IEEE CONTROL SYSTEMS SOCIETY TECHNICAL COMMITTEE ON DISCRETE EVENT SYSTEMS

Newsletter..... January 2018

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Contents:

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Editorial

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

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Activities

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2.1 Sponsored Activities

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2018 American Control Conference
Milwaukee, Wisconsin, United States, June 27–29, 2018
http://acc2018.a2c2.org/

2018 Conference on Control Technology and Applications
Copenhagen, Denmark, August 21-24, 2018
http://ccta2018.ieeecss.org/

2018 Conference on Decision and Control
Miami Beach, FL, USA, December 17-19, 2018
https://cdc2018.ieeecss.org/

2.2 Technically Co-Sponsored activities

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2018 SICE International Symposium on Control Systems
Tokyo, Japan, March 9-11, 2018
http://iscs2018.sice-ctrl.jp/

The 14th Workshop on Discrete Event Systems
Sorrento Coast, Italy, May 30 - June 1, 2018
http://wodes2018.unisa.it/

30th Chinese Control and Decision Conference (2018 CCDC)
Shenyang, China, June 9-11, 2018
http://www.ccdc.neu.edu.cn/

2018 International Conference on Unmanned Aircraft Systems
Dallas, TX, USA, June 12-15, 2018
http://www.uasconferences.com/

37th Chinese Control Conference (CCC2018)
Wuhan, China, July 25-27, 2018
http://ccc2018.cug.edu.cn/

23rd International Conference on Methods and Models in Automation and Robotics
Międzyzdroje, Poland, August 27-30, 2018
http://mmar.edu.pl/

22nd International Conference on System Theory, Control and Computing
Sinaia, Romania, October 10-12, 2018
http://www.icstcc.ugal.ro/2018/

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Selections of Journal Publications

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

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SELECTIONS OF THE IEEE TRANSACTIONS ON AUTOMATIC CONTROL
VOLUME: 63 ISSUE: 1
JANUARY 2018

(1) Mode-Target Games: Reactive Synthesis for Control Applications

Author: Ayca Balkan ; Moshe Vardi ; Paulo Tabuada

Abstract

In this paper, we introduce a class of linear temporal logic (LTL) specifications for which the problem of synthesizing controllers can be solved in polynomial time. The new class of specifications is an LTL fragment that we term Mode Target (MT) and is inspired by numerous control applications where there are modes and corresponding (possibly multiple) targets for each mode. We formulate the problem of synthesizing a controller enforcing an MT specification as a game and provide an algorithm that requires O(∑itin2) symbolic steps, where n is the number of states in the game graph, and ti is the number of targets corresponding to mode i.

Full-text available at: http://ieeexplore.ieee.org/document/7967684/

(2) Complexity of Infimal Observable Superlanguages

Author: Tomáš Masopust

Abstract

The infimal prefix-closed, controllable, and observable superlanguage plays an essential role in the relationship between controllability, observability, and co-observability—the central notions of supervisory control theory. Existing algorithms for its computation are exponential and it is not known whether a polynomial algorithm exists. We answer the question by studying the state complexity of this language. State complexity of a language is the number of states of its minimal deterministic finite automaton (DFA). For a language with state complexity n, we show that the upper bound state complexity on the infimal prefix-closed and observable superlanguage is 2n+1 and that this bound is asymptotically tight. Hence, there is no algorithm computing a DFA of the infimal prefix-closed and observable superlanguage in polynomial time. Our construction shows that such a DFA can be computed in time O(2n). The construction involves nondeterministic finite automata (NFAs) and a computation of the supremal prefix-closed sublanguage. We study the computation of supremal prefix-closed sublanguages and show that there is no polynomial-time algorithm computing an NFA of the supremal prefix-closed sublanguage of a language given as an NFA even if the language is unary.

Full-text available at: http://ieeexplore.ieee.org/document/7962165/

(3) A Finite Convergence Criterion for the Discounted Optimal Control of Stochastic Logical Networks

Author: Yuhu Wu ; Tielong Shen

Abstract

Stochastic logical networks (SLNs) are discrete-time stochastic dynamical systems with Boolean (or multivalued) logical state variables. The discounted infinite horizon optimal control problem for SLN is addressed in this paper. By resorting to the equivalent Markov decision process description, the infinite horizon optimization problem is presented in algebraic form. Then using the increasing-dimension technique, an improved finite convergence criterion, which can find the optimal stationary policy, is derived for value iteration approach. To demonstrate the theoretical value of this approach, it is applied to the optimization problems of the human–machine game and the p53-Mdm2 gene network.

