IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... March 2016

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3.7 SELECTIONS from International Journal of Control, Published Online Feb and Mar 2016

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Editorial

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

Personal note from the editor:

WELCOME TO THE MARCH 2016 NEWSLETTER.

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Activities

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2.1 Sponsored Activities

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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/

2016 American Control Conference
Boston, United States, Jul 6 - Jul 8, 2016
http://acc2016.a2c2.org/

2.2 Technically Co-Sponsored activities

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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 (SysTol'16)
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/

24th Mediterranean Conference on Control and Automation (MED'16)
Athens, Greece, Jun 21 - Jun 24, 2016
http://www.med2016.org/

12th World Congress on Intelligent Control and Automation (WCICA 2016)
Guilin, China, Jun 12 - Jun 17, 2016
http://wcica2016.org/

2016 International Conference on Unmanned Aircraft Systems (ICUAS'16)
Arlington, United States, Jun 7 - Jun 10, 2016

http://www.uasconferences.com/

13th International Workshop on Discrete Event Systems (WODES 2016)
Xi'an, China, May 30 - Jun 1, 2016
http://wodes2016.diee.unica.it/

2016 5th International Conference on Systems and Control (ICSC'16)
Marrakech, Morocco, May 25 - May 27, 2016
http://lias.labo.univ-poitiers.fr/icsc/icsc2016/

14th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks
Tempe, United States, May 9 - May 13, 2016
http://www.wi-opt.org/

Selections of Journal Publications

Contributed by: Jin Dai (jdai1@nd.edu)

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Selections from the IEEE Transactions on Automatic Control
VOLUME: 61, ISSUE: 3,
MAR 2016

(1) Synthesis of Optimal Insertion Functions for Opacity Enforcement

Author: Yi-Chin Wu and St®¶phane Lafortune

Abstract

Our prior work has studied the enforcement of opacity security properties using insertion functions. Given a system that is not opaque, the so-called All Insertion Structure (AIS) is a game structure, played by the system and the insertion function, that embeds all valid insertion functions. In this paper, we first propose a more

compact AIS that can be constructed with lower computational complexity. We then introduce the maximum total cost and the maximum mean cost, and use them as quantitative objectives to solve for optimal insertion functions. Specifically, we first determine if an insertion function with a finite total cost exists. If such an insertion function exists, we synthesize an optimal total-cost insertion function. Otherwise, we construct an optimal mean-cost insertion function. In either case, we find an optimal insertion strategy on the AIS, with respect to the corresponding cost objective. The algorithmic procedures are adapted from results developed for minimax games and mean payoff games. The resulting optimal strategy is represented as a subgraph of the AIS that consists of all the system actions and the optimal insertion actions. Finally, we use this subgraph to synthesize an optimal insertion function that is encoded as an I/O automaton.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7117372&filter%3DAND%28p_IS_Number%3A7419936%29

(2) On Distributed and Parameterized Supervisor Synthesis Problems

Author: Liyong Lin, Alin Stefanescu, and Rong Su

Abstract

It is shown that the problem whether an arbitrary regular language has a non-empty decomposable sublanguage with respect to a fixed distribution is decidable if and only if the independence relation induced by the distribution is transitive. A sufficient condition on the distributed control architecture is then derived, under which there exist some fixed non-blocking local generators such that the distributed supervisor synthesis problem is undecidable. We also show that a natural formulation of the parameterized supervisor synthesis problem is undecidable for a fixed non-blocking generator template, so long as the template alphabet has at least two private events and one global event that are controllable. In particular, all the undecidability results are still valid even if star free specification languages are considered.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7128357&filter%3DAND%28p_IS_Number%3A7419936%29

(3) Nonblocking Supervisory Control of Discrete Event Systems Modeled by Mealy Automata With Nondeterministic Output Functions

Author: Toshimitsu Ushio and Shigemasa Takai

Abstract

In the conventional supervisory control framework for discrete event systems (DESs) with partial event observation, it is assumed that, for each event, the corresponding output symbol is determined uniquely. However, this assumption does not hold in DESs such as a system with sensor errors and a mobile system, where an output symbol depends on not only an event but also a state at which the event occurs. In this technical note, we model such a DES by a Mealy automaton with a nondeterministic output function. We consider a supervisor, called the anti-permissive supervisor, that assigns its control action based on an anti-permissive policy. We introduce a notion of AP-achievability to characterize a class of languages achievable by the anti-permissive supervisor, and discuss the existence of a nonblocking supervisor.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7131449&filter%3DAND%28p_IS_Number%3A7419936%29

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SELECTIONS FROM THE IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY
VOLUME: 24 ISSUE: 2
MAR 2016

(1) Robust Landing and Sliding Maneuver Hybrid Controller for a Quadrotor Vehicle

