷽s Falcone

Abstract

Users wanting to monitor distributed or component-based systems often perceive them as monolithic systems which, seen from the outside, exhibit a uniform behaviour as opposed to many components displaying many local behaviours that together constitute the system﷽s global behaviour. This level of abstraction is often reasonable, hiding implementation details from users who may want to specify the system﷽s global behaviour in terms of a linear-time temporal logic (LTL) formula. However, the problem that arises then is how such a specification can actually be monitored in a distributed system that has no central data collection point, where all the components﷽ local behaviours are observable. In this case, the LTL specification needs to be decomposed into sub-formulae which, in turn, need to be distributed amongst the components﷽ locally attached monitors, each of which sees only a distinct part of the global behaviour. The main contribution of this paper is an algorithm for distributing and monitoring LTL formulae, such that satisfaction or violation of specifications can be detected by local monitors alone. We present an implementation and show that our algorithm introduces only a negligible delay in detecting satisfaction/violation of a specification. Moreover, our practical results show that the communication overhead introduced by the local

monitors is generally lower than the number of messages that would need to be sent to a central data collection point. Furthermore, our experiments strengthen the argument that the algorithm performs well in a wide range of different application contexts, given by different system/communication topologies and/or system event distributions over time.

Full-text available at:
http://link.springer.com/article/10.1007/s10703-016-0253-8

==========