Full-text available at: http://ieeexplore.ieee.org/document/7962159/

(4) Distributed Event-Based State Estimation for Networked Systems: An LMI Approach

Author: Michael Muehlebach ; Sebastian Trimpe

Abstract

In this paper, a dynamic system is controlled by multiple sensor-actuator agents, each of them commanding and observing parts of the system's input and output. The different agents sporadically

exchange data with each other via a common bus network according to local event-triggering protocols. From these data, each agent estimates the complete dynamic state of the system and uses its estimate for feedback control. We propose a synthesis procedure for designing the agents' state estimators and the event triggering thresholds. The resulting distributed and event-based control system is guaranteed to be stable and to satisfy a predefined estimation performance criterion. The approach is applied to the control of a vehicle platoon, where the method's tradeoff between performance and communication and the scalability in the number of agents are demonstrated.

Full-text available at: http://ieeexplore.ieee.org/document/7962159/http://ieeexplore.ieee.org/document/7974794

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SELECTIONS OF AUTOMATICA
VOLUME: 87
JANUARY 2018

(1) Symbolic reachability analysis and maximally permissive entrance control for globally synchronized templates

Author: Liyong Lin, Alin Stefanescu, Weilin Wang, Rong Su, W. MurrayWonham

Abstract

This paper studies the symbolic reachability relations of a class of parameterized systems in the framework of regular model checking. The modules of each system are instantiated from a globally synchronized template, and each globally synchronized template is represented by a finite state automaton whose event set consists of global events and local events. It is shown that the symbolic reachability relations of these systems are effectively iteration-closed star languages. And for any iteration-closed star language, there exists a template with only global events that realizes it. Application of the symbolic reachability analysis to computing the entrance control functions that enforce deadlock freeness and blocking freeness is then illustrated for systems with idle modules. In particular, we show that the maximally permissive entrance control functions can be encoded using finite state automata.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817305150

(2) Symbolic reachability analysis and maximally permissive entrance control for globally synchronized templates

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Abstract

This paper studies the symbolic reachability relations of a class of parameterized systems in the framework of regular model checking. The modules of each system are instantiated from a globally synchronized template, and each globally synchronized template is represented by a finite state automaton whose event set consists of global events and local events. It is shown that the symbolic reachability relations of these systems are effectively iteration-closed star languages. And for any iteration-closed star language, there exists a template with only global events that realizes it. Application of the symbolic reachability analysis to computing the entrance control functions that enforce deadlock freeness and blocking freeness is then illustrated for systems with idle modules. In particular, we show that the maximally permissive entrance control functions can be encoded using finite state automata.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817305150

(3) Deadlock characterization and control of flexible assembly systems with Petri nets

Author: Keyi Xing, Feng Wang, Meng Chu Zhou, Hang Lei, Jianchao Luo

Abstract

Efficient deadlock controllers are critical in the operation of automated manufacturing systems. This work focuses on a deadlock control problem for flexible assembly systems (FAS). Petri nets are used to model the systems. Through their liveness analysis, it characterizes two kinds of structural objects. Each object can lead to a siphon, and may cause the system to deadlock. Based on such objects, a necessary and sufficient condition about the liveness of Petri net models is obtained. In order to prevent each such object from causing FAS to deadlock, a Petri net controller is designed such that its induced siphon cannot be empty. The conjunction of all these controllers is proved to be capable of ensuring deadlock-free operation of a large class of FAS. The effectiveness of the proposed approach is shown via an FAS example.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0005109817304703

(4) Model-free event-triggered control algorithm for continuous-time linear systems with optimal performance

Author: Kyriakos G.Vamvoudakis， Henrique Ferra

Abstract

This paper proposes a new model-free event-triggered optimal control algorithm for continuous-time linear systems. The problem is formulated as an infinite-horizon optimal adaptive learning problem, and we are able to simultaneously address the issue of designing a control and a triggering mechanism with guaranteed optimal performance by design. In order to provide a model-free solution, we adopt a Q-learning framework with a critic network to approximate the optimal cost and a zero-order hold actor network to approximate the optimal control. Since we have dynamics that evolve in continuous and discrete-time, we write the closed-loop system as an impulsive model and prove asymptotic stability of its equilibrium. Numerical simulation of an unknown unstable system is presented to show the efficacy of the

proposed approach.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S000510981730136X

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SELECTIONS OF IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING
VOLUME: 15 ISSUE: 1
JANUARY 2018

(1) Integration of Learning-Based Testing and Supervisory Control for Requirements Conformance of Black-Box Reactive Systems

Author: Huimin Zhang ; Lei Feng ; Naiqi Wu ; Zhiwu Li
Abstract

While cryptography is used to protect the content of information (e.g., a message) by making it undecipherable, behaviors (as opposed to information) may not be encrypted and may only be protected by partially or fully hiding through creation of ambiguity (by providing covers that generate indistinguishable observations from secrets). Having a cover together with partial observability does cause ambiguity about the system behaviors desired to be kept secret, yet some information about secrets may still be leaked due to statistical difference between the occurrence probabilities of the secrets and their covers. In this paper, we propose a Jensen–Shannon divergence (JSD)-based measure to quantify secrecy loss in systems modeled as partially observed stochastic discrete event systems, which quantifies the statistical difference between two distributions, one over the observations generated by secret and the other over those generated by cover. We further show that the proposed JSD measure for secrecy loss is equivalent to the mutual information between the distributions over possible observations and that over possible system status (secret versus cover). Since an adversary is likely to discriminate more if he/she observes for a longer period, our goal is to evaluate the worst case loss of secrecy as obtained in the limit over longer and longer observations. Computation for the proposed measure is also presented. Illustrative examples, including the one with side-channel attack, are provided to demonstrate the proposed computation approach.