Author: David Cabecinhas, Roberto Naldi, Carlos Silvestre, Rita Cunha and Lorenzo Marconi

Abstract

This paper addresses the design and experimental evaluation of a robust controller for a quadrotor landing maneuver comprising the approach to a landing slope and sliding on that slope, before coming to a complete halt. During the critical landing flight phase, the dynamics of the vehicle change with the type of contact with the ground, and a hybrid automaton, whose states reflect the several dynamic behaviors of the quadrotor, is employed to model the vehicle throughout the complete maneuver. The quadrotor landing problem is broken down as separate maneuver generation and

robust trajectory tracking problems, which are combined to achieve a successful maneuver that is robust to possible uncertainties. The experimental results are provided to attest to the feasibility of the proposed landing procedure.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7243336&filter%3DAND%28p_IS_Number%3A7410136%29

(2) Optimal Control of Multiroom HVAC System: An Event-Based Approach

Author: Zijian Wu, Qing-Shan Jia, and Xiaohong Guan

Abstract

Building energy saving is of great practical interest due to the increasing energy consumption in buildings. The optimal control of the heating, ventilation, and air-conditioning (HVAC) systems leads to great energy saving potential. However, this problem is challenging due to the exponentially increasing state space and policy space. In this brief, we consider this important problem and make the following major contributions. First, we formulate the multiroom HVAC control problem as an event-based optimization, where decisions are made only when certain events occur. The size of the event space is significantly smaller than that of the state space. Second, to further simplify the calculation process, we develop an approximate solution method which focuses on local-event-based policies. These policies control the terminal devices in a room using solely the information in that room. Third, we demonstrate the performance of this method through two sets of numerical examples. In the small-scale two-room example, it is shown that our method can achieve a near-optimal solution. In the large-scale example, it is shown that the local-event-based approach can achieve a policy which is better than the threshold-based control method, hysteresis control method, and predictive control method.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7165607&filter%3DAND%28p_IS_Number%3A7410136%29%26pageNumber%3D2

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SELECTIONS FROM THE IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS
VOLUME 46, ISSUE 3
MAR 2016

(1) Cyberphysical Security and Dependability Analysis of Digital Control Systems in Nuclear Power Plants

Author: Chi-Shiang Cho, Wei-Ho Chung, and Sy-Yen Kuo

Abstract

The use of nuclear energy to generate electric power is crucial to meet the high energy demand of a modern economy. In newly constructed nuclear power plants (NPPs), the trend among control systems is to replace the obsolete analog hard-wired systems with the contemporary digital and cyber-based systems. Therefore, cyberphysical security as well as dependability are critical issues in safety critical NPPs. In this paper, we present different levels/layers of protection to manage cyber/physical security. We also discuss the interrelationship between cyber and physical attacks. We adopt generalized stochastic Petri nets to quantitatively evaluate the intrusion probability. We then propose a new cyberframework and show that the proposed framework not only prevents cyberattacks but also conforms to cybersecurity regulations. We also propose a physical framework to prevent potential physical attacks. Finally, we discuss dependability through three metrics, i.e., reliability, maintainability, and availability. A case study is presented to demonstrate that the proposed cyberframework is highly dependable through analyzing steady-state probabilities.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=7192645&filter%3DAND%28p_IS_Number%3A7406817%29

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SELECTIONS FROM THE IEEE Systems Journal
VOLUME 10, ISSUE 1
MAR 2016

(1) A Hybrid Systems Approach to Modeling Real-Time Situation-Awareness Component of Networked Crash Avoidance Systems

Author: Ehsan Moradi-Pari, Amin Tahmasbi-Sarvestani, and Yaser P. Fallah

Abstract
A new approach is introduced for modeling the estimation and networking processes of networked crash/collision avoidance systems (NCAS) in a single framework. An NCAS relies on real-time situation awareness, which is acquired through cooperation

with neighboring vehicles in a wireless network, to predict and respond to hazards. The subsystem that provides situation awareness consists of an estimation process and a networking/communication process. The estimation process is the source of vehicle data that is broadcast through the underlying vehicular network (communication process). The performance of vehicle tracking (estimation process) is significantly affected by the performance of the communication network because any issues in sending or receiving the information could result in erroneous position estimates and possibly crashes. It is therefore essential to produce models that allow a clear view into the dynamics of these two components. We employ probabilistic timed automata to model the networking component; a hybrid automata is then used to combine and model both networking and estimation components in a single framework. We extend the presented hybrid automata to model the broadcast network of NCAS in presence of heavy hidden node interference. We verify model accuracy by comparison with proven network simulator 3 (NS-3) simulation models; model checking for the purpose of studying some features of NCAS is also presented.

Full-text available at:
http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6805592&filter%3DAND%28p_IS_Number%3A7416301%29

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SELECTIONS FROM DISCRETE EVENT DYNAMIC SYSTEMS: THEORY AND APPLICATIONS
VOLUME 26 ISSUE 1
MAR 2016

(1) Synchronizing sequences on a class of unbounded systems using synchronized Petri nets

Author: Marco Pocci, Isabel Demongodin, Norbert Giambiasi, and Alessandro Giua

Abstract

Determining the state of a system when one does not know its current initial state is a very important problem in many practical applications as checking communication protocols, part orienteers, digital circuit reset, etc. Synchronizing sequences have been proposed in the 60° Øs to solve the problem on systems modeled by finite state machines. This paper presents a first investigation of the synchronizing problem on unbounded systems, using synchronized Petri nets, i.e., nets whose evolution is driven by external input events. The proposed approach

suffers from the fact that no finite space representation can exhaustively answer to the reachability problem but we show that synchronizing sequences may be computed for a particular class of unbounded synchronized Petri nets.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-016-0225-6

(2) A framework for compositional nonblocking verification of extended finite-state machines

Author: Sahar Mohajerani, Robi Malik, and Martin Fabian

Abstract

This paper presents a framework for compositional nonblocking verification of discrete event systems modelled as extended finite-state machines (EFSM). Previous results are improved to consider general conflict-equivalence based abstractions of EFSMs communicating both via shared variables and events. Performance issues resulting from the conversion of EFSM systems to finite-state machine systems are avoided by operating directly on EFSMs, deferring the unfolding of variables into state machines as long as possible. Several additional methods to abstract EFSMs and remove events are also presented. The proposed algorithm has been implemented in the discrete event systems tool Supremica, and the paper presents experimental results for several large EFSM models that can be verified faster than by previously used methods.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-015-0217-y

(3) Supervisory control synthesis for deterministic context free specification languages
Enforcing controllability least restrictively

Author: Anne-Kathrin Schmuck, Sven Schneider, Jorg Raisch, and Uwe Nestmann

Abstract
This paper describes two steps in the generalization of supervisory control theory to situations where the specification is modeled by a deterministic context free language (DCFL). First, it summarizes a conceptual iterative algorithm from Schneider et al. (2014) solving the supervisory control problem for language models. This algorithm involves two basic iterative functions. Second, the main part of this paper presents an implementable algorithm realizing one of these functions, namely the calculation of the largest controllable marked sublanguage of a given

DCFL. This algorithm least restrictively removes controllability problems in a deterministic pushdown automaton realizing this DCFL.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-015-0221-2

(4) Supervisory control and reactive synthesis: a comparative introduction (original article)

Author: R®πdiger Ehlers, St®¶phane Lafortune , Stavros Tripakis, and Moshe Y. Vardi

Abstract
This paper presents an introduction to and a formal connection between synthesis problems for discrete event systems that have been considered, largely separately, in the two research communities of supervisory control in control engineering and reactive synthesis in computer science. By making this connection mathematically precise in a paper that attempts to be as self-contained as possible, we wish to introduce these two research areas to non-expert readers and at the same time to highlight how they can be bridged in the context of classical synthesis problems. After presenting general introductions to supervisory control theory and reactive synthesis, we provide a novel reduction of the basic supervisory control problem, non-blocking case, to a problem of reactive synthesis with plants and with a maximal permissiveness requirement. The reduction is for fully-observed systems that are controlled by a single supervisor/controller. It complements prior work that has explored problems at the interface of supervisory control and reactive synthesis. The formal bridge constructed in this paper should be a source of inspiration for new lines of investigation that will leverage the power of the synthesis techniques that have been developed in these two areas.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-015-0223-0

(5) On-line compositional controller synthesis for AGV (original article)

Author: Johan Girault, Jean-Jacques Loiseau, and Olivier H. Roux

Abstract
This paper deals with the on-line design of a supervisor to coordinate an automated guided vehicle (AGV) fleet. This supervisor ensures the system safety (no collision) and a good coordination between vehicles (no blocking situations). It is the so-called Wonham-Ramadge supervisor, it is the least restrictive, and ensures controllability and nonblocking. We propose a compositional procedure to resolve this problem allowing an efficient on-line synthesis. A calculation on the fly is

made at every attribution of a new mission for an AGV, to actualize the supervisor and adapt it to the new situation. This compositional approach allows to increase the number of AGV taken on compared to the monolithic approach. We show on some tests the efficiency of this method for the on-line synthesis of supervisor to coordinate a fleet of mobile robots for real cases.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-015-0222-1

(6) A poisson equation for the risk-sensitive average cost in semi-markov chains

Author: Rolando Cavazos-Cadena

Abstract

This work concerns semi-Markov chains evolving on a finite state space. The system development generates a cost when a transition is announced, as well as a holding cost which is incurred continuously during each sojourn time. It is assumed that these costs are paid by an observer with positive and constant risk-sensitivity, and the overall performance of the system is measured by the corresponding (long-run) risk-sensitive average cost criterion. In this framework, conditions are provided under which the average index does not depend on the initial state and is characterized in terms of a single Poisson equation.