Full-text available at: http://ieeexplore.ieee.org/document/7930430/

(2) Event-Based Supervisory Control for Energy Efficient Manufacturing Systems

Author: Yang Li ; Qing Chang ; Jun Ni ; Michael P. Brundage

Abstract

It becomes more and more critical for manufacturing enterprises to improve energy efficiency because of

the escalating energy prices, increasing global competitions, and more rigorous government regulations. In this paper, a systematic method is developed to improve the energy efficiency of a multistage manufacturing system through production control. The method aims at reducing energy consumption with minimal negative impact on production. We start from the analysis of system dynamics and develop quantitative methods to estimate energy saving opportunities. A supervisory control algorithm is developed to improve system energy efficiency by periodically taking the saving opportunities. Simulation case studies are performed to validate the effectiveness of the control algorithm.

Full-text available at: http://ieeexplore.ieee.org/document/7517231/

(3) Census Signal Temporal Logic Inference for Multiagent Group Behavior Analysis

Author: Zhe Xu ; A. Agung Julius

Abstract

In this paper, we define a novel census signal temporal logic (CensusSTL) that focuses on the number of agents in different subsets of a group that complete a certain task specified by the STL. CensusSTL consists of an “inner logic” STL formula and an “outer logic” STL formula. We present a new inference algorithm to infer CensusSTL formulas from the trajectory data of a group of agents. We first identify the “inner logic” STL formula and then infer the subgroups based on whether the agents’ behaviors satisfy the “inner logic” formula at each time point. We use two different approaches to infer the subgroups based on similarity and complementarity, respectively. The “outer logic” CensusSTL formula is inferred from the census trajectories of different subgroups. We apply the algorithm in analyzing data from a soccer match by inferring the CensusSTL formula for different subgroups of a soccer team.

Full-text available at: http://ieeexplore.ieee.org/document/7587357/

(4) Revised Test for Stochastic Diagnosability of Discrete-Event Systems

Author: Jun Chen ; Christoforos Keroglou ; Christoforos N. Hadjicostis ; Ratnesh Kumar

Abstract

This paper provides revisions to the algorithms presented by Chen et al., 2013 for testing diagnosability of stochastic discrete-event systems. Additional new contributions include PSPACE-hardness of verifying strong stochastic diagnosability (referred as A-Diagnosability in Thorsley et al., 2005) and a necessary and sufficient condition for testing stochastic diagnosability (referred as AA-Diagnosability in Thorsley et al., 2005) that involves a new notion of probabilistic equivalence.

Full-text available at: http://ieeexplore.ieee.org/document/7463534/

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SELECTIONS OF CONTROL ENGINEERING PRACTICE
VOLUME: 70
JANUARY 2018

(1) Sensitivity analysis and sensitivity-based design for linear alarm filters

Author: Ying Xiong, Yindi Jing, Tongwen Chen

Abstract

This paper conducts sensitivity analysis and sensitivity-based design for linear filter alarm monitoring systems. Based on a derivative-based local sensitivity measure, models are proposed to assess the sensitivity of the system detection errors to changes in the trip point and to uncertainties in the collected data. Then, analytical expressions are derived to quantitatively evaluate the sensitivity of a general linear alarm filter with unknown data distributions. Subsequently, a new sensitivity-based linear filter design method is formulated to minimize a weighted sum of the detection errors subject to upper bounds on the system sensitivities. Extensive simulations with both Gaussian and industrial data are conducted to verify the analytical results and to show trade-offs between the detection errors and sensitivities of linear filter alarm system.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0967066117302162

(2) A decentralized control strategy for the coordination of AGV systems

Author: Maria Pia Fanti, Agostino M.Mangini, Giovanni Pedroncelli, Walter Ukovich

Abstract

This paper deals with the complex problem of controlling and coordinating Autonomous Guided Vehicles (AGV) by a decentralized approach. Each AGV selects its route by a consensus algorithm based on some Integer Linear Programming problem solutions. Moreover, the AGVs move inside a zone-controlled guidepath network and coordinate their movements by a decentralized protocol based on a zone-controlled approach, which guarantees the avoidance of deadlocks and collisions. The proposed decentralized strategy is applied to a guidepath network by means of a simulation software.

Full-text available at: http://www.sciencedirect.com/science/article/pii/S0967066117302253
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