Full-text available at:
https://link.springer.com/article/10.1007/s10626-015-0224-z

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SELECTIONS FROM INTERNATIONAL JOURNAL OF CONTROL
PUBLISHED ONLINE FEB AND MAR 2016

(1) Event-triggered sliding mode control for a class of nonlinear systems

Author: Abhisek K. Behera and Bijnan Bandyopadhyay

Abstract

Event-triggering strategy is one of the real-time control implementation techniques which aims at achieving minimum resource utilisation while ensuring the satisfactory performance of the closed-loop system. In this paper, we address the

problem of robust stabilisation for a class of nonlinear systems subject to external disturbances using sliding mode control (SMC) by event-triggering scheme. An event-triggering scheme is developed for SMC to ensure the sliding trajectory remains confined in the vicinity of sliding manifold. The event-triggered SMC brings the sliding mode in the system and thus the steady-state trajectories of the system also remain bounded within a predesigned region in the presence of disturbances. The design of event parameters is also given considering the practical constraints on control execution. We show that the next triggering instant is larger than its immediate past triggering instant by a given positive constant. The analysis is also presented with taking delay into account in the control updates. An upper bound for delay is calculated to ensure stability of the system. It is shown that with delay steady-state bound of the system is increased than that of the case without delay. However, the system trajectories remain bounded in the case of delay, so stability is ensured. The performance of this event-triggered SMC is demonstrated through a numerical simulation.

Full-text available at:
http://www.tandfonline.com/doi/full/10.1080/00207179.2016.1142617

(2) Event-based broadcasting containment control for multi-agent systems under directed topology

Author: Kaien Liu, Zhijian Ji, Guangming Xie, and Ruiping Xu
Abstract

The event-based broadcasting containment control problem for both first-order and second-order multi-agent systems under directed topology is investigated. Based on certain event, each agent decides when to transmit its current states to its neighbours and the agents° Ø distributed control algorithms are based on these sampled state measurements, which can significantly decrease the number of the controllers° Ø updates. All the agents are divided into two groups, namely, the leaders and the followers. The formation control is introduced. The leaders exchange their information to converge to a formation. The followers utilise the information from both their leader neighbours and their follower neighbours and are driven to the convex hull of the leaders using the proposed control algorithms. Numerical simulations are provided to illustrate the effectiveness of the obtained theoretical results.

Full-text available at:
http://www.tandfonline.com/doi/full/10.1080/00207179.2016.1157899

(3) Delay-robustness in distributed control of timed discrete-event systems based on supervisor localisation

Author: Renyuan Zhang, Kai Cai, Yongmei Gan, and W. M. Wonham

Abstract

Recently, we studied communication delay in distributed control of untimed discrete-event systems based on supervisor localisation. We proposed a property called delay-robustness: the overall system behaviour controlled by distributed controllers with communication delay is logically equivalent to its delay-free counterpart. In this paper, we extend our previous work to timed discrete-event systems, in which communication delays are counted by a special clock event tick. First, we propose a timed channel model and define timed delay-robustness; for the latter, a verification procedure is presented. Next, if the delay-robust property does not hold, we introduce bounded delay-robustness, and present an algorithm to compute the maximal delay bound (measured by number of ticks) for transmitting a channelled event. Finally, we demonstrate delay-robustness on the example of an under-load tap-changing transformer.

Full-text available at:
http://www.tandfonline.com/doi/abs/10.1080/00207179.2016.1147606

(4) Decentralised consensus for multiple Lagrangian systems based on event-triggered strategy

Author: Xiangdong Liu, Changkun Du, Pingli Lu, and Dapeng Yang

Abstract

This paper considers the decentralised event-triggered consensus problem for multi-agent systems with Lagrangian dynamics under undirected graphs. First, a distributed, leaderless, and event-triggered consensus control algorithm is presented based on the definition of generalised positions and velocities for all agents. There is only one triggering function for both the generalised positions and velocities and no Zeno behaviour exhibited under the proposed consensus strategy. Second, an adaptive event-triggered consensus control algorithm is proposed for such multi-agent systems with unknown constant parameters. Third, based on sliding-mode method, an event-triggered consensus control algorithm is considered for the case with external disturbance. Finally, simulation results are given to illustrate the theoretical results.

Full-text available at:
http://www.tandfonline.com/doi/full/10.1080/00207179.2015.1118663

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